Quantum Energetics Volume 1: Theory of Superunification

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Abstract

[This work is dedicated] to the quantum theory of Superunification written in 1996-2000 and published in English in England (2010) and India (2011). The Theory of Superunification (SU) is the Unified Field Theory (UFT) or the Theory of Everything (TE), which physicists around the world are trying unsuccessfully to create, ignoring the fact that the Superunification theory was created 20 years ago. The theory of Superunification is a theory of quantum gravity that logically completes Einstein's general theory of relativity (GR). The theory of Superunification is the first quantum theory of relativity (QR). The theory of Superunification is based on the discovery of a new universal particle the quantum of space-time (quanton), as a particle of dark matter. Quanton was discovered by Vladimir Leonov in 1996. The dynamic interferometer Leonov in 2020 was the first to detect the field of quantons as dark matter particles. The theory of Superunification has been confirmed experimentally. This is a sensational scientific breakthrough that brings fundamental physics out of its deepest crisis. The elastic dark matter tissue is presented by us as a four-dimensional quantized space-time consisting of quantons. This is the global static electromagnetic field of the Universe, which is the carrier of the superstrong electromagnetic interaction (SEI) - the fifth fundamental force (Superforce). Electromagnetism and gravitation are manifestations of the SEI field perturbation. Electromagnetism is the result of the electromagnetic polarization of quantized space-time. Gravity is the result of spherical deformation of the elastic dark matter tissue. The mass of particle (body) is like a nodule inside the elastic dark matter tissue in the form of a lump (cluster) of its deformation energy. Gravitational well appears around the body's mass inside the elastic tissue of dark matter as a result of its spherical deformation. Gravitational well is the physical basis of gravity and the principle of relativity. In this case, the gravitational field is described by the deformation vector D inside the elastic dark matter tissue as a gradient of the quantum density (p) of the medium D = grad (p). The force of gravity F is the gradient F = gradW of the dark energy W. The accelerated run of galaxies from the center of the Universe under the action of the force F = gradW is possible only for an inhomogeneous spherically deformed Universe.

Contents

Preface

At the very beginning of 1996 I was lucky enough to discover purely theoretically the quantum of space-time, named subsequently as the quanton. This was preceded by 30 years of continuous meditations regarding nature of electromagnetism and then gravity.

The discovery of the quantum of space-time was immediately followed by the discovery of the superstrong electromagnetic interaction (SEI) - the fifth force, which was the subject of search by physicists throughout the entire 20th century.

It is gratifying that I was not lonely in this search. In 1985 the book ‘Superforce. The search for a grand unified of theory of nature’ by the outstanding English theoretical physicist Paul Davies, was published. Actually, in order to combine the four known forces of nature (electromagnetism, gravity, nuclear and electro-weak forces) it is necessary to have a fifth force in the form of a superforce. Only the superforce can subordinate weaker forces, including nuclear. This is the gold rule of mechanics. There is iron logic in this.

The very idea of the Superforce was brilliant in its basis. Paul Davies anticipated events, and it remained only to realise the idea of the Superforce in the form of superstrong electromagnetic interaction. This was the concretisation of the general theoretical idea to a concrete physical category.

The fundamental discoveries of the quantum of space-time (quanton) and superstrong electromagnetic interaction served as a basis of the creation of the theory of Superunification of fundamental interactions which is the subject of the first volume of this book. The theory of Superunification reveals the united nature of electromagnetism, gravity, nuclear and electro-weak forces as different manifestations of superstrong electromagnetic interaction.

In order to be objective, it is necessary to note that the creation of the theory of Superunification was helped by the colossal work of a large number of physicists both theoretical and experimental, throughout the entire 20th century, and in previous centuries, starting with Newton. To me it remained to only generalise their work, after cleaning darnel from seeds.

New ideas are important in physics and such ideas were advanced by brilliant minds. First of all, it is the concept the idea of the unified field of Albert Einstein, directed to the integration of electromagnetism and gravity. In his work Einstein had time to combine space and time into the united substance the space-time, carrier of which, as it has now been established, is the quantum of space-time (quanton). Quantum theory has been expanded by the real quantisation of space-time. It was possible to prove that the law of relativity is the fundamental property of the quantised space-time, uniting the quantum theory and the theory of relativity. But space-time itself is a united carrier of electromagnetism and gravity. This is the unquestionable experimental fact, observed everywhere. The very ideas of the unified field and Superforce proved to be equivalent on the road to the integration of interactions.

The concept of the electromagnetic nature of gravity was first advanced by Michael Faraday who attempted to prove this experimentally. In spite of the failure of his experiments, he was confident that he was right. It is also necessary to give due credit to H. Lorentz, who assumed that there is a special medium – the carrier of electromagnetic energy which is the carrier of all known forces (interactions). This it was also the threshold of the fifth force. But in this case Lorentz erroneously connected this medium with the hypothesis of gas-like aether whose insolvency was confirmed in the experiments by Michaelson and Morley. These are the paradoxes of history.

When I started work on the creation of the theory of Superunification, theoretical physics operated with greatly differing concepts as fundamental length, the Dirac magnetic monopole, quantisation, super-strings, quarks, symmetry, and others. I realised that from the viewpoint of the united positions all these separate physical concepts must be connected together. In my hands I had the quantum of space-time (quanton) and superstrong electromagnetic interaction. These were strong arguments for the correctness of the selected direction of studies. Ideas hanged in the air and the course of events was no longer dictated by me but by theory. It was hit in the purpose. Everything rapidly fitted into proper places and a clear picture of the universe appeared. The human mind is far more powerful than the finest and most sensitive apparatus and is capable of penetrating into areas where such instruments are powerless. This concerns the region of the ultra-micro world of quantons at lengths of the order of 10^{-25} m. This is exactly where the fundamental length, Dirac's monopole, superstrings and quarks have found shelter.

The theory of Superunification could not be created without the use of the brilliant concept of quarks - the initial building blocks of the universe. In the theory of Superunification the concept of quarks from quantum chromodynamics (QCD) was transferred from the structure of hadrons to the structure of the quantised space-time. Specifically, the quantum of space-time (quanton) consists of quarks. All the contradictions of QCD are thus removed.

Further, it was quite easy to determined the structure of the proton and the neutron and define the nature of nuclear forces and the mechanism of the formation of mass of elementary particles.

Instead of three fractional quarks in the structure of hadrons, the quanton as the quantum of space-time, includes four whole quarks: two electrical (+1*e* and -1*e*) and two magnetic (+1*g* and -1*g*), uniting electricity and magnetism in the united substance - electromagnetism. This is the first stage on the road to integration, missed by theoretical physicists. The presence of whose elementary electric charges is not doubted by anybody, in contrast to the fractional charges. The effects which are attributed to the indirect manifestation of fractional charges are unconvincing, and they can be explained by other approaches.

As far as the magnetic quarks (Dirac's monopoles) are concerned, their reality does not fit the fundamental nature of the laws of electromagnetism and Maxwell equations. Dirac was the first who began to search for the relationship between the electrical and magnetic charges. Unfortunately, his solution $g = 68.5e$ proved to be erroneous and is corrected in the theory of Superunification. On the basis of the analysis of Maxwell's equations for the vacuum $g = Ce$, where C is the speed of light in vacuum. The relationship $g = Ce$ (or $C = g/e$) determines symmetry between electricity and magnetism, the general carrier of which is the quanton. And on the contrary, applying the perturbation method to the quanton, the analytical conclusion of Maxwell's equations was obtained for the first time, explaining the nature of electromagnetism and vacuum.

The problem of symmetry and asymmetry is connected with the structure of the quantised space-time. The electromagnetic symmetry of the quanton is confirmed by the symmetry of Maxwell's equations in vacuum. This was already indicated by Heaviside, reducing Maxwell's equations in vacuum to the symmetrical form and defining bias currents by the reality of displacement from the equilibrium of electrical and magnetic charges in vacuum. For more than a century Heaviside's foresight remained a hypothetical assumption. In the theory of Superunification the reality of the electrical and magnetic bias currents is confirmed by the quantised structure of space-time. The procedure of calculation of real bias currents proved to be not so complex. I would like to note that real electromagnetic, yes even gravitational phenomena, are characterised by very small displacements of charges inside the quanton from the equilibrium state.

It has been established that quantised space-time itself is electrically asymmetric, i.e., besides quantons it includes a certain surplus of electrical quarks (whole electrical monopoles). Specifically, the electrical asymmetry of quantised space-time determines the entire variety of living and inanimate nature. The variety of only four quarks was required to create our universe. These four quarks (two electrical and two magnetic) are connected inside the quanton. Calculations show that in nature there are no forces capable of splitting the quanton into separate quarks. Free magnetic charges are absent for this reason in nature.

But still there are two excess electrical quarks, not connected inside the quanton. Specifically, these two excess quarks determine the electrical asymmetry of the quantised structure of space-time. Because of their presence there is a material (ponderable) matter generating gravity. In this plan Einstein's idea about the nature of gravity as the real distortion of the quantised space-time found its confirmation before the theory of Superunification.

It has been established that gravity appears as a second formation inside the quantised space-time. Gravity begins with the generation of mass in elementary particles. This is observed quite clearly in the generation of mass in the electron (positron). Actually, if we throw the entire electrical quark (elementary electric charge) into the quantised space-time, then under the action of the ponderomotive forces the quantons are pulled to the central electrical perturbing charge, compressing the quantised medium near the charge and extending it on departure. The quantised space-time is spherically bent (deformed) around the perturbing charge and the charge acquires its mass, degenerating into the electron. In fact, the masses, in the understanding of the material world, as is today accepted, simply do not exist in nature.

This was the first blow of the theory of Superunification to the established dogmas. The realization of the fact that you do not have a mass and you are the structure of the bent space-time, being the composite and indissoluble part of the universe, causes a shock. It already happened in the past. So, for example, all saw, that the Sun does rise and then goes down and the Earth seem by the motionless centre of the universe. Actually has appeared that the Earth rotates around of the Sun. This idea now accepted by everything centuries was forbidden. But even our more educated century is far away from perfection. It is not so simple to accept that isolated objects do not exist in nature. The theory of Superunification opens for us the realias of the open quantum-mechanical systems, including man.

The fact that the mass, as the carrier of gravity, is secondary and is manifested by the special state of superstrong electromagnetic interaction inside the quantised space-time, explains the nature of wave-particle duality. It is completely logical that the mass transfer in space is the wave transfer of the spherical deformation of the quantised space-time around the perturbing charge in the electron (positron) or a group of charges in nucleonss. The principle of wave-particle duality is the fundamental property of the quantised space-time when the particle simultaneously shows corpuscular and wave properties.

So it turned out that the analytical derivation of the classical wave equations of particles during their motion in the quantised space-time is not so difficult. The wave mass transfer of particles is the basis of wave (quantum) mechanics. With the discovery of the quantum of space-time (quanton) and the quantised structure of space-time, the quantum theory changes from probabilistic to deterministic. This is what Einstein insisted in endless arguments with Bohr ('God does not play dice'). The theory of Superunification is the quantum theory of the open quantum-mechanical systems.

The theory of Superunification investigates the properties of space-time in the range 10^{25}…0…10^{-25} m, from the dimensions of the quanton, i.e. 10^{-25} m, to the dimensions of the universe - 10^{25} m, and it is today the most powerful analytical apparatus for investigating the matter. It is gratifying that the structure of the basic elementary particles has been discovered by purely theoretical approaches: electron, positron, proton, neutron, electronic neutrino, photon. This alone has made it possible to save huge means on the construction of superaccelerators. I would like to mention that no accelerator has made this possible. This is the clear manifestation of the power of the theory of Superunification.

It is natural that the nuclear forces, based on the united positions of the theory of Superunification, are also the form of the manifestation of superstrong electromagnetic interaction. Quantum chromodynamics (QCD) did not connect the parameters of nucleons with their mass. However, the quark models of nucleons is one of the achievements of QCD. In order to connect the quark model of the nucleon with the formation of the nucleon mass, it was necessary to understand the nature of gravity. In these terms, the nucleon must be capable of the spherical deformation of quantised space-time, i.e., it must know how to bend it (according to Einstein). This is possible only in one case, if the electrical whole quarks with both positive and negative polarity, form the alternating shell of the nucleon. Only this alternating shell is capable of being compressed, compressing the quantised space-time inside the shell and extending it from the outside, forming the nucleon mass.

On the other hand, the electric field of the alternating shell is a short-range field. Specifically, this short-range field ensures the operation of Coulomb attracting forces over a very short distance corresponding to the action of nuclear forces. As a result, the nuclear forces are reduced to the electrical interaction of the alternating shells of nucleons. This is the logic of Superunification when all forces, in the final analysis, are reduced down to electromagnetism. In this case the complete compensation of electrical charges (quarks) of positive and negative polarity in the neutron shell ensures its electrical neutrality. The presence of the uncompensated charge of positive polarity in the proton shell determines its charge.

However, the theory of strong interactions would be incomplete without the calculation of the antigravitational repulsion of the alternating shells of nucleons over distances shorter than the action of nuclear forces. This ensures the stability of nucleons, preventing their collapse and also the collapse of atomic nuclei. Like gravity, antigravity is also widespread in nature. The action of antigravity like that of gravity is determined by the bending (deformation) of quantised space-time. This determines the action of gravitational force on mass. Based on the position of quantum theory, the direction of gravitational force is given by the gradient of the quantum density of the medium, i.e., by nonuniform distribution of the quantons in the volume inside the quantised space-time. In one case this is the manifestation of gravity forces, in another case of antigravity repulsion.

With interaction of two protons at a large distance they experience the Coulomb repulsion of the charges of positive polarity. With the contact approach of the alternating shells, the Coulomb attraction of the alternating charges of the proton shells exceeds the Coulomb repulsion of the positive uncompensated charges. Further approach of the nucleon shells is limited by their antigravity repulsion, determining the complex nature of nuclear forces. The undoubted achievement of the theory of Superunification is the detection of the zones of antigravity repulsion in nucleons.

Without considering antigravity it is not possible to explain the accelerated galactic recession in our universe. Our universe is bent and its quantum density gradient of the medium is directed from the centre down to the periphery, ensuring the acceleration of galaxies and their recession from the centre of the universe. Outwardly this resembles the antigravity repulsion of galaxies from the central core of the universe, causing an illusion that this nucleus consists of antimatter. Calculations show that the bending of quantised space-time even in the conditions of strong acceleration, is so insignificant that it is not possible to determine it by contemporary astronomical instruments. Therefore, for the astronomer-observer our universe appears to be flat.

The unjustified hopes for the superstring theory found their new embodiment in the theory of Superunification where the quantons can be considered as structural formations locked by power strings. In this case, real infinite electromagnetic superstrings formed by the quantons can be observed in quantised space-time. This has made it possible to calculate the colossal tension of the elastic quantised medium (EQM) which is the quantised space-time.

In this brief preface to volume 1 it is not possible to clarify all problems of the theory of Superunification and show its possibilities. Therefore, I present here for comparison two lists of the key problems of contemporary physics: 'Ginzburg's list' and 'Leonov's list'. The first list of 30 points presented by Nobel laureate Vitalius Ginzburg in a review paper "On some advances in physics and astronomy over the past three years' published in the Russian journal Uspekhi Fizicheskikh Nauk (volume 172, No. 2, 2002, pp. 213-219)

'Ginsburg's list':

1. Controlled thermonuclear fusion
2. High-temperature and room temperature superconductivity
3. Metallic hydrogen. Other exotic substances
4. Two-dimensional electronic liquid
5. Some questions of solid state physics
6. Second order phase transitions
7. Physics of surface. Clusters
8. Liquid crystals. Ferroelectrics. Ferrotoroics
9. Fullerenes. Nanotubes
10. Behavior of matter in superstrong magnetic fields
11. Nonlinear physics. Turbulence. Solitons. Chaos. Strange attractors
12. Rasers, grasers, superpowerful lasers
13. Superheavy elements. Exotic nuclei
14. Mass spectrum. Quarks and gluons. Quantum chromodynamics. Quark- gluon plasma
15. The unified theory of weak and electromagnetic interaction. $W^{\pm}$-Z^{0}-bosons. Leptons.
16. Standard model. Great integration. Superunification. Proton decay. Neutrino mass. Magnetic monopoles.
17. Fundamental length. Interaction of particles at high and superhigh energies. Colliders.
18. Nonconservation of SR- invariance.
19. Nonlinear phenomena in vacuum and in superstrong electromagnetic fields. Phase transitions in vacuum.
20. Strings. M-theory.

21. Experimental verification of the general theory of relativity.
22. Gravity waves, their detection.
23. Cosmological problem. Inflation. Λ-term and ‘quintessence’.
24. Neutron stars and pulsars. Supernova.
25. Black holes. Space strings (?).
26. Quasars and the nuclei of galaxies. Formation of galaxies.
27. Problem of dark matter (hidden mass) and its detection.
28. Origin of cosmic rays with the superhigh energy.
29. Gamma splashes. Hypernovas.
30. Neutrino physics and astronomy. Neutron oscillations.

Analyzing the Ginzburg list we cannot find there the causal problems of fundamental interactions:

1. In the region of gravity. The reasons for gravity and inertia *are unknown*.
2. In the region of electromagnetism. The carrier of electromagnetism *is unknown*. Maxwell's equations are recorded purely empirically and, until now, do not have analytical derivation.
3. In the field of physics of elementary particles. The structure of none of the elementary particles, including the basic particles: electron, positron, proton, neutron, photon, neutrino, is known The reason for the formation of mass in particles *is unknown*.
4. In the field of nuclear physics. The nature of nuclear forces and reason for the mass defect of the atomic nucleus as the basis of energy release, *is unknown*.

It is gratifying that all problems of physical science enumerated above are solved in the theory of Superunification, which is the most powerful analytical apparatus for a study of matter.

When Ginzburg composed his list, he did not know of the theory of Superunification. In order to consider the possibilities of the theory of Superunification and new fundamental discoveries of the quanton and the superstrong electromagnetic interaction, I have compiled an additional ‘Leonov’s list’ of also 30 new problems in order to enlarge ‘Ginszburg’s list’.

‘Leonov’s list’:

1. Primary matter, the quantum of space-time, the zero element, the discrete structure of quantised vacuum, quantisation. Superstrong electromagnetic interaction (SEI). Theory of the elastic quantised medium (EQM).

2. Electrical and magnetic monopoles. Electrical asymmetry of the universe.
3. Alternating fields, infinite superstrings and their tension.
4. Time as the material category of space-time. Chronal fields.
5. Spherical invariance and the principle of the relative-absolute dualism of the quantised space-time.
6. Quantum theory of relativity. Nonlinear relativity.
7. Absolute velocity. Methodology of measurement. Resistance of vacuum to uniform motion and to motion with acceleration.
8. The theory of united electromagnetic field (TUEF) and Superunification, the open quantum-mechanical systems.
9. Quantum nature of gravity. Solution of Poisson's equation for the spherically deformed vacuum. Nature of mass. Gravitational diagrams, well and hill. Mass defect.
10. Balance of gravitational potentials, quantum density and energy.
11. Wave transfer of substance and wave-particle duality. Nature of wave (quantum) mechanics.
12. Structure of electron and positron. Zones of attraction and repulsion.
13. Spin and mass. Equivalence of energy and mass.
14. Alternating shells of nucleons. Nature of nuclear material and nuclear forces. Complex structures of elementary particles. Formation of heavy nuclei. Atomic structures, valence bonds, the stability of molecules. New materials. Fullerenes. Clusters. Electron-positron plasma. Ball lightning.
15. Maximum parameters of relativistic particles.
16. Structure of neutrino. Speed, energy and direction distributions of the neutrino. Methods of registration. Energy-information interactions. Field structure of the DNA. Protection from fluxes of space neutrinos.
17. Derivation of Maxwell's equations. Nature of magnetism, electricity and electromagnetism. Electromagnetic symmetry of vacuum.
18. Non-radiation of the orbit electron inside the gravitational well of the atomic nucleus. Perpetual motion. Electron motion in vacuum without emission. Nature of superconductivity. Photon electron emission.
19. The two-rotor structure of the photon. Wave trajectory of the photon in optical media. Retarding the linear speed of the photon.
20. Faster-than-light speeds. Tachyons. Kozyrev waves.
21. Free energy, the methods of release. Quantum energetics.
22. Temperature of substance. Heat capacity. Quantum thermodynamics. Open quantum thermodynamics systems.

23. Cold synthesis of particles and antiparticles. Usherenko effect. Quantum reactors.
24. Creation of nonequilibrium force in vacuum. The Searl effect. Quantum engines. Perpetual motion machines (?).
25. Wave processes in vacuum. Longitudinal gravity waves. Veinik waves. Torsional oscillations of vacuum.
26. Nonlinear energy phenomena in liquid. Cavitation heating. Quantum heat-generators.
27. Antimatter and antigravity. Black and white holes.
28. Model of the quantised universe and its latent energy. Space curvature.
29. Relaxation of the universe and the motion of galaxies with acceleration.
30. Circulation and the conservation of global energy. Problem of eternity.

I do not comment on the two lists, I simply present them for comparison. The readers have the possibility to study theory of Superunification in greater detail. I would like to mention only that the new fundamental discoveries and the theory of Superunification have high applied value, opening the prospects for quantum energetics - power engineering of the 21st century, which includes both the known power cycles (chemical and nuclear reactions), and fundamentally new ones. I also would like to state that the superstrong electromagnetic interaction is the sole energy source of the universe and everything else, including nuclear reactions, are only methods of extracting the energy of this interaction. Our task is to learn to master for the good of the civilization new ecologically safe power cycles, relying on the great opportunities of the theory of Superunification and new experimental facts. This will be described in the second volume of the book: Quantum Energetics, vol. 2. New energy and space technologies. Before then, I would be happy if the theory of Superunification becomes the property of the world scientific community.

1

Fundamental discoveries of the space-time quantum (quanton) and superstrong electromagnetic interaction (SEI)

1.1. The need for introducing the space-time quantum into physics

Fundamental science has accumulated a sufficiently large amount of knowledge to support the very fact of the discovery of the space-time quantum (quanton) and superstrong electromagnetic interaction (SEI). The concept of Superunification was formulated by physicists. Many physicists do not doubt that electromagnetism, gravitation, nuclear and electroweak forces are the manifestation of the united origin. The concept of the unified field was formulated by Einstein and he devoted 30 years to the development of this concept in the path to unification of gravitation and electromagnetism. He succeeded within the framework of the general theory of relativity (GTR) to combine space and time into the single space-time substance. Already at the end of his life, Einstein concluded that it is necessary to use discrete approaches to the problem of space-time and unification of the interactions within the framework of quantum theory.

There are various approaches to solving these problems in theoretical physics. This also concerns the problem of unification. We can go along the path of finding some universal formula (or a set of formulas) describing the fundamental interactions by mathematical methods, or along the path of finding a universal unifying particle. The alternate path was less attractive to investigators because physics did not know such a particle and the possibilities of discovering this particle were not clear. However, this second approach has been selected in the path to unification of interactions. This also determined the logics and expected success.

The positive example provided by Einstein in the path of unification of space and time created completely new possibilities in theoretical physicist. However, progress has been made only in the geometrisation of gravitation. The physicists require new particles for further development of the theory. Therefore, the physicists started to study the theory of quarks and quantum chromodynamics (QCD) and the strings theory. However, these are hypothetical objects and experimental verification requires colossal amounts of energy. Naturally, the concept of finding new particles which would solve the given physical problem has also become attractive for the theory of Superunification.

However, can we think that there is only one universal unifying particle forming the basis of all known interactions? Primarily, physics is an experimental science and if a new particle is introduced to theoretical physicists, this would require experimental confirmation. Naturally, in the area of physics of elementary particles this confirmation can only be indirect. Nobody has ever held even the well-known electron. Its charge and mass were measured by indirect methods. However, prior to these measurements, it was necessary to justify the reality of the electron.

In this respect, the discovery of the quanton started with the realisation of its reality. The concept of the space-time having a structure and a structure that is finer than that of the atomic matter, was around throughout the entire 20th century. The mechanistic gas-like aether was rejected by physics on the basis of experiments carried out by Michaelson and Morley. However, which other matter determines the structure of cosmic vacuum, if it cannot be observed in experiments? In particular, the structure of vacuum remained a grey area in science, delaying the development of physics and Superunification theory.

Nevertheless, experimental snags were encountered and they related to the symmetry of Maxwell equations in a vacuum. Electricity and vacuum magnetism in an electromagnetic wave manifested themselves completely equivalently to the same extent and simultaneously.

Figure 1.1 of the electromagnetic wave in vacuum shows that the electrical and magnetic fields (vectors $\mathbf{E}_x$ and $\mathbf{H}_y$) exist and change in the direction of speed **C** together and simultaneously, without any phase shift with respect to time. The vectors $\mathbf{E}_x$ and $\mathbf{H}_y$ are only orthogonal to each other in space, but in time they exist at the same time. This is an undisputed experimental fact. However, how shall we interprete it? In order to justify the independence of the electromagnetic wave which appears not to need its own carrier, theoretical physicists have ignored experimental facts. According to their views, the propagation of the electromagnetic wave in vacuum is due to the fact that the electric field generates the magnetic

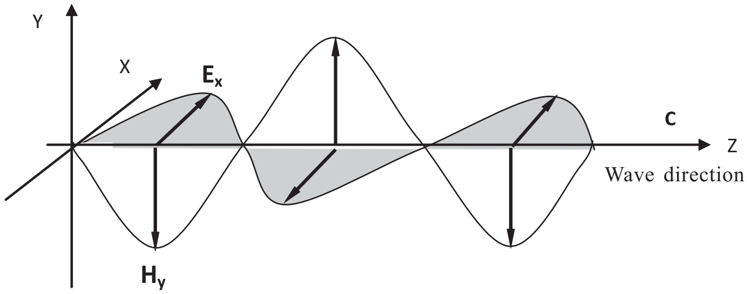

Fig. 1.1. Electromagnetic wave in vacuum with transverse polarisation of the quantised space-time.

field and vice versa. However, this is only possible in one case if there is a phase shift with respect to time between the variations of the electric and magnetic fields of the wave. In experiments, the phase shift with respect to time has not been observed. In transformers the phase time shift does occur but the theory of the transformer cannot be transferred in mechanically to the electromagnetic wave in vacuum.

This was the first snag in the path of experimental substantiation of the suggestion that the cosmic vacuum has a structure which is a carrier of electromagnetism. Figure 1.1 shows that electromagnetism exists as an independent category which links simultaneously electricity and magnetism into a single substance. This means that electricity in the electromagnetic wave does not generate magnetism and vice versa. Magnetism and electricity in the electromagnetic wave appear and change simultaneously. This experimental fact can be explained only by having its own independent carrier of electromagnetism which belongs to space vacuum or, more accurately, to the quantised space-time.

The unification of electricity and magnetism into a single substance – electromagnetism – is the first stage in the path of unification of interactions from which the Superunification theory starts. This first stage of unification was missed. Further development of the Superunification theory is not possible without the first stage of unification.

In order to be more convincing, attention should be given to the fact that rotors of the electrical and magnetic fields have not been detected in the electromagnetic wave in vacuum. Try to introduce rotors into the graph in Fig. 1.1. Nothing will happen and the graph will be destructed. This means that in a vacuum the rotor of the electrical field does not generate the rotor of the magnetic field, and vice versa. It would seem that the theory of electromagnetism was completed at the beginning of the 21st century. However, discrepancies between theory and experiments cast doubts on the suggestion that the theory of electromagnetism is complete. Electromagnetism requires an intrinsic carrier, like electricity the electrical charge, and magnetism the magnetic charge.

If the situation regarding the electrical charge was sufficiently explained, problems remained with the magnetic charge. The magnetic charge has not been detected by experiments in the free state. Magnetism is evident only in a combined dipole form. This is an experimental fact. Thus far the theory combined the appearance of electromagnetism with dynamic electricity i.e., with current, the independence of the magnetic charge was a secondary problem. However, this does not represent a scientific approach to the problem when the causality of the phenomenon is rejected and in principle the reason for the phenomenon should occupy the first place. It appears that due to the incomprehensible topology of space, the electrical current generates magnetism. To eliminate unnecessary questions, it is essential to know the topology and structure of space-time. The origin of magnetism then becomes clear. One does not have to be clairvoyant in order to see that magnetism belongs to vacuum only, i.e., to the quantised space-time.

However, if magnetism belongs only to quantised space-time, then electricity, because of the symmetry of Maxwell equations in vacuum, should also belong to the vacuum. Space vacuum in the concept of quantised space-time must be the carrier of magnetism and electricity at the same time, i.e., it must be the carrier of electromagnetism, independent substance showing its electromagnetic properties. In the introduction, we already mentioned the electrical asymmetry of the quantised space-time when the manifestation of electricity does not have the form connected with the structure of the quanton.

Thus, analysis of the current state of the theory of electromagnetism and theoretical discrepancies with the experimental facts logically bring the physics to the introduction of an independent carrier of electromagnetism. For this purpose, it is necessary to combine electricity and magnetism into a single substance whose carrier is, as indicated later, the quanton – the space-time quantum.

The suggestion that the quanton is a real particle, carrier of electromagnetism in vacuum, is confirmed indirectly by all electromagnetic processes taking place in vacuum. Vacuum behaves as an electromagnetic medium which shows electrical and magnetic properties in polarisation. For example, the dielectric medium in electrical polarisation shows its dielectric properties and is characterised by dielectric permeability. The magnetic medium in magnetic polarisation shows its magnetic properties and is characterised by magnetic permeability. Naturally, the processes of electrical and magnetic polarisation take place through the vacuum which represents the unifiedd electromagnetic medium and is characterised by electrical and magnetic parameters (constants ε_0 and μ_0).

The capacity of vacuum for electromagnetic polarisation enables us to describe the structure of the quanton. In the equilibrium state, this should be an electrically and magneto-neutral particle whose electrical and magnetic properties become evident when the electrical and magnetic equilibrium is disrupted, i.e., in electromagnetic polarisation. This is possible in one case only, if the quanton includes two dipoles – electrical and magnetic, linking electricity and magnetism into a single substance. However, to obtain two dipoles included in the structure of the quanton, we must have electrical and magnetic charges of positive and negative polarity forming the dipole.

Thus, the realias of the magnetic charge, as the electrical charge, have been reflected in the structure of the quanton which will be described in detail in the next chapter. The initial building blocks are referred to as quarks. These are massless particles having no mass and acting only as charge carriers. To form a quanton, one must have only four quarks, i.e., four elementary charges: two electrical ($+1e$ and $-1e$) and two magnetic charges ($+1g$ and $-1g$). To connect electricity and magnetism inside a quanton into a single substance it is necessary to introduce the superstrong electromagnetic interaction (SEI), with the quanton being the carrier of this interaction. The electromagnetic substance cannot exist without the realias of SEI.

Figure 1.2 shows schematically the structure of a quanton, including four quarks separated by different shading and denoted by: electrical (+ and –) and magnetic (*N* and *S*). The particle which includes all four charges – quarks, is an electromagnetic quadrupole, not known previously in the theory of electromagnetism. As shown later, the electromagnetic perturbation of the quadrupole (quanton) as a result of its electromagnetic polarisation forms the basis of all electromagnetic phenomena. The quanton represents the field form of weightless matter, being the carrier of electromagnetism and superstrong electromagnetic interaction.

Figure 1.3 show schematically the structure of the quantised space-time as a result of electromagnetic quantisation with filling of the volume with quantons. In the equilibrium state it is a neutral medium having electrical and magnetic properties which become evident as a result of electromagnetic perturbation (polarisation). These processes are discussed and described mathematically in detail in the following chapter. The quantons, having the capacity of bonding together through the charges with opposite signs, form an elastic quantised medium (EQM) being the carrier of superstrong electromagnetic interaction.

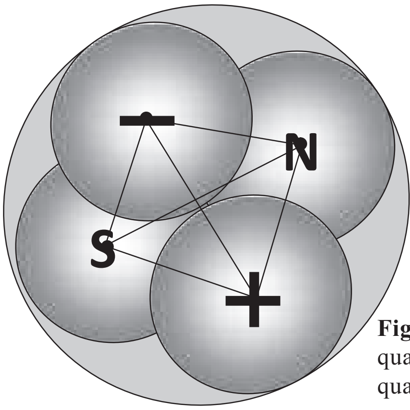

Fig. 1.2. Schematic representation of the space-time quantum (quanton) in the form of an electromagnetic quadrupole.

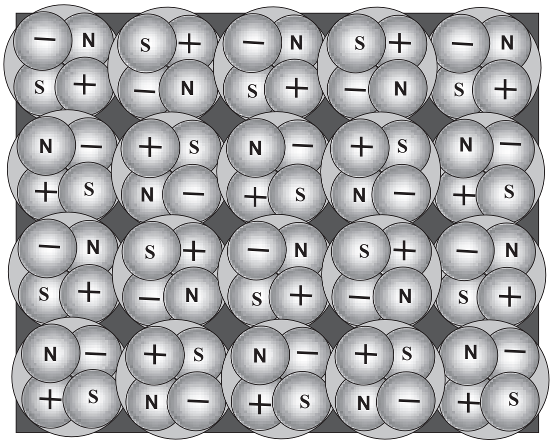

Fig. 1.3. Schematic representation of the structure of quantised space-time as a result of electromagnetic quantisation.

Now it becomes clear that the quanton is the universal particle, not only the carrier of electromagnetism, but also the carrier of space-time, occupying a specific volume. Time itself is enclosed in the quantum, which is a cavity electromagnetic resonator, defining the rate of motion to the three-dimensional clock. The clock ticks at every point of space. Naturally, in compression of the quantum the rate increases and in extension it decreases. This was already substantiated by Einstein who determined the slowing down of time in the region of strong gravitational fields associated with the tensioning of quantons in the external region of the deformed space-time. Gravitation forms during deformation (distortion according to Einstein) of quantised space-time, as the secondary manifestation of the superstrong electromagnetic interaction.

Thus, the introduction of the quantum of space-time (quanton) to physics enabled the realisation of the first stage of unification of electricity and magnetism into an independent substance, i.e., electromagnetism, and consequently represent the quanton as the carrier of time and space as a result of its electromagnetic quantisation. This was followed by the discovery that the quanton is also the carrier of gravitation which is manifested as a result of the deformation (distortion) of the quantised space-time. Both gravitation and electromagnetism are also based on the superstrong electromagnetic interaction.

No mathematical calculations have been mentioned so far because it is important, although briefly, to describe the declarative concept of the unification of gravitation and electromagnetism on the path to the Superunification theory through the introduction of an unifying particle – the space-time quantum (quanton). It was found that the quanton is actually the universal unifying particle and as shown by all theoretical and experimental facts, the quanton does not contradict these facts thus providing the scientistwith a powerful tool for study of matter.

1.2. Main problems on the path to the Superunification theory

1.2.1. Problem of energy levels

The introduction into theoretical physics of the space-time quantum (quanton) as the unifying particle, being the base of the Superunification theory, required revision of a number of assumptions regarding the problem of world creation. The development of elementary particle and atomic nucleus physics showed that when going into the depth of atomic matter, we are concerned with the colossal increase of energy concentration. In this respect, the quantised space-time is not an exception. However, if the dimensions of atomic matter do not exceed 10^{-15} m, the dimensions of the quanton are ten orders of magnitude smaller ($\sim 10^{-25}$ m). This means that the quantised space-time is a concentrator of colossal superenergy, the carrier of superstrong electromagnetic interaction. It has been possible to determine more accurately the energy levels in vacuum, assuming that the cosmic vacuum has the maximum energy level accepted as the starting point in counting. All the remaining energy levels are connected for the sake of their reduction relative to the energy level of vacuum, strictly observing the energy hierarchy and the laws of energy conservation.

1.2.2. Problem of motion

Figure 1.3 show schematically the structure of the quantised space-time densely filled with quantons. As already mentioned, this is the field form of weightless matter. However, it resembles more the solid state structure with colossal tension. Therefore, the main problem on the path to the theory of Superunification has been the solution of the problem of motion of a solid (particle) in a superhard and superelastic medium. This motion cannot take place from the viewpoint of classic mechanics.

However, the quantum theory breaks all the usual stereotypes. From the viewpoint of classic mechanics, the solid (particle) is an isolated object.. In the theory of Superunification, as quantum theory, in accordance with the principle of corpuscular-wave dualism all the particles (solids) represent open quantum-mechanical systems, being a continuous and integral part of the quantised space-time. The mass of the particle is regarded as the domain of the spherically deformed space-time. Consequently, the transfer of the mass of the particle in the quantised medium should be regarded as the wave transfer of spherical deformation of quantised space-time. This approach provides clear information on the motion as a complex quantum exchange process, describing the wave transfer of mass in the superhard and superelastic quantised medium.

1.2.3. Problem of mass

From the classic viewpoint, the mass is the basis of matter. Paradoxically, the quantum theory also breaks this stereotype, showing that mass is only spherical deformation of quantised space-time, i.e., its distortion (according to Einstein). The energy of spherical deformation is the equivalent of mass. This is the electromagnetic energy of the superstrong electromagnetic interaction. Simply, the mass is expressed in other measurement units. Therefore, in liquidation of mass, for example in annihilation processes, the elastic energy of spherical deformation of the quantised space-time changes to the photon radiation energy.

1.2.4. Problem of relativity

The formation of the mass of a particle as a result of spherical deformation of quantised space-time has enabled the formulation of the principle of spherical invariance, extended to any object having mass. The quantised space-time, having colossally high elastic properties, is a unique medium whose properties are not similar to any of the material media (gas, liquid, solid, plasma). Only the quantised space-time retains the spherical symmetry of its deformation around the elementary particle in the entire speed range, including relativistic speeds. To an exterior observer it appears that the given sphere is compressed in the direction of motion. However, this is only a reaction to relative measurement.

It has been established that the speed of light in the quantised medium changes with the variation of the gravitational potential. In accordance with the spherical deformation principle, the gravitational field of the Earth retains its form, irrespective of the speed of motion, retaining the variation of the gravitational potential in individual directions. This means that there is no difference in the variation of the speed of light in the direction of movement of the Earth and across this direction. This was also observed in the experiments carried out by Michaelson and Morley who, in fact, justified by experiments the principle of spherical invariance in accordance with which the principle of relativity is the fundamental property of quantised space-time.

Thus, the problems of energy, motion, mass and relativity are the main problems, breaking the stereotypes of classic mechanics, and they have been solved during the development of the theory of Superunification described in the following chapters.

The space-time quantum, as shown schematically in Fig. 1.2, was discovered of January 10, 1996. This was a fundamental discovery together with the subsequent discovery of the superstrong electromagnetic interaction (SEI) which was then used as the basis for the theory of Superunification.

To provide more information regarding the theory of Superunification, I now present the popular science article ‘The universe: Boiling ‘bouillon’ of quantons’, published on the Internet. More information on the theory of Superunification can be found in the following chapters.

1.3. The universe: Boiling ‘bouillon’ of quantons

1.3.1. Introduction

In my studies, the problems of cosmology are considered only indirectly because the main direction of investigations had been the development of the theory of Superunification of fundamental interactions: gravitation, electromagnetism, nuclear and electroweak forces, and also investigations of the physics of elementary particles (their structure) as open quantum-mechanical systems. The applied field of research is the development of new energy and cosmic technologies, gravitational communication channels.

At the same time, the development of the theory of Superunification enables new knowledge to be applied to inflationary cosmology. I should mention that the well-known Russian physicist Andrei Dmitrievich Linde works in this area at the Stanford University in the USA [1–4]. In particular, his lecture 'Inflation, quantum cosmology and anthropic principle', delivered at the conference devoted to the 90 years birthday of the well-known theoretical physicist John Wheeler, has been used as the starting point for my comments in the area of quantum cosmology. It appears that the inflationary theory may be also useful in describing the quantisation of the universe at the moment of its birth.

In particular, attention should be given not only to differences but also to finding general approaches to cosmology which link together the inflationary and quantum theory. In fact, Andrei Linde outstripped time, regarding inflation as expansion of the universe (or of its individual fragments, or a set of universes) at the moment of its origin when there were no single elementary particles.

Inflation resembles to me the process of growth of a beautiful rose from a small indivisible seed assuming that up to this moment, the information on the rose had been stored in the double DNA helix. After all, this is a very rough although colourful comparison, taking into account the fact that we do not know all mechanisms of the blooming of the rose, to say nothing of the universe.

Nevertheless, it is evident that we shall never know the actual picture of birth of the universe, but with the development of science and new knowledge we shall proposed and discuss always new theories and hypothesis, providing suitable food for the flight of fancy. Naturally, although very seldom, hypothetical considerations of the universe will be confirmed by experimental investigations, for example, as was the case with the discovery of the red shift and relict microwave radiation. At the same time, experiments confirm the accelerated recession galaxies but even with the most intensive flight of fancy physics does not have any suitable explanation for this phenomenon.

The development of the theory of Superunification at the boundary of the centuries, as the fundamental quantum theory, based on the discoveries of the space-time quantum (quanton) and superstrong electromagnetic interaction divided physics into old (the physics of the 20th century) and new (physics of the 21st century) [5–13].

The new physics of the 21st century is the physics of open quantum-mechanics systems, and the old physics of the 20th century is the physics of closed quantum-mechanics systems which simply do not exist in nature. In this respect, the physics of the 20th century suffers from the metaphysical considerations of world creation, regardless of the 'coarse' materialistic base, regarding the elementary particles and solids as isolated objects. However, this does not agree with the principle of corpuscular-wave dualism in which the particle (solid) shows both the wave and corpuscular properties, being the inseparable and compound part of the quantised space-time.

Only the physics of open quantum-mechanical system has made it possible to discover the structure of the main elementary particles: electron, positron, proton, neutron, neutrino, photon and the nature of nuclear forces within the framework of the theory of Superunification. However, for this purpose it is necessary to determine the vacuum structure of the quantised space-time as the primary matter, forming the basis of our existence.

Naturally, I was interested in the question: 'who quantised the universe and how did this take place'? I did not find any answer and simply concluded that the space-time is quantised and has a discrete structure. This is confirmed indirectly by all the available experimental facts, interpreted in the framework of the theory of Superunification. Evidently, we shall never know who quantised the universe and whether this was somebody's idea. However, we may attempt to imagine how this took place, by which scenario. Here, the inflationary theory is quite attractive for describing the development of the universe.

The inflationary theory, proposed for the first time by the Russian physicist A.A. Storobinskii and subsequently developed further by Andrei Linde, was known to me a long time ago but si nce cosmology is not my specialisation, I treated it with care. The impetus for writing this popular science article was to me not only the desire to find an answer for myself to the question of the scenario of development of quantisation of the universe but also to focus the attention of the scientists who, in contrast to myself, are far more experienced in these subjects.

One of the main shortcomings of the inflationary theory was the metaphysical approach. Inflation describes the development of the universe at the moment of its birth when there were no currently known elementary particles: electron, positron, proton, neutron, photon, and others. So what could then expand? The theory of Superunification provides the materialistic basis for the inflationary theory in the form of the quantised space-time whose appearance is associated with the birth of the universe.

1.3.2. 'Bouillon' from quantons

As mentioned previously, the main problem in the world creation has always been the problem of the primary matter. What did exist prior to the time when there were no elementary particles? Now we have a strictly scientific answer with indisputable experimental confirmation. **Primary matter is**

the quantised space-time.

To breathe new life into the inflationary theory, it is necessary to investigate how the theory operates in the quantised space-time. The inflationary theory lacked the materialistic base. According to the logics of things it is obvious that there should be primary matter. So if something expanded when there were no elementary particles, something must have existed. I do not agree that emptiness can be expanded, in the understanding of emptiness as the category of free from matter and energy.

Unfortunately, the physics of the 20th century regarded the space vacuum as the absolute emptiness with the zero energy level. The quantum theory attributed very carefully but in any case to the vacuum the small level od energy of fluctuations under the effect of indisputable facts of formation of elementary particles from vacuum. Of course, the particles cannot form from nothing. Only the theory of Superunification returned the cosmic space to its initial position of primary matter. The quantised space-time is the high-potential vacuum medium, characterised by the maximum gravitational potential C_0^2 (not with the zero potential as originally thought) and the maximum energy level.

The main achievement of Einstein is that he was the first one to propose the concept of the unified field, replacing the old mechanistic aether with no experimental substantiation by the four-dimensional space-time. However, at that time, with the exception of the apparatus of the general theory of relativity (GTR) Einstein did not have any other tools. Nevertheless, in the last 30 years of his life, regardless of the criticism and absence of results, he fought vigorously over the development of the theory of the unified field, and at the end of his life he proposed the concept of quantisation of space-time (see the Einstein posthumous phrase).

Analysing the failures of Einstein on the road to the theory of the unified field, it has been established that he omitted an important stage in the path of unification of gravitation and electromagnetism. In particular, it was necessary to unify electricity and magnetism into a single concept, i.e., electromagnetism, assuming that this new unified electromagnetism is in reality the Einstein unified field which is not only the carrier of electromagnetism but also of gravitation. To make this happen, it was necessary to obtain building bricks for the base of the United field.

In physics, the building bricks are represented by quarks, i.e., weightless charges. Unfortunately, the beautiful concept of the quarks as the initial material was erroneously directed to explaining the structure of nuclear matter in quantum chromodynamics (QCD) instead of the formation of primary matter. This was an attempt to bypass the non-investigated stage. Science does not pardon inconsistent actions. At the present time, the QCD faces a large number of unsolved problems and cannot even come close to explaining the generation of mass at nucleons, to say nothing of other elementary particles. Most importantly, the QCD operates with fractional quarks – electrical charges with the relatively integral elementary charge **e** which have not been detected in experiment. The apparently detected indirect manifestations of fractional charges may have a different explanation.

Thus, to sutdy closer the structure of primary matter, it was necessary to have new quarks and not only whole quarks. This removed all the contradictions because the presence of the whole electrical charge **e** with both positive and negative polarity was the experimentally confirmed fact with the accuracy to 10^{-20} *e*. The elementary electrical charge **e** is the most stable constant in nature and no better basis is available for constructing a new theory.

Thus, two whole quarks (–1*e* and +1*e*) were already available in physics in the form of electrical carriers of charges at the electron and the positron. However, the two whole quarks were not sufficient for producing the first building brick of primary matter, i.e., the space-time quantum.

In fact, in order to isolate the space-time quantum, it is necessary to isolate its minimum volume which cannot be divided any further. Only four coordinates points 1, 2, 3, 4, are required for this purpose. One point is simply a point, two points can be used to draw a line, three points to produce a surface, and four point to isolate the volume. The four coordinates points are geometry. In transition from geometry to physics, the points must be replaced by physical objects, i.e., quarks. The four quarks have been planned by nature itself in the form of four weightless (massless) monopole charges: two electrical (+1*e* and –1*e*) and two magnetic (+1*g* and –1*g*), connected inside the electromagnetic quadrupole (Fig. 1.4). The monopole elementary charges are represented by the elastic spheres 5 of different shading, with the centre containing the source (drain) of the electrical (magnetic) field.

The electromagnetic quadrupole, shown in Fig. 1.4, has not as yet formed as the space-time quantum. It is evident that under the effect of the colossal forces of mutual attraction between the monopole charges, the electromagnetic quadrupole must be compressed into a spherical particle forming a quanton as the space-time quantum (Fig. 1.5). The quanton is protected against collapse by the properties of the monopoles: their finite dimensions and elasticity. In particular, the electricity and magnetism inside the quanton are connected by the superstrong electromagnetic interaction (SEI), merging into a single substance. The arrangement of the centres of the monopole charges at the tips of the tetrahedron inside the quanton forms a superelastic and stable structure.

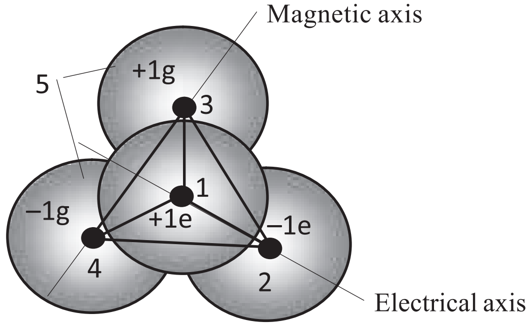

Fig. 1.4. The electromagnetic quadrupole (top view).

It may be seen that two magnetic quarks (+1*g* and –1g), the so-called Dirac monopoles, added to the two whole electrical quarks (+1*e* and –1*e*). The Dirac monopoles are connected by the relationship:

$$g = C_0 e = 4.8 \cdot 10^{-11}\,\text{A·m (or Dc)} \tag{1.1}$$

where $C_0 = 3 \cdot 10^8$ m/s is the speed of light in the quantised space-time, not perturbed by gravitation; $e = 1.6 \cdot 10^{-19}$ C is the elementary electrical charge.

In the Superunification theory, calculations are carried out in the SI system. Therefore, the dimension of the magnetic charge in the SI system is amperes per metre [Am], because the dimension of the magnetic moment is [Am^2]. According to Dirac, the magnetic and electrical charges have the same dimension [Coulomb]. This is very convenient because it determines the symmetry between the electricity and magnetism which in the ideal case would be expressed in the complete equality of the values of the magnetic and electrical monopoles. However, Dirac made an error in the calculations because he selected incorrectly the initial values, obtaining $g = 68.5e$. The true relationship (1.1) between the magnetic and electrical charge was obtained only by analysing the Maxwell equations in vacuum.

In the SI system, the dimensions of magnetism are determined by the electrical current. Therefore, the equality between the magnetic and electrical charges in (1.1) is connected by the dimensional multiplier C_0. Taking into account pioneering studies by Dirac in the area of the magnetic monopole, I propose that the dimension of the magnetic charge in SI [Am] should be referred to as Dirac [Dc]. At the present time, it is the extrasystem nic dimension but I assume that with time it will be accepted officially.

Having a quanton consisting of four quarks, it is possible to produce a 'buillion' of primary matter, filling the volume with quantons (Fig. 1.3). As a result of the tetrahedral distribution of the charges inside a quanton, it would appear that there is a complete chaos inside the separated volume.

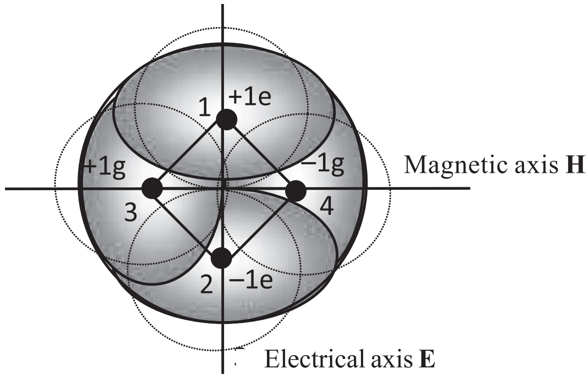

Fig. 1.5. The quanton in projection (rotated in space).

The charges with positive signs try to attract each other, and the single-pole charges repulse each other. The calculated diameter of the quanton is very small, of the order of 10^{-25} m.

If we could glance into the domain of the ultra-microworld of quantons, we would see that quantons oscillate. These chaotic oscillations of quantons resemble boiling. It is possible that these fluctuations also determined the tone of relict radiation which is not the residual echo of the Big Bang and it is the natural fluctuations background of the quantised space-time.

As a result of the tetrahedral distribution of the charges inside a quanton, the quantised space-time structure has the minimum level of the chaos which prevents in space the definition of a specific electrical or magnetic direction, i.e., excludes anisotropy. The electrical and magnetic charges balance each other. Therefore, in the macroworld domain, the space-time is treated as a homogeneous, isotropic and neutral vacuum medium.

The quantised space-time is also a weightless primary matter thus far free from mass (elementary particles). As shown in the Superunification theory, the quantised space-time is the carrier of the superstrong electromagnetic interaction, the fifth force which was the subject of research in the 20th century. To combine the known four forces (electromagnetism, gravitation, nuclear and weak forces), the superforce (SEI) was necessary. Only the superforce can combine other, weaker forces in itself. This is the golden rule of physics which will not be discussed here.

The calculations show that the quantised space-time, as the carrier of the superstrong electromagnetic interaction, has a colossal energy capacity, approximately 10^{73} J/m^3. If only one m^3 of the energy of cosmic vacuum is activated, this would be sufficient for generation of another universe as a result of a big bang. At the present time, physical science possesses data according to which the energy corresponding to the Big Bank exists in nature, together with us (and inside us). However, whether a big bang would occur, is the problem which requires constant study. It is not possible to release the energy of the quantons by splitting the quanton into individual charges because in nature there are no forces capable of this. The absence of free magnetic charges (Dirac monopoles) confirms this. However, how can we explain the presence of free electrical charges in nature?

In particular, the presence of the free electrical charges determines the entire variety of ponderable matter. This is possible only in the case of the electrical asymmetry of quantised space-time. However, the structure of the quantum is characterised by electromagnetic symmetry, i.e., by two pairs of electrical and magnetic charges, balancing each other. Evidently, the problem of the generation of electrical asymmetry of the universe can also be answered by the inflationary theory. Apparrently, in the period of expansion of the universe, the emission of quantons was accompanied by the emission of the electron neutrinos containing a pair of electrical quarks (charges).

1.3.3. How to weld elementary particles

In the usual concept, the bouillion consisting of quantons, shown in Fig. 1.3, does not yet contain any elementary particle. The quarks, as the basis of primary matter, are not regarded as elementary particles, although as matter of fact the elementary particle are not so elementary, and the quarks are elementary as regards their basis. This caused complications in the terminology in the area of elementary particles even in the period in which the complicated structure of the elementary particles was not yet known.

Having a boiling bouillon of quantons, it is now quite easy to weld an elementary particle, for example, an electron. For this purpose, the bouillion should be filled with a quark of negative polarity whose presence is determined by the electrical asymmetry of the universe. In fact, if a weightless electrical perturbing charge is injected into the quantised space-time, the quantons start to travel to the central electrical charge. Specks of dust also travel to an electrified comb in the same manner.

However, what happens to the quantised space-time? Evidently, in the vicinity of the perturbing central charge, the quantised space-time is compressed, being an elastic medium. However, this is possible only as a result of tension in movement away from the central charge. The results of compression and tension are separated by some gravitational boundary. The process of spherical deformation of the quantised medium has taken place. The deformation energy is the equivalent of the particle mass. In spherical deformation of the medium (our bouillon) the quark acquired the mass *m* and degenerated into an elementary particle, i.e., the electron, a carrier of the elementary electrical charge *e* and mass *m*.

The energy *E* of spherical deformation of the medium at generation of the rest mass *m* of the elementary particle is determined by the work (integral) in transition of the mass *m* from the region with the zero gravitational potential to the quantised space-time which, as mentioned previously, is the high potential and is characterised by the gravitational potential $\varphi = C_0^2$:

$$E = \int_0^{C_0^2} m d\varphi = mC_0^2 \tag{1.2}$$

The integral (1.2) is the simplest and easiest to understand conclusion of the Einstein equation $E = m C_0^2$, defining the equivalence of the energy and mass. In order to avoid confusing *E* (1.2) with the strength of the electrical field *E*, in the Superunification theory the energy is denoted by the symbol *W*. Returning back to (1.2) it is confirmed that the quantised space-time is characterised by the gravitational potential $\varphi = C_0^2$. If this is not the case, then doubts can be cast on the Einstein equation which has the indisputable experimental confirmation.

Thus, the equivalence of mass and energy proves that the mass is also energy only it is measured in arbitrary measurement units proposed previously when the mass was determined on a balance, i.e., by weight.

Paradoxically, however, regarding the mass as the energy of spherical deformation of the quantised space-time, we realise that the mass is a secondary formation in primary matter. However, current physics teaches that the mass, as the base of ponderable matter, is primary. At the present time, the Superunification theory removes one of the main errors of contemporary physics, regarding the movement of mass as the wave transfer of spherical deformation of the quantised space-time. The mass as such simply does not exist in nature. There is only the energy of deformation of the quantised space-time which we regard as the mass.

According to Einstein, spherical deformation of the quantised space-time is only is a distortion which can be represented by Lobachevski spheres of different curvature, threaded on each other. If we use this path, we obtain a relatively complicated geometrical theory of gravitation represented in the general theory of relativity (GTR).

However, the quantised space-time can also be characterised as some scalar field, with the distribution of the quantum density of the medium (*x*, *y*, *z*). The quantum density of the medium is the concentration of the quantons in unit volume. Consequently, the previously described process of generation of an elementary particle as a result of compression–extension of the medium from the position of vector analysis is nothing else but the divergence of the gradient of the quantum density of the medium. Consequently, we have obtained a new concept of the Poisson gravitational equation characterising the elementary particle in the quantised space-time:

$$\operatorname{div}(\operatorname{grad}\rho) = k_0\rho_m \tag{1.3}$$

where k_0 is the proportionality coefficient, ρ_m is the density of matter, kg/m^3.

Equation (3) includes the deformation vector **D** of the medium for the case in which the scalar field ρ (*x*, *y*, *z*) changes during deformation into the effect of field, characterising the formation of gravitation:

$$\mathbf{D} = \operatorname{grad}\rho \tag{1.3a}$$

Thus, equation (1.4) shows convincingly that gravitation is based on the deformed quantised space-time (Fig. 1.3) being the carrier of the superstrong electromagnetic interaction. In its basis, gravitation has electromagnetism. In explanation, the gravitational principle of the Poisson equation (1.3) and (1.4) will become evident.

The two-component solution of the Poisson gravitational equation (1.3) in statics for the spherically deformed space-time was proposed for the first time in the theory of Superunification for the distribution of the quantum density of the medium ρ_1 (tension region) and ρ_2 (compression region):

$$\begin{cases} \rho_1 = \rho_0\left(1 - \dfrac{R_g}{r}\right) \quad \text{for } r \geq R_S \\ \rho_2 = \rho_0\left(1 + \dfrac{R_g}{R_S}\right) \end{cases} \tag{1.4}$$

where R_S is the radius of the gravitational boundary (radius of the particle), *m*; *r* is the distance from the centre of the particle in the region ρ_1, m; R_g is the gravitation radius of the particle without the multiplier 2, m; P_0 is the quantum density of the non-deformed medium:

$$R_g = \frac{Gm}{C_0^2} \tag{1.5}$$

where *G* is the gravitational constant.

It should be mentioned that the Poisson equation (1.3) and its solution (1.4) also include the time factor (*t*), but in the hidden form. This will be shown later. The equation (1.3) and its solution (1.4) describes the gravitational state of the particle in the four-dimensional space-time. The fact is that the quantum (Fig. 1.5) is an elastic volume electromagnetic resonator defining the lapse of time at every point of space-time (Fig. 1.3). In deformation of the medium, the spatial lapse of time also changes accordingly. However, this will be discussed later.

Figure 1.6 shows the generalised model of an elementary particle with mass in the quantised space-time, corresponding to the Poisson gravitational equation (1.3) and its two-component solution (1.4). As already mentioned, the non-deformed space-time is characterised by the quantum density ρ_0. We introduce a sphere with a radius R_0 and start to compress it uniformly together with the medium to the radius of the gravitational boundary R_S. The quantised space-time inside the gravitational boundary is compressed to quantum density ρ_2 (dark region). In the external region, the space-time is expanded to the quantum density ρ_1 (light region). Moving away from the particle $\rho_1 \to \rho_0$ the field weakens, characterising the distribution $\rho_1 = f(r)$ of the relative curvature R_g/r of the space-time.

It should be mentioned that the gravitational interface is not any rigid dimension of the particle but it is the boundary formed as a result of spherical deformation of the quantised space-time freely letting in quantons and releasing them in the wave transfer of mass. Any wave is also transferred by the same mechanism. The wave does not transfer its content, it transfers deformation. In fact, the gravitational interface is the wave boundary. The

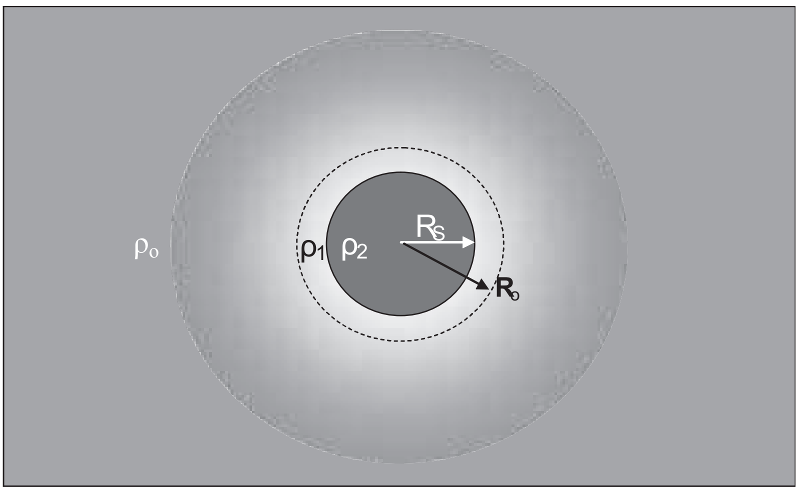

Fig. 1.6. Modelling of elementary particles in the form of regions of spherically deformed quantised space-time. R_S – the gravitational interface of the medium; ρ_1 – the region of expansion (light) and ρ_2 – the region of compression (dark).

elementary particle is a single volume wave in our bouillon of quantons, with the soliton regarded as a rough analogue of this wave,

The mass of any elementary particle is a variable quantity and depends on the quantum density of the medium in which it is located, and the speed of movement in the medium. With increasing speed, the wave gravitational boundary captures increasing numbers of the quantons from the external medium, increasing the quantum density ρ_2 (dark region) and reducing ρ_1 on the outside (light region) of the medium. This is equivalent to the increase of the energy of spherical deformation of the quantised medium and, correspondingly, the particle mass.

Usually, the increase of the particle mass in relation to speed v is taken into account by the classic relativistic factor γ which leads to infinite solutions of the mass and energy of the particle when the latter reaches the speed of light. The problem of infinity was solved in the Superunification theory by introducing the normalised relativistic factor γ_n, restricting the limiting parameters of the particle:

$$\gamma_n = \frac{1}{\sqrt{1-\left(1-\frac{R_g^2}{R_S^2}\right)\frac{v^2}{C_0^2}}} \tag{1.6}$$

As a result of introducing the normalised relativistic factor γ_n (1.6) into (1.3), the Poisson equation and its solution (1.4) change from the static to dynamic state, including movement at the speed of light. The limiting parameters of the mass m_{Max} and energy $W_{\max}$ of the relativistic particle at $v = C_0$ are obtained:

$$m_{\max} = \frac{C_0^2}{G} R_S \tag{1.7}$$

$$W_{\max} = \frac{C_0^4}{G} R_S \tag{1.8}$$

In accordance with (1.7), if a proton is accelerated to the speed of light, its mass will be finite and will not exceed the mass of an iron asteroid with a diameter of 1 km.

The Poisson equation (1.3) and its two-component solution are connected with the quantum density of the medium which is an analogue of the gravitational potential ($\rho_0 \to C_0^2$, $\rho_1 \to \varphi_1 = C_0^2$; $\rho_2 \to \varphi_2$). Consequently, we transfer from the gravitational Poisson equation and its two-component solution by representing the parameters of the particle by the gravitational potentials taking into account normalised relativistic factor γ_n (6):

$$\operatorname{div}\operatorname{grad}(C_0^2 - \varphi_n\gamma_n) = 4\pi G\rho_m \tag{1.9}$$

$$\begin{cases} \varphi_1 = C^2 = C_0^2\left(1 - \dfrac{R_g}{r}\gamma_n\right) \text{ at } r \geq R_S \\ \varphi_2 = C_0^2\left(1 + \dfrac{R_g}{R_S}\gamma_n\right) \end{cases} \tag{1.10}$$

The Poisson equation (1.9) and its two-component solution (1.8) characterise the dynamic state of the particle in the four-dimensional quantised space-time in the entire speed range, including the speed of light. A relative special feature of the four-dimensional Poisson equation (1.9) and of its solution (1.10) is the absence in the equation and its solution of the distinctive time coordinate (t), as accepted in the four-dimensional representation. The time component has already been included in (1.9) and (1.8) and the appropriate calculation procedure has been developed. Using equations (1.9) and (1.8), this procedure makes it possible to separate the time parameter as the independent function of distribution of the time scalar field for the moving particle in the entire speed range.

In the past, the transition to four-dimensional gravitation would have made it possible to obtain completely new results, with the main result being the one which shows that gravitation distorts space-time. However, the introduction of every additional measurement into the equation complicates the equation to such an extent that they become accessible to only a small number of experts. My task was to develop calculation procedures which would make it possible to transform the multidimensional systems to the conventional three-dimensional system. Additional gravitational potentials would have to be introduced for this purpose:

1. C_0^2 – the gravitational potential of the non-perturbed quantised space-time;
2. C^2 – the gravitational potential of the action (replaces the Newton potential φ_n);
3. φ_2 – the gravitational potential inside the gravitation boundary;
4. φ_n – the Newton potential (as the imaginary potential).

Previously, the gravitational theory operated with only one Newton potential φ_n. The calculation possibilities of this potential are limited. In order to determine the exact state of the particle (1.4) in the entire speed range, without taking into account C_0^2, C^2 and φ_2, it would have to be necessary to adjust the calculation apparatus to such an extent so that the latter becomes quite heavy and still would not provide the exact solution.

From (1.8) we obtain the balance of the gravitational potentials through the action potential C^2 for the elementary particle in the external region of the space-time (Fig. 1.6, grey region):

$$C^2 = C_0^2 - \varphi_n \gamma_n \tag{1.11}$$

Multiplying the balance of the gravitational potentials from (1.11) by R_S/G at $r = R_S$, we obtain the balance of the dynamic mass m of the particle in the entire speed range, including the speed of light:

$$\frac{C^2}{G} R_S = \frac{C_0^2}{G} R_S - \varphi_n \frac{R_S}{G} \gamma_n \tag{1.12}$$

Equation (1.12) includes the limiting mass $m_{\max}$ of the particle (1.7), its hidden mass m_s and the relativistic mass m:

$$m_s = \frac{C^2}{G} R_S \tag{1.13}$$

$$\frac{\varphi_n}{G} R_S \gamma_n = \frac{Gm_0}{R_S} \frac{R_S}{G} \gamma_n = m_0 \gamma_n = m \tag{1.14}$$

Taking into account (1.13) and (1.14) we can write the mass balance (1.12) in a simpler form:

$$m = m_0 \gamma_n = m_{\max} - m_s \tag{1.15}$$

Multiplying the mass balance (1.15) by C_0^2 we obtain the dynamic balance of the energy of the particle in the entire speed range, including the speed of light:

$$W = W_0 \gamma_n = W_{\max} - W_s \tag{1.16}$$

Equation (1.16) includes the hidden energy $W_s = m_s C_0^2$ of the particle as the component of the quantised space-time, and its limiting energy $W_{\max}$ (1.8).

In the range of low speeds $v \ll C_0$, the normalised relativistic factor γ_n (1.6) changes to the classic factor γ which can be expanded into a series and, rejecting the numbers with the higher orders, the balance (1.16) can be transformed to the standard form:

$$W = W_{\max} - W_s = m_0 C_0^2 + \frac{m_0 v^2}{2} \tag{1.17}$$

In this context, the kinetic energy of the particle is in fact the increase of the spherical deformation energy with the increase of the speed of the particle inquantised space-time. The kinetic energy in the equivalent is directed to increasing (decreasing) the mass of the particle during its acceleration (deceleration).

The previously described balances of the gravitational potentials (1.11), mass (1.15) and energy (1.16), (1.17) confirm convincingly that the elementary particle, being the integral part of quantised space-time, is in fact the open quantum-mechanical system characterised by complicated exchange processes in movement in quantised space-time. The hidden mass and energy can transfer to its real parameters, increasing with increasing speed.

Usually, physicists, describing the four dimensional state, use the concept of action S according to Lagrange, for example, Andrei Linde:

$$S = N\int d^4x\sqrt{g(x)}\left(\frac{R(x)}{16\pi G} + L(\phi(x))\right) \tag{1.18}$$

However, the action (1.18) can also be used to describe the state of the elementary particle at a specific point of space-time. Equation (1.18) results in the formation of an unbalanced force, instability of the particle, instability of space-time and in its collapse. Only the two-component solutions (1.4) and (1.10) make it possible to separate the gravitation boundary and balance its forces acting from the external and internal sides, ensuring the stable state of the system and preventing its collapse. However, for the inflationary state, the action (1.18) is fully justified because the presence of the unbalanced force results in the expansion of the universe.

To understand the approximate nature of the calculation apparatus of four-dimensional gravitation, it is sufficient to compare the dynamic balance of the gravitational potentials (1.11) with the four-dimensional interval ds^2

$$ds^2 = (C_0\,dt)^2 - (dx)^2 - (dy)^2 - (dz)^2 \tag{1.19}$$

For this purpose, we transform (1.19)

$$\left(\frac{ds}{dt}\right)^2 = C_0^2 - \left(\frac{dx}{dt}\right)^2 - \left(\frac{dy}{dt}\right)^2 - \left(\frac{dz}{dt}\right)^2 \tag{1.20}$$

Equation (1.20) includes the equivalents of the speeds C and v, in the form of their squares:

$$\left(\frac{ds}{dt}\right)^2 = C^2 \tag{1.21}$$

$$\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2 + \left(\frac{dz}{dt}\right)^2 = v^2 \tag{1.22}$$

Taking the equations (1.21) and (1.22) into account, we obtain the balance of the gravitation potentials formed as a result of the transformations of the four dimensional interval ds^2 (1.19):

$$C^2 = C_0^2 - v^2 \tag{1.23}$$

Comparing the precise balance (1.11) with balance (1.23) we may clearly see that the four dimensional interval ds^2 describes approximately the gravitational state of the particle in the four-dimensional space-time, since the dynamic potential $\varphi_p\gamma_p$ in equation (1.11) is not equal to the square of the speed d^2 in (1.23). Equation (1.11) shows that the precise balance is represented by the squares C^2 and C_0^2, and the dynamic gravitational potential $\varphi_n\gamma_n$ has the dimension identical with the square of speed [m²/s²]. In this context, the formal unification of the linear coordinates (x, y, z) and time t through the Pythagoras quadratic equation (1.19). However, this solution was only approximate. The further development of this direction in the four dimensional geometrical theory of gravitation was also only approximate.

We could present here the analytical conclusion of the wave equation of the particle in quantised space-time but this will be carried out in Chapter 3.

To conclude the popular description of the behaviour of the particle in the quantised space-time it is necessary to present its gravitational diagram (Fig. 1.7) which characterises the distribution of the gravitational potentials (1.8) or the quantum density of the medium (1.4). The gravitational diagram is the two-dimensional analogue of the three-dimensional representation of the particle (Fig. 1.6). The region of compression is indicated by the dark tone, the expansion region by the light tone. The gravitational boundary R_S is characterised by a jump of the gravitational potential and quantum density of the medium $2\Delta\rho_1$. The gravitational diagram shows the curvature of the space-time in the external (grey) region and the presence of a gravitational well at the particle which was discovered for the first time in the Superunification theory. It is characteristic that the gravitational field of the particle is not described by the Newton potential φ_n and is described by the action potential C^2, ensuring the balance of the gravitational potentials (1.11).

The theory of Superunification describes the structure of the main elementary particles: electron, positron, proton, neutron, electronic neutrino, photon, as open quantum-mechanics systems. The quantised space-time is a vessel used for ‘cooking’ not only elementary particles, forming atoms and molecules, but also a vessel for ‘cooking’ the entire matter, forming planetary systems and where stars are born and disappear. Naturally, in a popular article, it is not possible to embrace all aspects of the theory of Superunification but its main elements, relating to cosmology, must be shown. However, prior to doing this the electromagnetic properties of the quantised space-time should be discussed.

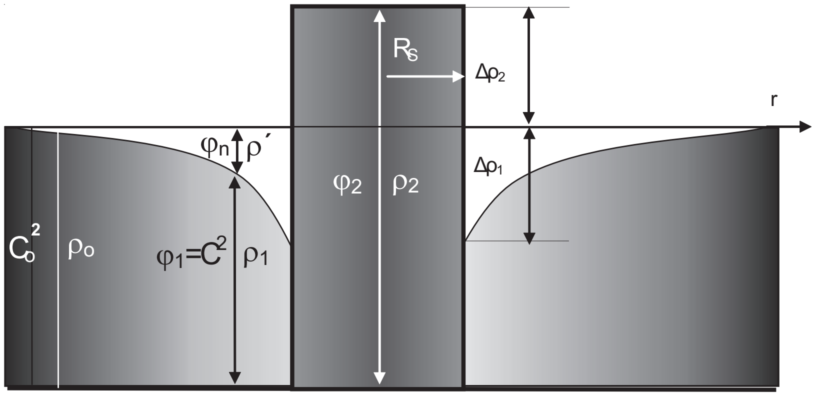

Fig. 1.7. Gravitational diagram of an elementary particle in quantised space-time.

1.3.4. Return to the light-bearing (luminiferous) medium

The quantised space-time, as the carrier of the superstrong electromagnetic interaction, returns to physics the light-bearing (luminiferous) medium, unjustifiably rejected in the 20th century. There were both objective and subjective reasons for this. It should be mentioned that Maxwell, deriving the equations of the electromagnetic field in vacuum, took into account the realias of the luminiferous medium, referring to the medium as electromagnetic aether. Maxwell presented these equations, without describing analytical derivation. Here, we write the Maxwell equations in the form in which they are used today in vacuum for the strength of the electrical **E** and magnetic **H** fields, and the densities of the electrical $\mathbf{j}_e$ and magnetic $\mathbf{j}_g$ bias currents:

$$\mathbf{j}_e = \operatorname{rot}\mathbf{H} = \varepsilon_0 \frac{\partial \mathbf{E}_x}{\partial t} \tag{1.24}$$

$$\mathbf{j}_g = \frac{1}{\mu_0}\operatorname{rot}\mathbf{E} = \frac{\partial \mathbf{H}_y}{\partial t} \tag{1.25}$$

where ε_0 is the electrical constant of the vacuum; μ_0 is the magnetic constant of the vacuum.

In particular, because of the rotor form of the equations (1.24) and (1.25) the concept of the luminiferous medium was rejected assuming that the rotor of the magnetic field generates the rotor of the electrical field and, vice versa, ensuring transfer of the electromagnetic wave in vacuum. It would appear that the electromagnetic wave represents an independent substance which does not require an additional carrier in the form of the luminiferous medium.

However, in experiments, the electromagnetic field in vacuum did not contain rotors and, in addition to this, the vectors of the electrical **E** and magnetic **H** fields exist at the same time (Fig. 1.1). This means that the rotor of the magnetic field cannot generate the rotor of the electrical field and vice versa.

The analytical derivation of the Maxwell equations and removal of the resultant errors became possible for the first time in the theory of Superunification, analysing the electromagnetic polarisation of the quantons (Fig. 1.5) in quantised space-time.

Figure 1.8a shows a quanton in the equilibrium state. Taking into account the fact that the quanton is situated inside the quantised space-time (Fig. 1.3), all the remaining quantons are also in the electromagnetic equilibrium. There is no external manifestation of the electrical and magnetic fields. The electrical and magnetic axes of the quanton are orthogonal in relation to each other.

The passage of an electromagnetic wave is accompanied by electromagnetic polarisation of the quanton and disruption of its electromagnetic equilibrium. Figure 1.8b shows that the electrical charges inside the quanton are displaced from the equilibrium state, stretching the quanton along the electrical axis, and this is accompanied by the displacement of the magnetic charges, compressing the quanton along the magnetic axis, and vice versa (Fig. 1.8c). Further, it will be shown that the quanton itself is not stretched in the electromagnetic processes and that only charges inside the quanton are displaced. The simultaneous displacement of the charges results in the disruption of the electrical and magnetic equilibrium of the medium and in the formation of the external electrical **E** and magnetic **H** fields whose strength vectors exist at the same time and remain orthogonal in relation to each other **E⊥H**. This fully corresponds to the nature of the

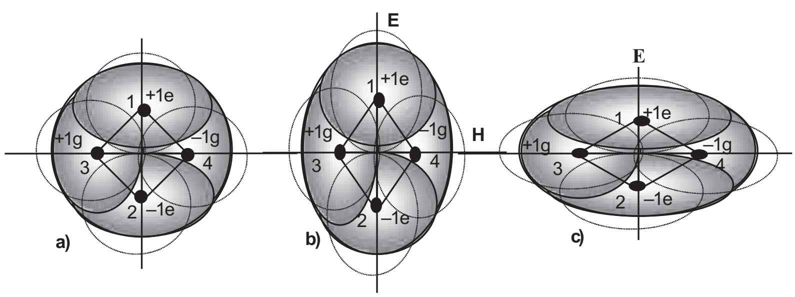

Fig. 1.8. Electromagnetic polarisation of the quanton during the passage of an electromagnetic wave.

electromagnetic wave in vacuum (Fig. 1.1). The displacement of the electrical and magnetic charges inside the quanton results in the formation of real currents of electrical and magnetic displacement in vacuum, which were already described by Heaviside.

In the Superunification theory, the problems of passage of the electromagnetic waves through the quantised space-time were studied quite extensively and this resulted in the analytical derivation of the Maxwell equations which in the case of vacuum are reduced to one vector and roptor equation, connecting together three orthogonal vectors: **E**, **H**, **C** (where **C** is the vector of speed of light) (Fig. 1.1):

$$\varepsilon_0 \left[\mathbf{C}_0 \dot{\mathbf{E}} \right] = -\dot{\mathbf{H}} \tag{1.26}$$

Thus, analysis of the electromagnetic perturbation of the quantised space-time confirms that it is the real luminiferous medium without which the propagation of electromagnetic waves is not possible.

In order to provide a more convincing confirmation, we study the two-rotor structure of the photon resulting from the relativistic Maxwell rotor equations (1.24) and (1.25). The rotors do exist in the electromagnetic wave but they also exist simultaneously on the wave sphere:

$$\mu_0 \left| \mathbf{C} \cdot \text{rot}\,\mathbf{H} \right| = \text{rot}\,\mathbf{E} \tag{1.27}$$

Figure 1.9 shows the diagram of simultaneous circulation of the vectors **E** and **H** in the form of rotors (1.27) on the sphere of the electromagnetic wave in orthogonal cross-sections. The source of the spherical electromagnetic wave is situated in the centre 0. Any two orthogonal sections of the sphere of the wave form two diagonal points *a* and *b* with arbitrary coordinates. At the points *a* and *b*, the vectors **E** and **H** are orthogonal in relation to each other and the rotors themselves (1.7) circulate in the orthogonal planes Z0X and Y0X, satisfying equation (1.27). Regardless of the arbitrary coordinates of the diagonal points *a* and *b* on the wave sphere,

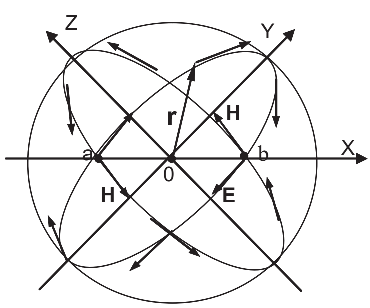

Fig. 1 .9. Simultaneous circulation of the vectors **E** and **H** on the sphere of the electromagnetic wave in orthogonal cross-sections.

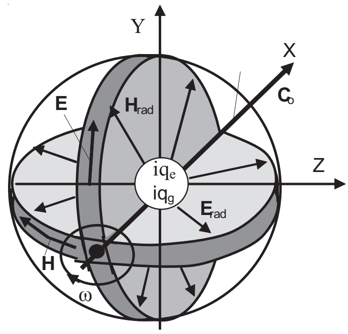

Fig. 1.10. The two-rotor structure of a low-energy photon emitted by an orbital electron.

the pattern of the electromagnetic field of the spherical wave is represented by the scheme in Fig. 1.9 for an arbitrarily rotated pattern in space.

Figure 1.10 shows the two-rotor structure of a low-energy photon emitted by an orbital electron, when the diameter of the photon is equal to the wavelength of the electromagnetic field of the photon. The structure of the photon is formed at the moment of emission of the relativistic electron at the speed close to the speed of light. Two-rotor radiation (Fig. 1.9) of the electron in the relativistic domain cannot produce an expanding spherical way. In accordance with the relativism rules, the spherical wave is 'frozen' at the speed of light. The wave does not expand and transforms to the relativistic wave particle – photon. It should be mentioned that two orthogonal rotors of the photon – electrical and magnetic, form the ideal gyroscopic system ensuring the directional movement of the photon in the quantised space-time in the direction of the major axis.

The two-rotor structure of the photon explains its behaviour, including in optical media with partial dragging during movement of the medium (Fizeau experiment). We shall discuss the formal explanation of the reason for the deceleration of light in optical media and partial dragging of the photon by the moving medium.

As mentioned, the photon is a two-rotor electromagnetic formation in quantised space-time and, having gyroscopic properties, travels in the straight direction with the speed of light C_0.

The optical medium is also a component part of the quantised space-time because the medium consists of molecules and atoms and they consist in turn of elementary particles. As already mentioned, the elementary particles are the component part of the quantised space-time.

Inside the optical medium, the photon is transferred due to the quantised space-time, i.e., the luminiferous medium. However, the optical medium and, more accurately, atomic centres of the lattice of the medium cause perturbations in the movement of the photon deflecting it periodically from the straight path. Consequently, as shown by the calculations, the photon moves inside the optical medium along a trajectory close to sinusoidal (cosinusoidal), slowing down in the straight direction.

The photon moves in the optical medium with the speed of light $\mathbf{C}_0$ in the direction of the vector $\mathbf{C}_0$ (along the major axis of the photon). The deflection of the photon from the straight direction does not change its speed $\mathbf{C}_0$ because this wave speed is determined by the luminiferous medium, i.e., by the quantised space-time. However, in contrast to the straight line, the movement along the sinusoid extends the path of the photon in the optical medium (Fig. 1.1a). Let it be that along the straight line it is ℓ_z, along the sinusoid ℓ_y. The speed of light C_0 = const. Here, $\ell_y/\ell_z = n_0$, where n_0 is the refractive index of the stationary medium. The phase speed C_{po} of the photon is determined by the time t_y of movement of the photon along the sinusoid (or another periodic trajectory):

$$C_{p0} = \frac{\ell_y}{t_y} = \frac{\ell_z n_0}{t_y} = \frac{C_0 t_y}{t_y} n_0 \tag{1.28}$$

From (1.28) we obtain the well-known equation according to which the refractive index of the medium is determined by the ratio of the speed of light C_0 to the phase speed C_{p0} and, more accurately, by the ratio of the length of the trajectory of the photon along the sinusoid to the length of the trajectory along the straight line:

$$n_0 = \frac{C_0}{C_{p0}} = \frac{\ell_y}{\ell_z} \tag{1.29}$$

Thus, the movement of the photon in the optical medium can be described by two wave equations: for the electromagnetic field with the speed C_0, and for transverse oscillations of the photon in relation to the director of movement with the phase speed C_{po}. The two-rotor structure of the photon explains the electrical and magnetic polarisation of light and rotation of the polarisation plane during movement of the photon in optical media.

In movement in flowing water (Fizeau experiment), the photon is partially carried away by water with the speed lower than the speed of movement of the water v_b (Fig. 1.11b). This is caused by the constant speed of light C_0 in quantised space-time. Using the Einstein equation of the composition of the velocities for the system with the constant speed of light C_0 = const, we determine the speed of the photon C_p in flowing water:

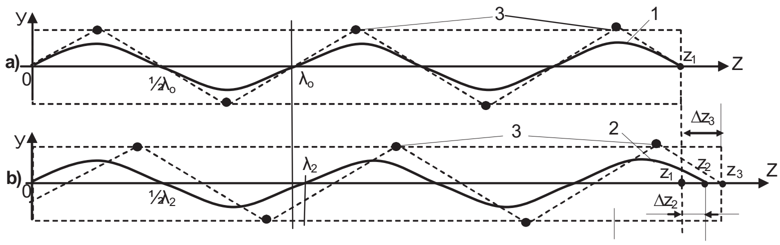

Fig. 1.11. Movement of the photon in the optical medium along the sinusoidal trajectory 1 in a stationary medium (a) and 2 in a water flow (b). 3 – the centres of the molecular lattice of water.

$$C_p = \frac{C_{p0} + v_b}{1 + \frac{C_{p0} v_b}{C_0^2}} \tag{1.30}$$

From equation (1.30) we obtain the well-known Frenel equation for the dragging of light in the Fizeau experiment:

$$C_p = C_{p0} \pm v_b \left(1 - \frac{1}{n_0^2}\right) \tag{1.31}$$

Equation (1.31) can be derived by other methods differing from the Einstein equation (1.29), but all the derivations are based on the constancy of the speed of light in quantised space-time in its local domain.

In order to end the eternal dispute regarding the origin of the luminiferous medium, it is necessary to comment on the experiments carried out by Michaelson and Morley which appeared to have excluded the luminiferous medium from physics. At the same time, physicists, including Lorentz, did not distinguish between the luminiferous medium and the mechanistic gas-like aether. The luminiferous medium, as shown previously, is weightless quantised space-time, the carrier of superstrong electromagnetic interaction (SEI). The mechanistic gas-like aether is a hypothetical ponderable substance filling the cosmic space and, as shown in the Superunification theory, this substance that does not exist in nature. Therefore, we cannot accept any dragging of light, as observed in the Fizeau experiments, in the gas-like non-existent aether.

So, what was recorded in the experiments carried out by Michaelson and Morley in the measurement of the speed of light in the direction of movement of the Earth and across the movement which proved to be identical?. For this purpose, we would have to have the formula of the speed of light in the gravitational field of the morning Earth. No such equation was available at that time. This equation was derived only in the theory of Superunification from the balance of the gravitational potentials (1.11):

$$C = \sqrt{\varphi_1} = C_0\sqrt{1 - \frac{\gamma_n R_g}{r}} \tag{1.32}$$

According to (1.32), the speed of light in the gravitational field of the Earth depends on the distance r from the centre of the Earth. On the surface of the Earth, the speed of light in the direction of movement of the earth and in the direction normal to this direction remains the same. This was also observed in the experiments. However, equation (1.32) was derived from (1.11) for a spherically symmetric system which retains its spherical symmetry throughout the entire speed range thus substantiating the principle of spherical invariance. In particular, the principle of spherical invariance determines the fundamental nature of the relativity principle. This was also recorded in the experiments carried out by Michaelson and Morley. For an independent observer, measurements give the compression of the field in the direction of movement. However, one should not confuse the theory of relative measurements with the relativity principle. These are different concepts. At the present time, the theory of Superunification proposes procedures which enable measurements of the absolute speed of movement in quantised space-time.

1.3.5. Gravity. Inertia. Black holes

The Poisson gravitation equation (1.9) and its two-component solution (1.10) were obtained for the elementary particle for the formation of the particle mass as a result of spherical deformation of the quantised space-time. Gravitation starts with the birth of the elementary particles. However, the principle of superposition of the fields operates in nature in which the summation of the fields from the entire set of the elementary particles, included on the composition of the solid or cosmological object, determines its gravitation parameters.

In this context, the Poisson equation (1.9) and its two-component solution (1.8) can also be extended to cosmological objects. The gravitation interface R_S may already be regarded as the radius of the cosmological object. At the present time, the solution (1.10) does not take into account the distribution of the gravitational potential or quantum density of the medium inside the gravitation boundary R_S. However, this is of no principal importance for the analysis of the reasons for gravity in the external gravitation field of the object.

For the spherically symmetric system, the distribution of the Newton gravitation potential φ_n is described by the equation:

$$\varphi_n = -\frac{Gm_1}{r} \tag{1.33}$$

Formally, in the law of universal Newton gravity, the perturbing Newton potential φ_n (1.33) determines the gravitational force $\mathbf{F}_m$, acting on the trial mass m_2 ($\mathbf{1}_r$ is the unit vector with respect to radius):

$$\mathbf{F}_m = m_2 \operatorname{grad} \varphi_n = G\frac{m_2 m_1}{r^2}\mathbf{1}_r \tag{1.34}$$

The theory of Superunification shows that the Newton potential φ_n is fictitious, and the action potential C^2 (1.10), (1.11) acts in the quantised space-time. The gravitational force is expressed by means of the action potential C^2 (1.11) at $\gamma_n = 1$:

$$\mathbf{F}_m = m_2 \operatorname{grad}(C_0^2 - \varphi_n) = G\frac{m_2 m_1}{r^2}\mathbf{1}_r \tag{1.35}$$

As indicated by (1.30), the substitution of the Newton potential φ_n (1.33) by the action potential C^2 (1.11) does not change the Newton law. The point is that the gradient from the constant C_0^2 in (1.35) is equal to zero. Differential calculus in the gravitational theory has a significant shortcoming. Using the increments, it is very difficult to find the limiting value of the unification constant C_0^2. The theory of Superunification operates with the limiting parameters of the field.

Taking into account the equivalence of the gravitation potentials to the quantum density of the medium, the gravitational force (1.35) can be expressed by means of the deformation rector **D** (1.3a) of the quantised space-time:

$$\mathbf{F}_m = \frac{C_0^2}{\rho_0} m_2 \operatorname{grad}(\rho) = \frac{C_0^2}{\rho_0} m_2 \mathbf{D} \tag{1.36}$$

The deformation vector **D** in (1.36) is an analogue of the vector of the strength **a** of the gravitation field (**a** is freefall acceleration):

$$\mathbf{a} = \frac{C_0^2}{\rho_0}\mathbf{D} \tag{1.37}$$

Figure 1.12 shows that the trial mass m_2 is situated in a heterogeneous gradient field of the Earth. Quantum density ρ (action potential C^2) weakens at the Earth surface. However, the function ρ and C^2 do not determine the gravitational force and determine its gradient (1.36) i.e., deformation **D** (1.3a) of the quantised space-time. The theory of Superunification changes our views on gravity which cannot form outside the quantised space-time. Einstein connected gravity with the distortion of the space-time. It can now be said that the gravity is based on the real deformation of the quantised space-time.

As already mentioned, the quantised space-time, regardless of its electromagnetic nature, which is also gravitational in its basis, is characterised by the gravitational potential C_0^2. In the absence of a gravitation perturbation, the potential C_0^2 is uniformly distributed in space and there are no gradients and forces. Only the presence of gradients leads to the formation of a non-balanced force.

Figure 1.7 showed the gravitation diagram of the elementary particle inside a gravitation well. The gravitation well forms in exactly the same manner around any object, having a perturbing mass. Figure 1.13 shows that formally the trial mass rolls into the gravitational wave towards the perturbing mass, ensuring their gravity. The theory of gravitation has never considered the presence of gravitation dwells inside the quantised space-time during its gravitational perturbation.

From the gravity field of the perturbing mass m_1 (Fig. 1.12) we transfer the trial mass m_2 to a separate diagram in Fig. 1.14, without changing the heterogeneity of the gravitation field inside the gravitation interface of the trial mass. Consequently, the deformation rector **D** is not affected and this vector can be described more efficiently by the indexes D_2^i, where i is the inertia vector, 2 is the deformation of the field inside the trial mass. In this case, the trial mass is subjected to the effect of the accelerating inertia force $\mathbf{F}_i$, regardless of the fact that the surrounding quantised space-time is not deformed.

Inside the trial mass m_2 (Fig. 1.14) the quantum density of the medium increases from ρ_2^{i1} to ρ_2^{i2}, forming inside the solid the gradient of the quantum density of the medium which determines the direction and magnitude of the deformation vector D_2^i and the effect of the accelerating force $\mathbf{F}_i$:

$$\mathbf{D}_2^i = \text{grad}\ (\rho_2^i) \tag{1.38}$$

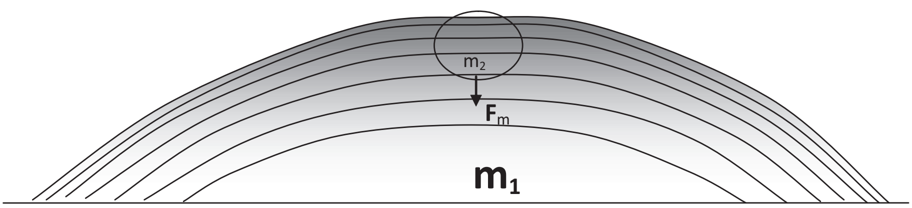

Fig. 1.12. Gravity force $\mathbf{F}_m$, acting on the mass m_2 in the field of the perturbing mass m_1.

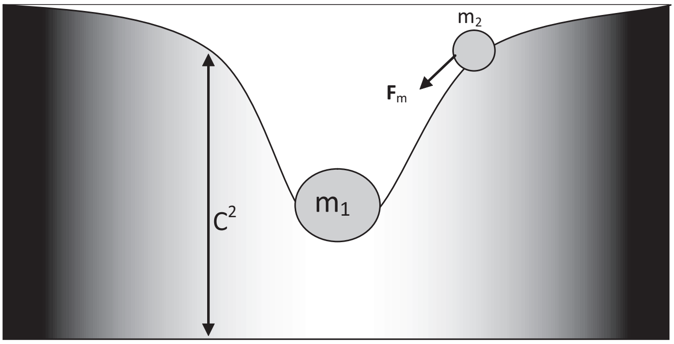

Fig. 1.13. Presence of a gravitation well in the quantised space-time around the perturbing mass m_1 two explains the effect of the gravity force $\mathbf{F}_m$ on trial mass m_2.

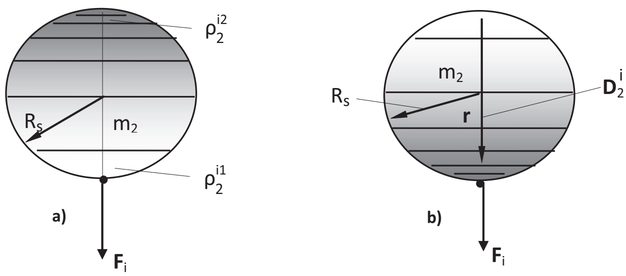

Fig. 1.14. Redistribution of the quantum density of the medium (or gravitation potentials) (a) and the formation of deformation vector $\mathbf{D}_2^i$ (b) inside trial mass m_2 as a result of the effect of the accelerating force F_i.

$$\mathbf{F}_m = m_2\mathbf{a} = m_2 \frac{C_0^2}{\rho_0} \mathbf{D}_2^i \tag{1.39}$$

$$\mathbf{a} = \frac{C_0^2}{\rho_0} \mathbf{D}_2^i \tag{1.40}$$

The equivalence of gravity and inertia is de termined by the capacity of the quantised space-time for deformation in the presence of which the unbalanced gravity force or inertia forms. The difference between gravity and inertia is that the deformation of the field inside the trial mass under the effect of gravity is caused by the external perturbing field, and in the case of inertia – by the effect of the perturbing force.

For the limiting case of the gravity force, the parameters of the gravitation object can be examined conveniently in the black hole state. The theory of

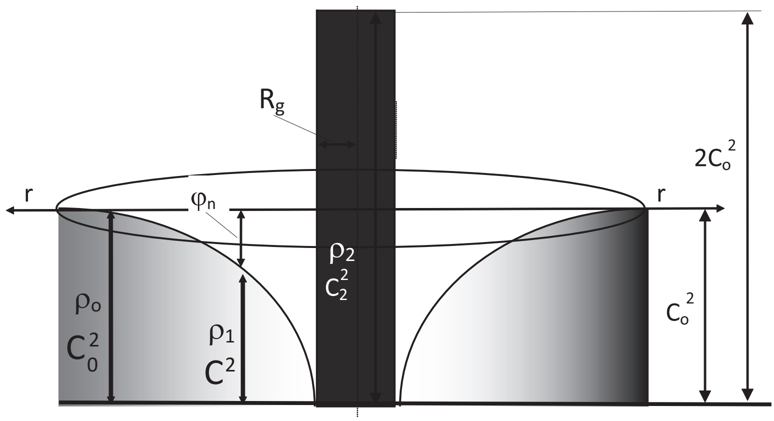

Fig. 1.15. Gravitation diagram of a black hole.

Superunification has its own method of calculating the parameters of black holes. Taking this into account, we can write the parameters of a static black hole on the surface from (1.10) for $r = R_g$ (1.5) and $\gamma_n = 1$

$$\text{At } r = R_g, \quad \varphi_1 = 0; \quad \varphi_2 = 2C_0^2 \tag{1.41}$$

Figure 1.15 shows the gravitation diagram of a black hole. The compression region is dark, the tension region is light. At the interface of the regions, there is a break in the luminiferous medium. For this reason, the light cannot penetrate into the black hole or escape from it. $C = 0$ on the surface of the black hole also results from the equation (1.32).

The theory of Superunification removes the fundamental errors relating to the theory of black holes. It is assumed that the strong gravitational field of the black hole captures the light and prevents it from escaping. In fact, the strong gravitational field results in breaks of the luminiferous medium, i.e., quantised space-time.

For a dynamic black hole, the collapse of matter takes place when the speed of the object is increased. At $C^2 = 0$ from equation (1.11) we obtain the condition of formation of the dynamic black hole:

$$\varphi_n \gamma_n = C_0^2 \tag{1.42}$$

At $r = R_g$ (on the surface of the black hole) we determine the mass of the black hole which determines the limiting mass of the particle (1.7). Evidently, when the speed of light is reached, the elementary particle transfers to the state of the dynamic black hole or, more accurately, a microhole. Equation (1.8) gives the limiting force $F_{T\max}$ of surface tension of the quantised space-time for the black hole:

$$F_{T\max} = \frac{C_0^4}{G} = 1.2 \cdot 10^{44}\ \mathrm{N} \tag{1.43}$$

The magnitude of the force (1.43) is the maximum force attainable by gravitation in quantised space-time.

1.3.6. Anti-gravitation. Minus mass. White holes

Anti-gravitation is gravitational repulsion. There is an erroneous view according to which anti-gravitation is the hypothetical conjecture of theoreticians and does not exist in nature. In fact, the effect of anti-gravitation in nature is manifested as widely as gravity. Only its effect is found in the area of cosmology and also in the area of elementary particles at a distance is smaller than the conventional radius of the electron.

In the area of cosmology, anti-gravitation repulsion from the centre of the universe explains the accelerated recession of galaxies and the nature of these forces is also described in the theory of Superunification.

These zones of anti-gravitational repulsion at distances smaller than the conventional electron radius have been found in the elementary particles: the electron, positron, proton and neutron. This excludes the collapse of atomic nuclei, balancing the nuclear forces as the forces of electrical attraction of nucleon shells. Evidently, the electronic neutrino, as a dipole structure, has the minus mass showing repulsion forces at short distances and, at the same time, having a small interaction cross-section.

Since this study is concerned with cosmology, the minus mass as the source of gravitation, can be described by the two-component solution (1.8) of the Poisson equation and by the balance of the gravitation potentials (1.11), replacing the minus sign (–) by the plus sign (+):

$$C^2 = C_0^2 + \varphi_n \gamma_n \tag{1.44}$$

$$\begin{cases} \varphi_1 = C^2 = C_0^2 \left(1 + \dfrac{R_g \gamma_n}{r}\right) \\ \varphi_2 = C_2^2 = C_0^2 \left(1 - \dfrac{R_g \gamma_n}{R_s}\right) \end{cases} \tag{1.45}$$

Figure 1.16 shows the gravitation diagram of the minus mass in accordance with (1.44) and (1.45). In contrast to the plus mass (Fig. 1.7 and 1.13), the minus mass forms a hillock and not a well in the quantised space-time (Fig. 1.13) Formally, this explains the rolling of the trial mass from the hillock as the representation of repulsion forces. In fact, the direction of the deformation vector **D** of the quantised medium changes and the gradient forces of repulsion act from the centre of the minus mass. In any case, the gradient forces act in the direction of the region of the decrease of the quantum density of the medium and gravitation potential of the quantised space-time (Fig. 1.13 and 1.16). The heterogeneity of the quantised space-time determines the effect of the gradient forces in the quantised space-time.

It should be mentioned that the positron, having the plus mass, relates to antiparticles. This means that the presence of the minus mass does not indicate that this mass is antimatter.

The minus mass can be in the state of a white hole (Fig. 1.17) on the condition:

$$\text{At } r = R_g, \quad \varphi_1 = 2C_0^2; \quad \varphi_2 = 0 \tag{1.46}$$

Evidently, our universe may be in the state of the white hole because only this state is characterised by the effect of the gradient forces from the centre of the universe on the galaxies starting acceleration of the latter.

Figure 1.18 shows the possible scheme of our quantised universe in the state of the white hole and the minus mass. This means that our universe has the form of a sphere expanding as a result of inflation and the centre of the sphere contains a white hole (the absence of the quantised medium). This allows the possibility of a big bang preceding inflation releasing the quantons and bonded and free electrical quarks. It is likely that the inflationary theory will provide the answer to the process of expansion of our universe and individual stages of this expansion.

It is possible that the gradient of the quantum density of the medium directed from the centre of the universe to the periphery which determines the direction of the deformation vector and the accelerated recession of the galaxies, could be referred to as a gigantic gravitational wave which periodically changes the direction of the gradient of the quantum density of

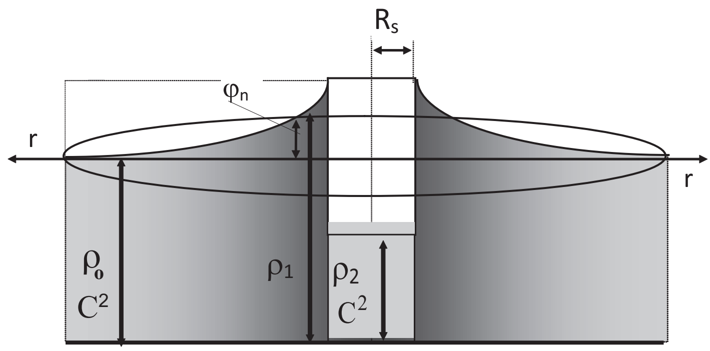

Fig. 1.16. The gravitation diagram of the minus mass. The compression region is dark , tension region light.

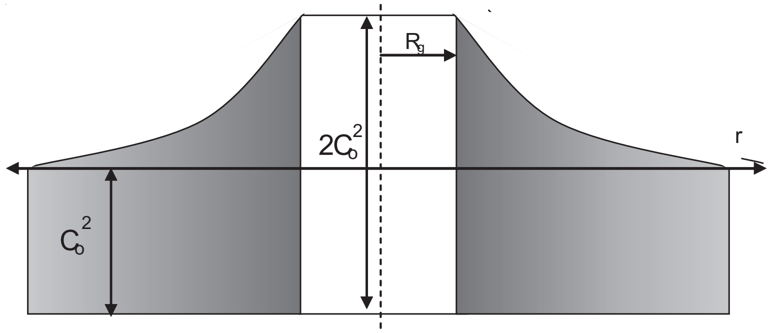

Fig. 1.17. The minus mass in the white hole state.

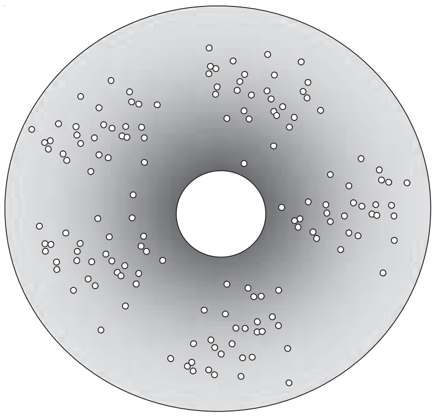

Fig. 1.18. Our post-inflationary quantised universe in the white hole state and the minus mass.

the medium. The recession of the galaxies is replaced by their movement in the direction to the centre of the universe.

The state of our universe may be described by the Poisson equation and its two-component solution for the minus mass (1.45) under the condition (1.46):

$$\begin{cases} \varphi_1 = C^2 = C_0^2\left(1+\dfrac{R_g}{r}\right) \\ \varphi_2 = C_2^2 = 0 \end{cases} \tag{1.47}$$

Unfortunately, the gravitation radius R_g of our universe as the minus mass is not yet known. The visible horizon of the universe is determined by the dimension 10^{26} m. However, this does not mean that we can see the actual image of the world. As indicated by Fig. 1.17, our universe is not flat and the quantised space-time is deformed from the centre to the periphery. The universe is distorted. In this deformed distorted luminiferous medium, the light beam is bent and does not travel along a straight line. The same galaxy can be seen from different sides as different objects. If a light beam from our Sun travels travel around a galaxy and returns to us, we would see our past. This is the real basis for a time machine to be used not for travel to the future but for observing the past.

The quantised space-time has gaps between quantons, i.e., the same wormholes and tunnels whose role should be investigated. The possible application of tunnels as channels ensuring the circulation of energy in the universe has been investigated as an example.

1.3.7. Problem of time. Chronal fields

The theory of quantum gravitation cannot be investigated separately from time whose carrier is the quanton, specifying the lapse of time with a period of $2.5\cdot10^{-34}$ s inside the quantised space-time (Fig. 1.5). In this respect, the quantin is an unique and universal particle uniting electromagnetism and gravitation, space and time. The problem of time is far more complicated than thought previously. The theory of Superunification presents for the first time a material carrier of time, a real 'electronic clock', defining the rate of time at every point of quantised space-time. The concentration of the time carriers in the volume of space is determined by the quantum density of the medium ρ_0 for the quantised space-time unperturbed by gravitation:

$$\rho_0 = \frac{k_3}{L_{q0}^3} = 3.55\cdot10^{75}\,\frac{\text{quantons}}{\text{m}^3} \tag{1.48}$$

where L_{qo} = $0.74\cdot10^{-25}$ m is the calculated diameter of the quanton, k_f = 1.44 is the filling coefficient.

The period T_0 of the electromagnetic oscillation of the quanton is determined by the speed of travel of the electromagnetic wave C_0. Separating L_{q0} from equation (1.48), we obtain:

$$T_0 = \frac{L_{q0}}{C_0} = \frac{1}{C_0}\left(\frac{k_3}{\rho_0}\right)^{\frac{1}{3}} \approx 2.5\cdot10^{-34}\ \text{s} \tag{1.49}$$

In the case of gravitation perturbation of the quantised space-time, the lapse of time T_1 and T_2 is determined by the changed quantum density of the medium ρ_1 and ρ_2 for the two-component solution (1.4):

$$T_1 = \frac{1}{C}\left(\frac{k_3}{\rho_1}\right)^{\frac{1}{3}} \tag{1.50}$$

$$T_2 = \frac{1}{C_2}\left(\frac{k_3}{\rho_2}\right)^{\frac{1}{3}} \tag{1.51}$$

The equations (1.50) and (1.51) determine the lapse of time in the external region from the gravitational boundary and inside the region in the presence of the perturbing gravitation mass in quantised space-time. Substituting the speed of light C and the quantum density of the medium ρ_1 into the equations (1.50) and (1.51), taking into account the normalised relativistic factor γ_n, we obtain the lapse of time in the external and internal regions of the gravitational diagram (Fig. 1.8) for the perturbing mass in the entire speed range from 0 to C_0:

$$T_1 = T_0\left(1 - \frac{\gamma_n R_g}{r}\right)^{-\frac{5}{6}} \tag{1.52}$$

$$T_2 = T_0\left(1 + \frac{\gamma_n R_g}{r}\right)^{-\frac{5}{6}} \tag{1.53}$$

Analysis of (1.52) shows that with the increase of gravity and the speed of movement of the perturbing mass, the period T_1 (1.52) in the vicinity of the mass increases. This is equivalent to reducing the rate of lapse of time. However, inside the gravitation boundary of the rate of lapse of time (1.6) increases. Naturally, the lapse of time is given by the elastic properties of space-time quantum (quanton) as a volume resonator playing the role of specific 'electronic' clock. With the increase of the speed of the body and the decrease of the quantum density of the medium on the surface of the body, the elastic properties of the medium decrease and, correspondingly, the rate of lapse of time in the vicinity of the body decreases.

Finally, it is interesting to investigate the course of the biological clock of cosmonauts flying in a spaceship at the speed close to the speed of light. According to Einstein, this problem was treated as the twins paradox where the deceleration of time at high speeds causes that one of the twins who returned from cosmic travel finds his brother to be an old man whereas he remains young. In fact, this problem is not so simple, and the twins paradox is only the Einstein's original concept in order to attract the attention of society to the theory of relativity during its popularisation.

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 crushed by the gravity force of his own body and even his matter can transfer to the state of a dynamic black microhole. However, even at lower speeds, the time is accelerated inside the shell of the elementary particles forming the body of the cosmonaut because the quantum and density of the medium increases. In the external region behind the shell (gravitational boundary) of the particles, i.e., inside the cosmonaut body, the time slows down. If it is imagined that the cosmonaut is not crushed by gravity, then it is difficult to estimate at the moment the effect of space travel on the ageing of the organism. However, even if the spaceship travels at a speed of 50% of the speed of light, which is a very high speed of the order of 150 000 km/s, the increase of gravity and the variation of the lapse of time will be small so the cosmonaut will not notice them. For the cosmonaut it is more difficult to withstand overloading and weightlessness. However, in travel with constant acceleration equal to the freefall acceleration on the Earth surface, the problem of weightlessness can be solved.

Equation (1.52) shows that the lapse of time in the quantised medium perturbed by gravitation is distributed nonuniformly and represents a scalar field which can be referred to as a chronal field. In fact, the chronal field is described by the Poisson equation for the lapse of time whose solution is represented by the equations (1.52) and (1.53).

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

1.3.8. Who lights up stars?

Working on the theory of Superunification, I did not found any convincing reasons for supporting the thermonuclear hypothesis of the source of luminosity of the stars. This is not caused by the solar neutrino and stability of the solar radiation over the period of billions of years from the moment of birth of biological life. It is not due even to the results of investigations carried out using the Hubble telescope which shows the birth of new stars. The entire point is the temperature concept of thermonuclear synthesis which still has no theoretical substantiation.

At the present time, the contradictions of the quantum theory lay between the temperature and recoil of the atom during emission (adsorption) of the photon. It would appear that as the energy of the emitted photon increases, the intensity of the recoil of the atom and by the photon should also increase and the temperature vibrations of the atoms (molecules) should become greater. However, in practice the situation is completely reversed, the most intensive recoil is shown by the low-energy infrared photon (thermal photon). It must be proved mathematically that the thermal recoil of the atom (molecule) is inversely proportional to the energy of the emitted photon. This problem has been solved successfully in the theory of Superunification.

We have been accustomed to think that the recoil of a gun is proportional to the momentum of the emitted projectile. However, the reverse must now be proven. These are the paradoxes of the quantum theory. For more than 40 years we have been led to believe that the future of power engineering is controlled thermonuclear synthesis (CTS) thus closing other investigation directions. It was promised that CTS would solve all energy problems of the mankind already by the year 2000, and huge sums of money have been spent on this project. The time has passed, the energy problems have not been solved and on the contrary, the situation is quite critical. The inoperative CTS systems of the Tokamak type have been replaced by the new international project ITER.

I say openly that the ITER project is the grandiose scientific adventure and clear waste money of taxpayers for the antiscientific and futile investigations, as already was the case with the Tokamak. The CTS is based on the false temperature concept of synthesis. Initially, it was assumed that it is sufficient to heat hydrogen-forming plasma in a magnetic trap to a temperature of 15 000 000° and the CTS of helium would start with the generation of energy as a result of a mass defect of the nuclei. The temperature in the plasma has already reached 70 000 000° but no CTS has taken place. It is evident that the temperature concept of synthesis of nuclei does not work.

When the nature of nuclear forces in the theory of Superunification became known, it appeared that there are no methods for including the temperature factor in the concept of CTS as the factor of overcoming the electrostatic repulsion of protons (hydrogen nuclei). The temperature concept of CTS was based on the positive experience of exploding hydrogen bombs in which the detonator was represented by a preliminary atomic explosion, accompanied by the generation of a colossal amount of energy. However, in this case, temperature is one of the energy generation factors. Other factors include high pressure and acceleration which ‘push’ the proton nuclei into each other to distances of the action of nuclear forces (electrical forces of alternating shells of the nucleons), overcoming the electrostatic repulsion of the nuclei.

Generation of colossal pressures and acceleration of particles under the effect of nuclear explosion inside a thermonuclear reactor in the laboratory conditions is not possible because of purely technical reasons. Heating of the plasma in the magnetic trap of the Tokamak is of no use here. Knowing the values of the nuclear forces and the cross-section of the effect of these forces, it is easy to calculate the pressures and forces which must be overcome to bring the nucleons together despite their electrostatic repulsion. For this purpose, the proton nuclei of light elements must be compressed by the accelerated fragments of the atomic nuclei of heavy elements (uranium, plutonium, etc), giving the fragments the force momentum, as is the case in the thermonuclear bomb. The fragments of the heavy nuclei are accelerated as a result of their stronger electrostatic repulsion in splitting at the moment of atomic explosion. The conditions for natural acceleration of nucleus fragments are generated.

Consequently, we obtain a nuclear press in which the light nuclei are compressed between the accelerated fragments of the heavy nuclei and quantised space-time representing the elastic quantised medium (EQM) which plays the role of a wall (anvil). The strength of this anvil increases with the increase of the strength of the effect of acceleration and momentum on the anvil. This is the factor of the quantised medium having the properties of super hardness under the effect of colossal acceleration and forces from the side of the second compulsory factor - accelerated fragments of the heavy nuclei which have not as yet been investigated in the theory of nuclear synthesis. Without these two factors playing the fundamental role in the explosion of the thermonuclear bomb, it is not possible to start controlled thermonuclear synthesis.

On the other hand, I wanted to verify by calculations the extent to which the temperature concept of thermonuclear synthesis is related with the synthesis of nuclei. I could not find in the literature sources any calculations linking nuclear forces with temperature. It is highly likely that they do not exist. In order to calculate these forces, it is necessary to have clear information on the temperature not as the parameter on the scale of the thermometer or the energy of the photon but as the thermal energetics parameter. However, here as already mentioned, the currently available quantum theory fails. It appears that as the photon energy increases the intensity of the recoil of the atom by the photon decreases; the most intensive recoil is characteristic of the low-energy infrared photon (thermal photon) which is not capable of ensuring a recoil momentum of the atomic nucleus for overcoming the electrostatic barrier between the elements of the light nuclei.

I paid special attention to this energy paradox because temperature is connected with the temperature oscillations of the atoms and molecules as a result of a recoil during radiation (reemission) of the photon. In its time, the development of quantum theory also started from the energy paradox when the discrete nature of radiation of the atoms and the dependence of the photon energy on its frequency (and not on the intensity of radiation) was discovered. This contradicted classic electrodynamics. At present, these contradictions of quantum theory are found between the temperature and the recoil of the atom at emission (absorption) of the photon when it is not possible to overcome the forces of electrostatic repulsion of the atomic nuclei when attempting their synthesis. The temperature concept of the CTS is anti-scientific in its nature and has no prospects for development in energetics. Other concepts must be found.

Thus, the solution of the given task is not only of the purely theoretical interest but is also of the colossal applied value in the processes of production of thermal energy in new energy cycles of quantum energetics. Here we are discussing a number of the experimental effects with the generation of excess heat, including the Usherenko effect (the effect of superdeep penetration of microparticles into hard targets). If the effect of positive generation of heat is still being attempted in the CTS, in the Usherenko effect this energy generation is 10^2–10^4 times higher than the kinetic energy of accelerated particles – strikers. However, this is only one of the many facts confirming by experiments the prospects for the development of quantum energetics as the basis of energetics of the 21st century. In fact, quantum energetics is a more general concept which also includes nuclear reactions which, in the final analysis, are only one of the methods of extracting the energy of superstrong electromagnetic interaction (SEI).

It has been established that the only source of energy in the universe is the superstrong electromagnetic interaction. This is the source of luminosity of stars. It is necessary to find new power cycles which would replace the thermonuclear concept of thermonuclear synthesis. The temperature on the Sun surface does not exceed 6000°C and the temperature inside the Sun has not been measured. It is necessary to develop new approaches to the energy of stars. The energy cycles in the electron–positron plasma appear to be more suitable for this purpose. It is completely justified to assume that these new energy cycles have been experimentally established in the Usherenko effect. Through the electron–positron plasma we can arrive to the birth of protons and neutrons and subsequently hydrogen and helium.

The principle of spatial transformation of energy provides a scientific substantiation for the release of the energy of superstrong electromagnetic interaction in new energy cycles in which the energy capacity may reach 10^{17} J/kg. This is three orders of magnitude greater than the energy capacity of nuclear and thermonuclear reactions. The new energy cycles are based on the reactions of cold synthesis of elementary particles and their antiparticles with subsequent annihilation. This is considerably simpler and safer than work with the synthesis of atomic nuclei.

Nobody has confirmed that the heavy elements form in the nuclei of stars. In all likelihood, the process of formation of heavy elements takes place outside the stars in the quantised space-time in which there are suitable conditions for the natural acceleration of light elements. The accelerated nuclei in collisions in the opposite directions, overcoming electrostatic repulsion, merge into heavier nuclei. Cosmos is the acceleration laboratory for the production of new elements, starting with the synthesis of elementary particles and their antiparticles in quantised space-time.

Figure 1.19 shows shell models of nucleons which contain electrical quarks of different polarity in their alternating shell. Such a shell is characterised by the tightening effect, compressing the quantised space-time inside the shell and expanding it on the external side. The effect of the alternating shell with respect to the spherical deformation of the quantised medium is considerably stronger in comparison with the effect of the central quark in the generation of the electron (positron). Therefore, the mass of the nucleons is considerably greater than the mass of the electron (proton). On the other hand, the alternating shell of the nucleons is characterised by the transmission capacity for the quantons, ensuring the wave transfer of nucleons in the quantised space-time.

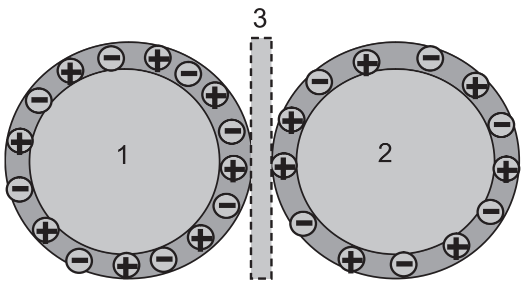

Fig. 1.19. Electrical interaction of alternating shells of nucleons. 1) neutron, 2) proton, 3) the region of the effect of nuclear forces.

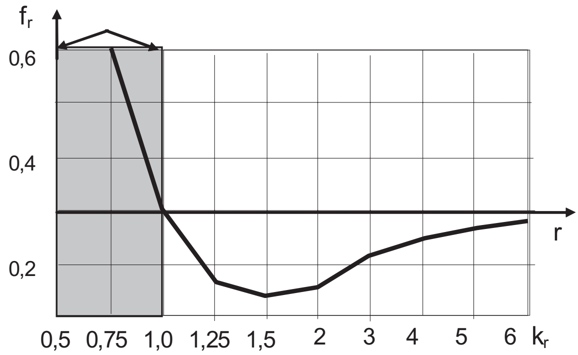

Fig. 1.20. Variation of electrical forces of repulsion and attraction in interaction of the shells of the nucleons as a function of f_r (k_r).

The difference between the proton and the neutron is the presence of the unbalanced electrical charge (quark) with positive polarity in the proton shell. In the neutron, the alternating shell contains the same amount of the charge with the opposite sign, showing its electrical neutrality. However, at shorter distances, the alternating shells of the nucleons attract each other and this results in the formation of nuclear forces as the forces of electrical attraction of quarks of different type (Fig. 1.20). At distances shorter than the classic electron radius zones of anti-gravitation repulsion were detected at the quarks inside the nucleon shell. These zones balance the forces of electrical attraction of the shells, ensuring the stability of the atomic nuclei at the main elements. The instability of the nuclei of the heavy elements is caused by the increase in the depth of the gravitation well and by the corresponding weakening of the electrical forces of attraction of the nucleon shells. The decay of heavy atoms is caused by the fluctuations ('boiling') of the quantised space-time.

The quark model of the nucleons has been included to the shell model without any objections.

1.3.9. Superstrings

The theory of Superunification has found a suitable applied position in many studies of theoreticians whose concepts were ahead of time. This refers to the space-time quantum, the Dirac magnetic monopole, quarks, fundamental length determined by the quanton diameter, anti-gravitation, the fifth force and the theory of superstrings.

The theory of the superstrings, as the quantum theory, assumes that gravity is determined by the exchange of locked strings which replace hypothetical gravitons. The theory of the superstrings also contradicts the Einstein gravitation theory, rejecting the role of the four-dimensional continuum in the nature of gravity. Unfortunately, none of the theoretical physicists, working in the area of string theory, can proposed methods for experimental verification of the theory.

At the same time, studies of the theory of Superunification, as a continuation of the unified field by Einstein, revealed the presence of real superstrings determining the tension of the quantised space-time.

Figure 1.21 shows that in the quantised space-time we can separate alternating superstrings from quantons. The tension of such an electromagnetic superstring is determined by the mutual attraction of the charges with opposite signs (quarks) inside the quantum and can be easily calculated. The tension force $\mathbf{F}_z$ of the string is calculated as the total effect of electrical F_e and magnetic F_g forces in the superstring ($\mathbf{1}_z$ is the unit vector along the superstring):

$$\mathbf{F}_z = \pm\mathbf{1}_z(F_e + F_g)\cos\alpha_z = \pm\mathbf{1}_z \frac{\pi}{12L_{q0}^2}\left(\frac{e^2}{\varepsilon_0} + \mu_0 g^2\right) = \pm 2\cdot 10^{23}\ \mathrm{N} \qquad (1.54)$$

The tension $\pm\mathbf{T}_z$ of the electromagnetic superstring is determined as the force $\mathbf{F}_z$ acting in the cross-section S_q of the quanton:

$$\pm\mathrm{T}_z = \frac{\pm\mathrm{F}_z}{S_q} = 4\frac{\pm\mathrm{F}_z}{\pi L_{qo}^2} = \frac{\pm 1_z}{3L_{q0}^4}\left(\frac{e^2}{\varepsilon_0} + \mu_0 g^2\right) = \pm 4.65\cdot 10^{73}\,\frac{H}{\mathrm{m}^2} \qquad (1.55)$$

As indicated by (1.54) and (1.55), the quantised space-time is characterised by colossal tension (and elasticity) which determines the high rate of the wave processes in it (the speed of light $3\cdot 10^8$ m/s).

In Fig. 1.22, the electromagnetic superstring (Fig. 1.21) is interpreted in a slightly different form in which the tension between the quantons is determined by short locked strings. In this respect, the string theory has a real physical basis.

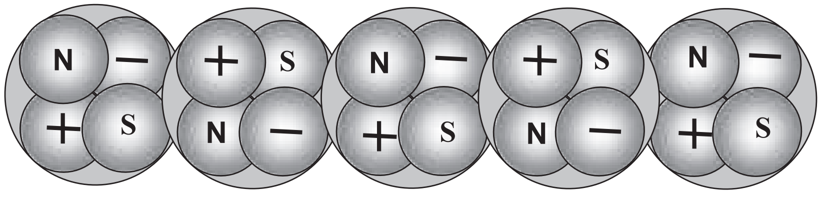

Fig. 1.21. Separation of the alternating electromagnetic superstring from the quantons inside quantised space-time.

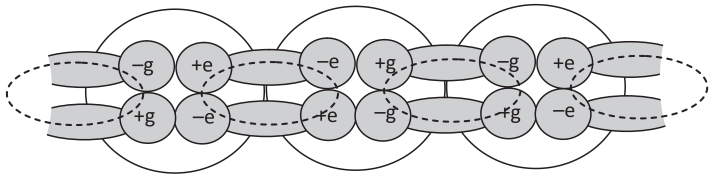

Fig. 1.22. Section of the electromagnetic superstring from quantons connected together by short strings. For better understanding electric and magnetic dipoles of the quantons are rotated in the plane of the figure whereas in reality their axes are mutually perpendicular (Fig. 1.5).

1.3.10 Main problems of modern physics

In the last ten years, since the discovery in 1996 of the quantum of space-time (quanton) and the superstrong electromagnetic interaction, I have completed the theory of Superunification of fundamental interactions which unites gravitation, electromagnetism, nuclear and electrical weak forces. The integrating factor is the superstrong electromagnetic interaction (SEI), i.e., the fifth force which is so far unknown to science. The SEI is the unified field whose realias were proposed by the genius Einstein who spent 30 years of his life to find within the framework of the general theory of relativity (see the section Einstein's posthmuous phrase).

The theory of Superunification is the main theory of contemporary physics. The main assumptions of the theory of Superunification have been published in open press and summing this up, I would like to mention that two volumes of studies have been collected, with the total volume of more than 1000 pages and several thousands of new equations. The period of active popularisation of new concepts is about to begin. There is no better approach to the popularisation of new fundamental discoveries and the theory of Superunification than the polemics between Ginzburg and Leonov

To understand the principal error made by Ginzburg, is it necessary to present his ideological viewpoint regarding matter taking the results of his studies into account? I hope that I am not too far away from the truth when assuming that in his concept, the basis of the material world is represented by the ponderable matter, i.e., the matter, and these are elementary particles having the mass and all other physical bodies, including stars and black holes. There are also photons with some small rest mass (?) and another electromagnetic matter, which however appears to be secondary and not main. The principal method of investigations ponderable matter is the decomposition method in which the matter is divided into smaller particles. We arrive here at the elementary particles which, it would appear, are not so elementary but their structure cannot be determined. Smaller particles have been invented, i.e., quarks, but no reliable experimental facts have been presented. In the area of the theory of elementary particles, special attention is given to the probability phenomenology of quantum theory, without understanding the reasons controlling the microworld, assuming that the end of certainty in physics has arrived. The space-time is the purely geometrical category with the minimum energy level, governed by the relativity principle. This is the basis of advanced theoretical physics which is somewhere accurate and somewhere erroneous. In particular, in some cases I did not touch this basis and in some cases I corrected it, but in the main I removed it completely in order to link physics by a single concept in the theory of Superunification. However, this will be discussed later.

Ginzburg clearly understood that the problem of Superunification lies in the fifth force but made the serious error in its formulation: '*Physicists know that the micro- and macroworld are controlled by four forces. The attempts to find the fifth force have been unsuccessful for more than 50 years*. *The physicists realise that they are looking for something incredibly weak that has been eluding detection so far (Vestnik RAN, vol. 69, No. 3, 1999, p. 200).* In fact, in order to combine the four fundamental interactions (forces): gravitation, electromagnetism, nuclear and electroweak forces, the fifth force is essential. However, dear Vitalii Lazarevich, to combine these forces, they must be governed by the fifth force: any schoolboy knows that: in '*in order to subordinate a force*, *an even greater force is required*'. This is the golden rule of physics. In order to subordinate nuclear (strong) interactions, it is necessary to have a force which is greater than the nuclear force. So what is the force you are referring to, saying that 'it is something incredibly weak?'. There is for example the electroweak force, i.e., we are discussing the fifth force as the superweak force. However, this force is not capable of combining all other forces. For this reason, you have not been able to create the theory of Superunification because no accurate concept of unification has been developed.

Superunification requires the Superforce. The well-known English theoretical physicist and science populariser Paul Davis devoted his popular book 'Superforce' in this problem, claiming: 'Entire nature, in the final analysis, is governed by the effect of some Superforce, manifested in different 'hypostases'. This force is sufficiently powerful to create our universe and provide it with light, energy, matter and the structure. However, the Superforce is something greater than simply something creating the beginning. In the Superforce, matter, space-time and interaction are combined into the indivisible harmonic whole generating such unity of the universe which previously no one assumed'. [Davies P., Superforce. The search for a grand unified theory of nature, New York, 1985].

It can be seen that not all the physicists in the world shared Ginzburg's views. I find it surprising why Davies, who correctly formulated the concept of the Superforce more than 10 years prior to the discovery of the quanton – the particle of the carrier of Superforce – did not do this instead of me. This could have been done by Einstein who accurately formulated the concept of the unified field whose carrier is also the quanton. The unified Einstein field cannot be separated from the Superforce. This is now clear and understood when it is presented in the theory of Superunification but this could not be done so simply until my research.

The Lord gave me the power to see what others cannot see. My brain enables me to penetrate into the secrets of the ultra-macroworld of quantised space-time. I simply see what takes place there. I then draw the observed physical models and calculate them. I have no rough copies. I have now reached a highly perfected state and all calculations are carried out immediately, accurately, with only a small number of errors. However, this required many years of training. I have never studied mathematics, I have only several books and the Encyclopaedia of Mathematics to which I refer only very seldom. I assume that it is much simpler to start everything from the beginning instead of studying conclusions made by others. Therefore, I do not experience any serious problems with the mathematical description of the processes which I observed in the ultra-microworld of the quantons. I explain this by the fact that the observed physical models are accurate in their basis and they contain the correct mathematical origins. There is one fine detail. I must have a problem long before without knowing how to solve it. It is evident that subconsciousness operates in this case and when the solution is ready, I only write it down. This was the procedure which I used for solving the most difficult problems of theoretical physics which had been regarded as insolvable. When I turned to mathematicians, nobody could help me. As the theoretical physicist, I have no secrets in the work of my laboratory. Evidently, this purely individual phenomenon explains the reasons for my successes in the development of the theory of Superunification. I work with real physical models and with phenomeno-logical models.

It is now possible to formulate the main problem of contemporary physics: 'what was the first, the matter as ponderable matter or weightless electromagnetic matter? Many mistakes have been made in this question and it is difficult to solve the situation. To explain this problem, we return to the concepts of the open quantum-mechanics system (OQS) and the closed quantum-mechanics system (CQS). For the latter, the base of the matter is the matter represented by ponderable bodies and particles. In this case, the particle (body) is treated as an object isolated in the void. However, this is not in agreement with the experimental results according to which the particle (body) shows both corpuscular and wave properties. How can the isolated particle (body) be both a wave and a corpuscule? The current quantum theory does not provide the answer to this question and postulates the principle of corpuscular–wave dualism as the fundamental physical category.

In order to solve this problem, it would be necessary to examine the structure of the quantised space-time as the carrier of the fifth force - Superforce. In the theory of Superunification, the ambitious term Superforce is replaced by the purely scientific term – superstrong electromagnetic interaction (SEI) whose carrier is the quantised space-time. I shall not discuss the problem of quantisation of space-time which has been explained in other studies. I should only mention that the problem of quantisation of the space is equivalent to the process of filling its volume with quantons - the elementary quanta of space-time, forming in this case the elastic quantised medium (EQM) with the gravitation potential equal to C^2 and not zero, as assumed previously. Here C is the speed of light, equal to the square root of the gravitation potential of the quantised medium which is used as the luminiferous medium. The waves cannot exist without a medium. The quanton itself unites electricity and magnetism, including in itself the electrical and magnetic elementary dipoles whose axes are orthogonal to each other.

In order to understand the reasons for corpuscular–wave dualism, we discuss the formation in quantised space-time of an elementary particle – electron which is the carrier of the electrical charge and mass. If an elementary electrical charge with negative polarity and no mass is thrown into the elastic quantised medium, then under the effect of ponderomotive forces the quantons start to move in the direction of the central charge, as pieces of paper travelling to an electrified comb. The quantised space-time around the central electrical charge is spherically deformed or, according to Einstein, distorted. Consequently, the electrical charge acquire mass and generates the electron as the carrier of charge and mass.

Therefore, the movement of the electron in the elastic quantised medium can be regarded as the wave process of spherical deformation of the medium, i.e., the wave transfer of mass, and the corpuscular transfer of the elementary charge. This is in complete agreement with the principle of corpuscular–wave dualism according to which the particle shows simultaneously its wave and corpuscular properties. The mass of the electron is the equivalent of the energy of elastic deformation of the quantised medium whose basis is electromagnetic. This explains the equivalence of the mass and electromagnetic energy of the particle, established by Einstein, where the energy mC^2 is determined by the work with the transfer of mass m into the region of the quantised medium with the potential C^2.

The principle of corpuscular–wave dualism concerns not only the elementary particles having mass, but also all physical bodies because they consist in the final analysis of elementary particles, being the integral part of quantised space-time. It can be seen that objects isolated from the quantised space-time do not exist in nature and also in closed quantum-mechanics systems. All the elementary particles and physical bodies are open quantum-mechanics systems, and the theory of Superunification has been developed for describing these systems.

The theory of Superunification shows that primary matter in nature is the quantised space-time, with the superstrong electromagnetic interaction (SEI) being its carrier. We live in the electromagnetic universe. In this respect, the energy is unique, and all known types of energy in the final analysis are reduced to extraction or transformation of the energy of the SEI. The theory of Superunification changes the philosophical approach to understanding the mass not as the basis of matter but as the secondary manifestation of the energy of the SEI as a result of spherical deformation of the quantised space-time. It appears that the mass as such does not exist in nature in the concept which we were presented. Mass is secondary.

Paradoxically, the development of fundamental science takes place along the path of its combination with the religious views. Religion always taught that the soul is primary and the body secondary. In the theory of Superunification this main assumption of religious teaching is completely confirmed. If the soul is regarded as the weightless (non-body) electron charge, the physics of the elementary particles leads to the scientific justification of the field form of energy-information interactions. The field form is the weightless (non-body) form of matter, with the information bit being the carrier of the latter. A classic example of the formation of an elementary information bit inside the quantised space-time is the reaction of annihilation of the positron and the electron. The positron differs from the electron only by the sign of the central electrical charge, in the positron the charge is of positive polarity.

When the electron and the positron come together to some specific critical distance their spherical fields break up. The electromagnetic energy of elastic deformation of the medium, released during this phenomenon, changes to wave photon radiation. This is similar to shooting from a catapult in which the elastic energy of tension in the rubber is released, ejecting the stone. However, what takes place with the weightless (non-body) charges of the electron and the positron? Their charges with positive and negative polarity form a weightless electrical dipole, some information bit in space on the existence of the pair of the particles: electron and positron. This determines the laws of conservation: energy, mass, charge, and information. It has been proven that the law of conservation of information is the fundamental law of nature. In order to produce an electron and a positron from vacuum it is necessary to split the information bit (weightless electrical dipole) into two charges which spherically deform the quantised medium, forming a mass at the charges and transforming them into elementary particles: electron and positron.

The concentration of the field (weightless) form of information inside the quantised space-time is extremely high and has the controlling importance for the formation of life and intelligence in the universe. A more suitable example confirming this assumption is the non-correspondence between the information detected in the double helix of the DNA and the information required for describing the man as a self-organising and self-reproducing social system. The number of the chemical links of the DNA determines $10^{20}...10^{21}$ bits of information. This information is on the cell level. It is easy to calculate that for the complete description of the man we require 10^{40}–10^{42} bits of information. Where to obtain 20 orders of missing information?

The annihilation of the electron and the positron takes place at distances of the order of 10^{-15} m. Calculation showed that the elementary information bit in the form of an electrical dipole has the size smaller than 10^{-15} m. It can easily be calculated that the information capacity of a single m^3 of quantised space-time may equal 10^{45} information bits. This is the level of information comparable with the level of information required for describing the man. Of course, missing information on the man is hidden on the field level inside quantised space-time. This weightless information is linked with the structure of DNA determining only the inheritance features but on the whole the man as a complicated energy-information system.

Physical investigations show that as we penetrate deeper into the matter, we need to deal with the higher and higher concentration of energy and information. The theory of Superunification shows that the man is an open quantum-mechanical and energy-information system, being the compound and inseparable part of quantised space-time. The man is the cosmos. It is believed that we live the most powerful computer which controls our life activity and also regulates us giving us some freedom of selection. Taking into account that the quantised space-time resembles a solid state structure with impurities, resembling a microprocessor in the local region, the analogy with the computer is fully acceptable. It appears to me that when I work on a computer, I enter the state unity with the information field obtaining new information. I am convinced that we are to face an interesting period, the complete description of the still unknown mysteries of the nature and ourselves.

The theory of Superunification is the most powerful apparatus of investigation of matter. We do not have to go very far for confirmation. For this purpose, we compare the 'Ginzburg list' and the 'Leonov' list, presented previously in the introduction by the author to volume 1.

1.3.11. Problems of inflationary theory

Inflationary theory does not take into account the presence of primary matter, i.e. quantised space-time. How to describe the process of quantisation of the universe? Why is the entire universe electrically asymmetric? Who filled the universe initially with photons?

These problems preceded the appearance of ponderable matter whose fraction is negligibly small in comparison with the primary matter that fills everything.

Will the inflationary theory be capable of answering these and other questions? The development of the theory of Superunification probably facilitated the solution or probably increased the complexity of the problems of inflationary theory. It is pleasing that the inflationary theory, the Big Bang hypothesis has been filled by new initial assumptions which must be clarified.

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1.4. The Einstein posthumous phrase

'*However, at the moment nobody knows how to find the basis of this theory*' is the final phase in the final scientific study of the greatest physicist of the 20th century Albert Einstein published at the year of his death (he died April 18, 1955). The article 'Relativistic theory of the asymmetric field' is barely cited by the physicistd because in it Einstein practically rejected all the scientific knowledge to which he devoted his life and proposes to start everything anew.

Much has been written about Einstein and the theory of relativity but his posthumous will to his successors has not been analysed. The point is that the theory of relativity was not completed by Einstein and after his death many investigators could not add anything significant to the theory. The history of science shows that science develops in jumps from genius to genius. Geniuses appear when a crisis arises in science and they eliminate the crisis by providing new knowledge. In gaps between the jumps new knowledge is required by the scientific community and the knowledge becomes the property of many. This takes many decades. However, nobody knows what to do next. This is the moment of appearance of another scientific crisis and it is necessary to await the arrival of the next genius in order to obtain new information for future generations

The scientific community exploits the knowledge of geniuses, thus living from them. This is the rule of life because scientists also need means. The theory of relativity has been mastered by many physicists who added something or changed something in Einstein equations, published scientific proceedings and books, defending thesis and obtaining academic titles and departments. In particular, for this wide scientific community, the Einstein claim that it is necessary to abandon everything that he di, and it is necessary to start anew, but he does not know how to do it, is unacceptable because it already affects their reputation. In order to have the undisputed scientific reputation, it is necessary to do more than Einstein. However, if it is not possible to do more, it is better to not say anything about the Einstein's posthumous phase. Yes, he was a genius, a strange man, he could afford any trick, even show his tongoue, this was how many perceived him.

It is natural that the majority of scientists do not possess the courage and adherence to principles of Einstein when scientific truth is more expensive than scientific reputation and career. No one forced Einstein to write such a frank scientific testament, he could have been silent. I attempted to analyze not only the reasons which forced Einstein to forego his scientific heritage, but also to trace the motion of his thoughts, to establish where he was right and where he was overcome by serious doubts.

The historians of science, yes even specialists, regards Einstein as the creator of the theory of relativity, at first the special theory of relativity (STR), and then the general theory of relativity (GTR). And only sometimes and that casually, they mention his work on the unified field theory, or more precisely the unified field theory. Einstein assumed that there exists, thus far inaccessible for the researcher, some united field which is also a carrier of gravity and electromagnetism. They are altogether only different manifestations of the unified field. If it is possible to penetrate into the essence of the unified field and to describe it mathematically, then it will be possible to combine gravity and electromagnetism. This was supported by the field theory in which gravity and electrostatics were described by a single differential Poisson equation. Moreover, the laws of the attraction of two masses and two electric charges had identical nature and it seemed that this is the manifestation of some forces, only in different measurements.

For a period of 30 years Einstein fanatically worked on the unified field theory, periodically publishing articles in which he noted that the result would soon be achieved. But time went by and there was no end to the work in sight. Friends and associates repeatedly attempted to dissuade Einstein from this hopeless occupation and they recommended to study quantum theory, especially because he was awarded the Nobel Prize for studies in this region. Young Landau (22 years) specially visited Einstein in 1930 in order to put him on the right track. But the effect was reverse, Einstein to the end of his life did not accept the statistical nature of quantum theory and continued his studies to the last day in order to finally forego its scientific heritage at the end.

Today, when reproaches come from all side to the address of the great physicist that it was his fault that physics came to a sequential crisis, and it is necessary to return to the concept of the universal aether which was allegedly buried by Einstein, I should come out in defense of the outstanding physicist. Several years ago I myself held the same opinion and personally participated in several scientific conferences, including international, dedicated to the criticism of the theory of relativity and wrote four articles on this subject which I now reject and do not refer to them.

The reason for this is the following. After my discovery in 1996 of the quantum of space-time (quanton) and superstrong electromagnetic interaction (SEI), it was necessary to consider the quantised space-time as an absolute substance and I erroneously assumed that the concept of the absolute is incompatible with the concept of relativity. To this contributed publications of a number of the contemporary physicists who categorically asserted that the physical reality is the essence of the geometry of empty space-time and nothing more. In this case they referred on the authority of Einstein and the principle of relativity which allegedly was valid only for the empty space. My studies of the structure of the quantised space-time gave opposite results – there cannot be voids in nature. I was confident that I was right, but the idea of the relativity as the property of empty space interfered with my reasoning. It meant that it was necessary to subvert the theory of relativity which in addition did not work as the theory of the unification of gravity and electromagnetism.

But as I continued my calculations I became convinced that the principle of relativity is indeed the fundamental property of quantised space-time and that Einstein is right. I finally understood that I am on the right track. I cannot find a better teacher than Einstein since the last 30 years of his life he spent on this problem also helped me to complete my work on the unification of fundamental interactions. The crux of the matter is not in personalities. He in fact worked alone for future generations so that the theory of Superunification could be created, uniting within the framework the Einstein's unified field: gravity, electromagnetism, nuclear and electroweak forces.

And now, returning to the last article by Einstein, I felt how stressed was his mind, already an old and very lonely person. He was confident that the united field does exist but that the derived equations are difficult to understand and are unconvincing for physics. He already abandoned the concept of the constancy of the speed of light and the concepts of the inertial and non-inertial systems which he used in the special theory of relativity. The general theory of relativity (GTR) with a constant tensor curvature in the equations of four-dimensional space-time, some complicated analogues of the Poisson equations was his last hope. He did not have any other mathematical apparatus. But the curvature of space-time characterizes only gravity and does not give in any transformation the output to electromagnetism. The field theory does not '*make it possible to understand the atomistic and quantum structure of reality*'. His consciousness could not agree with this. The mind goes round??? ‘quantisation”, ‘quantum phenomena’, ‘quantum numbers’…

Now, when the quantisation of Einstein space-time has been carried out in the theory of the elastic quantised medium (EQM) and the ‘quantum structure of reality’ has been understood, when it is established that the principle of relativity is the fundamental property of quantised space-time, reproaches to Einstein’s address regarding the suggestion that the theory of relativity led contemporary physics to a crisis state are unfounded. As it was noted, the present crisis has not been caused by Einstein but by contemporary physicists incapable of raising the bar of knowledge above the level established by Einstein. Only the discovery of the quanton and SEI, as the carrier of the unified field, has guided physics out of the crisis state. The time interval between ‘jumps’ in the development of fundamental science was 91 years (1905–1996). This was the period of the accumulation of new scientific facts for the next ‘jump’ of knowledge.

Then, at the beginning of the century in 1905 Einstein saved physics from a crisis, postulating the constancy of the speed of light and the independence of inertial systems on the speed of motion when only relative motion, characterized by relative intervals of length and time, determines the reality of motion of matter in the local region of space. Let us say that the constancy of the speed of light is characteristic for the local region of space during movement in it. This is the basis of STR named by Einstein the partial theory of relativity. The concept of gas-like aether dominant in physics up to that time did not allow this. However, in the experiments by Michaelson and Morley the speed of light was registered as constant in the direction and across the motion of the Earth. This contradicted the concept of gas-like aether and corresponded to Einstein’s claims. At that time the simple postulation of the constancy of the speed of light was sufficient in order to remove the emerging contradictions and thus forever exclude from physics the concept of gas-like aether as not having experimental confirmation.

But already in 1904 Poincaré formulated the principle of relativity, assuming that inside a closed camera moving in a straight line as regards inertia it is not possible to measure by physical instruments the speed of the camera relative to the absolute space (this refers to the measurement instruments available at the beginning of 20th century). His conclusions were categorical: if we cannot measure the absolute speed, then absolute space and time in nature do not exist in nature. For him the space was synonymous with the void. Reality can be represented only by relative intervals of time and length in the void. Poincaré was a mathematician and as a mathematician he became accustomed to operating with small speculative intervals, disregarding physics. Absolute space and time were introduced by Newton, but he was initially a physicist and only later a mathematician.

As the physicist, Newton allowed the presence of aether, a carrier of luminiferous medium which must be characterised by colossal elasticity. In a letter to Boyle, Newton suggests that gravity is also the reason for the pressure of the universal aether – some smallest invisible particles which fill entire space and penetrate solids. Since this could not be verified by experiments, then remaining the supporter of physics as an experimental science ('I do not invent hypotheses'), Newton did not carry out any serious studies in this direction and concentrated on the laws of motion in absolute space and time.

The tragedy of physics of the 20th century is that it did not consider the third version, when absolute space and time possess the unique properties of relativity. Poincaré and also independently mathematician Minkowski introduced, purely mathematically, the fourth time coordinate t, adding it to three spatial coordinates x, y, z on the basis of the Pythagoras quadratic formula. This was quite relevant although not accurate. Einstein attempted to find the physical sense of this mathematics, especially because this approach was in agreement with his studies. He reached the physical understanding of the unity of space-time as a continuous continuum capable of functional changes. In fact, Einstein performed the physical unification of space and time into a single substance. This was the first stage on the way to Superunification.

Einstein could not combine gravity and electromagnetism, but the first stage of the physical unification of space and time was realised by him. Mathematicians Poincaré and Minkowski did not give any physical value to the fourth coordinate introduced by them and examined only the geometric parameters of coordinates. Einstein, possessing colossal physical intuition, understood already at the very beginning when he formulated the concept of the unified field, that the united four-dimensional space-time contains colossal physical sense and is the carrier of gravity and electromagnetism. Therefore he could not for 30 years study any another problem and regarded this problem as the most important. And as time showed, Einstein was right.

But then in order to give mathematical meaning to the concept of the unified field, and Einstein was not a mathematician, he rejected the formulas derived by mathematicians Poincaré and Minkowski, characterising the metric properties of space-time by the four-dimensional interval. However, the functional possibilities of the four-dimensional interval for the analysis of the state of space-time are limited. This Einstein understood. He required a universal function, and by varying this function, from the properties of space-time one can transfer to gravity and then to electromagnetism.

Einstein's scientific intuition again surpassed the possibilities of mathematical apparatus. It is believed that he saw the curvature of cosmic space-time as a result of the disruption of its uniformity by many moving cosmological objects. At present, it is not possible to mathematically describe the visible picture of curvature. However, it can be seen on the surface of the sphere if we take two very close apparently parallel meridial lines on the equator, and they will inevitably cross far beyond the horizon on the pole. Einstein used this approach to the non-Euclidean geometry of Lobachevsky and Riemann, to the tensors, continuously complicating and complicating mathematical apparatus, but without reaching the necessary result of the unification of gravity and electromagnetism. Geometry made it possible to connect the distortion of space-time only with gravity.

I intentionally omitted reasonings about the transformations of the Lorentz coordinates and the relativism as integral parts of the theory of relativity, since all this can be found in books. Together with Einstein, founders of relativity are Poincaré and Lorentz. To me it is important to concentrate attention on the contradictions between the categories of absolute and relative in physics as the categories of unity and of fighting the opposite. Specifically, the prevailing contradictions between the categories of the absolute and the relative influenced the fate of physics in the 20th century.

Poincaré was categorical and connected relativity only with the empty space, completely denying the Newtonian concepts of absolute space and time. Lorentz originally supported the concept of the stationary absolute aether and did not determine its structure (gas-like or electromagnetic?), and after the publication of Einstein's studies, he agreed only with his mathematical computations, attempting to resuscitate the aether concept by the effect of reductions of linear dimensions in the direction of motion. Einstein categorically disagreed with him, but was very careful in his statements with respect to the aether during his entire life: '*According to the general theory of relativity space is unthinkable without aether*'; '*To deny aether – this, in the final analysis, it means to assume that the empty space has no physical properties*' (1920) and so forth.

As is evident, the basic problems of physics of 20th century concern the nature of the four-dimensional space-time. Even classics of science had the opposite opinions: from the complete negation of the structure in space (Poincaré) to the nonacceptance of empty space-time (Einstein). Einstein replaced the gas-like aether with the concept of four-dimensional space-time, completely denying the existence of empty space, and by aether he understood the medium which does not possess the properties of weighty matter regarded as the carrier of gravity and electromagnetism. The problem was that Einstein did not visualize the weightless structure of space-time.

If space-time is the carrier of light and gravity, and light as an electromagnetic wave moves with the colossal speed, then they understood everything that the structure of space-time must possess colossal elasticity. Taking into account that the electromagnetic wave is transverse waves, the space-time must resemble a solid body since the transverse waves can be transffered only in the solid body. Thus, the structure of space-time must resemble a superhard body and possess colossal elasticity. However, this appears to contradict the common sense, since other solid bodies are not capable of movement inside the superhard body and other bodies which can be only 'frozen in' the superhard structure. I had to face this paradox of contemporary physics when I accepted the relay which led me down to the discovery of the quantum of space-time (quanton). A new stage of the quantum theory, which was full of paradoxes, started.

Discussing the above reasons which prevented Einstein from discovering the quanton, I understood that these reasons were purely methodological. Einstein conducted the first stage on the way to Superunification after combining space and time into the united substance. Then he started the unification of gravity and electromagnetism, being confident that he goes in the right direction, but nothing was obtained. The methodology of science provides for step by step motion, and if something is not obtained, then a very important stage of studies is possibly passed. So what it was that Einstein did not foresee? Today it is clear to me that the stage of the unification of electricity and magnetism into electromagnetism was passed.

It would seem that everything is clear as regards electromagnetism, except one thing – the carrier of the magnetic field has not been determined. Carriers were found for the electric charge of negative and positive polarity – elementary particles: electron, positron, proton. The carrier was not determined for the magnetic charge. It turned out that magnetism originates from the space-time through its incomprehensible topology as a result of the motion of electric charges. This was some magic. No electric charges were generally found in the electromagnetic wave of electric charges but electrical and magnetic fields were present, moreover simultaneously.

Today I regard as very naive the explanation of the reasons for propagation of the electromagnetic wave in vacuum which is erroneously connected with the laws of electromagnetic induction. It is considered that an electrical rotor forms a magnetic rotor which gives birth to a new electrical rotor in the direction of propagation of the wave, and so on. However, in experiments the formation of the electrical component in the electromagnetic wave occurs simultaneously with the appearance of the magnetic component. This means that these components cannot consecutively produce each other since they exist simultaneously.

Analysis of the nature of the electromagnetic wave was of interest to me already in the school as a wireless enthusiast and, after all, it led me to realise the presence of the electrical and magnetic monopoles concealed in vacuum which do not possess mass and represent electrical and magnetic elementary charges. Mass-free monopoles were regarded as weightless matter, as indicated by Einstein. However, if the electric charge has its own a carrier-particle, then magnetic monopoles were not discovered experimentally. In spite of this, electrical and magnetic monopoles played the basic role during the quantisation of space-time and the unification of electricity and magnetism into a single substance – electromagnetism the carrier of which is quantised space-time.

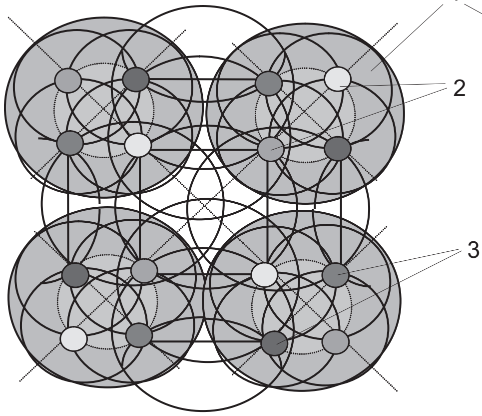
In order to isolate the elementary quantum of space as some volume, it is necessary to proceed from the rationality of nature which manages with minimum means. If it is necessary to fix a coordinate then a single point is sufficient. If it is necessary to isolate a line or a trajectory, then it is sufficient to have two points, and for the surface three points. The figure which separates the elementary volume is a tetrahedron with four points 1, 2, 3, 4 on the apices. In order to pass from the geometry to physics geometric points 1, 2, 3, 4 must be replaced with weightless particles which are planned by nature itself in the form of four monopole charges: two electrical (e^+ and e^-) and two magnetic (g^+ and g^-).

Figure 1.4 shows an electromagnetic quadrupole, not known earlier to science, which is the first stage of the unification of electrical and magnetic mater into electromagnetism.

Figure 1.5 shows how the quadrupole forms a quanton – spherical particle – the elementary space-time quantum - under the action of the forces of superstrong electromagnetic interaction (SEI). The quanton is the weightless field form of primary matter. In the quanton, the electrical and magnetic charges are connected into dipoles which cannot be split. Therefore, free magnetic charges have not been discovered experimentally. Magnetism belongs only to quantised space-time. The surplus of free electrical charges in nature is determined by the electrical asymmetry of the universe, but the presence of this asymmetry determines the presence of real matter.

Since the quanton is an elastic element, it also determines the rate of all physical processes at each point of space-time. The quanton is a real carrier and a time-setting device (electromagnetic clock) in nature (for more details see my studies of the EQM theory).

The electromagnetic quantization of space-time is the process of filling the volume with quantons.



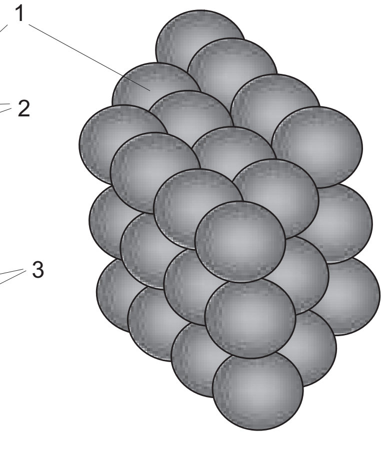


Fig. 1.23. Grid model of the quantised space-time in projection in the form of lines of force. 1) quantons; 2) electrical charges; 3) magnetic charges.

Fig. 1.24. (right) Solid-state model of quantised space-time.

Figure 1.23 shows the projection the simplified model of the local section of the quantised space-time of four quantons with the deposited grid of the lines of force of electrical and magnetic fields between the charges inside quantons and between them. This makes it possible to consider the quantised space-time as a discrete grid thrown on the entire universe which connects together all objects. The diameter of the quantons is of the order of 10^{-25} m, and their concentration is 10^{75} quantons in m^3, the density of accumulated energy is 10^{73} J/m^3. If we activate one cubic meter of vacuum, this is equivalent to the birth of another universe as a result of a Big Bang. The quantised space-time is the carrier of superstrong electromagnetic interaction (SEI) – Einstein's unified field.

In Fig. 1.24 (Fig. 1.3) the quantised space-time is represented in an even simpler form as a discrete close-packed structure of quantons in the form of spheres. This structure resembles the solid-state structure (charges inside quantons are not shown on the solid-state model).

The grid and solid-state elastic models of the quantised space-time are equivalent to each other. The grid model is convenient for studying electromagnetic wave processes, and the solid-state model for studying gravity. In the equilibrium state the charges with the opposite sign inside the quanton opposite are symmetrically balanced, presenting the quantised medium as neutral. I have omitted the moments of disruption of the electromagnetic equilibrium of the quantised space-time which are described in my works.

Let us examine the fundamentals of gravity which start with the phenomenon of formation of mass in elementary particles. Mass is a gravitational charge. It is gratifying that the nature of gravity completely coincides with Einstein's concept of distorted space-time. For the sake of clarity, the solid-state model in Fig. 1.24 is regarded as a cube of elastic sponge which consists of very small elastic quantons. I have already mentioned that the three-dimensional distortion of space-time is difficult to imagine. But this model makes this possible. Inside the elastic sponge we hypothetically separate a small spherical region and start to compress it evenly on all sides together with the quantons inside the sphere. It is obvious that with compression inside, on the outer side of the sphere the sponge will be stretched and the nearer to the sphere the stronger this extension is.

From the geometrical viewpoint, we can discuss a change in the topology of the space whose description is represented by many Lobachevsky's spheres with different curvature, placed as a Russian doll (matrioshka) inside each other. This approach leads to the serious complication of mathematical apparatus and to departure from the physics of the phenomenon. I acted as a physicist, abandoned the geometry of distorted space-time, and introduced a new unit of measurement – the quantum density of the medium which characterizes the concentration of the quantons per unit volume of space-time. This is the basis of the new quantum theory of gravity, whose mathematical description has become possible within the framework of the classic field theory.

I would like to mention that Einstein did not accept the statistical nature of the wave function – the basis of mathematical description in quantum theory. The introduction of the quantum density of the medium has returned the deterministic nature to the quantum theory. The spherical deformation of sponge, examined above, in transfer to the quantised space-time, causes that the quantum density inside the compressed sphere increases due to its decrease on the outer side. In the field theory, this process is called as the divergence of the gradient of the quantum density of the medium and is described by Poisson's equation which describes gravity. The two-component solution of Poisson's equation was thus obtained for the first time when the tension of medium (its distortion according to Einstein) is balanced by its compression.

It turns out that gravity is manifested as a result of the spherical deformation of the quantised space-time, and the sphere of final compression is the gravitational boundary which divides the regions of compression and tension of the quantised medium and which balance each other. For the elementary particle the process of the spherical deformation of the quantised space-time leads to the formation of mass in the particle, which is equivalent to the energy of elastic deformation of medium, only it is expressed in other measurement units. The release of the energy of elastic deformation of medium in wave photon emission is determined as the mass defect of elementary particles.

In order to form a gravitational boundary, it is necessary to have a certain surplus of free electrical monopoles not connected in quantons. This is determined by the electrical asymmetry of the universe. In nucleons, the gravitational boundary is formed in the form of an alternating shell, collected from several tens of electrical monopoles with the alternation of the polarity of the positive and negative charges which ensure the effect of compression of shell and the medium in formation of the nucleon mass. At the same time, this enables the alternating shells of nucleons inside the atomic nucleus to be mutually attracted by the electrical attraction forces of monopoles, regardless of the presence of the unbalanced charge of positive polarity in the protons. Thus, nuclear forces in the theory of Superunification are reduced to the forces of the electrical attraction of the alternating shells of nucleons. The electron does not have a clearly expressed gravitational boundary, since the weak effect of the spherical deformation of the quantised medium is produced by a single central electrical monopole charge. Therefore, the mass of the electron is considerably smaller, almost ~1800 times, than the mass of the nucleon. Thus, a study of the structure of elementary particles inside the quantised space-time made it possible to combine gravity and electromagnetism, considering gravity as a secondary formation.

Once Einstein described mass as the measure of inertness and gravity by the curvature of space-time. Now it is possible to refine the concept of mass as a measure of the elastic spherical deformation of the quantised space-time. In a popular publication I intentionally did not present any equations, despite the fact that the described complex processes can be described relatively simply in the field theory. It was important for me to show the physical essence of the generation of mass as the basis of gravity. When these unique scientific results were obtained, I was in a state of shock since the mass, as I was taught, does not exist in nature. It turns out that mass is the cluster of energy of the spherical deformation of the quantised space-time and not more. Therefore, an increase in the speed of a particle increases the energy of elastic deformation of the quantised medium and respectively the particle mass. Real matter is the integral and indissoluble part of the quantised space-time.

However, precisely this phenomenon of mass could explain the motion of one solid body inside the super-solid body as wave energy transfer. It turns out that the elementary particle, for example a nucleon, moves in space as a single wave, as some soliton, via the transfer of the spherical deformation of the medium (i.e., the nucleon mass) and monopole (mass-free) charges in the alternating shell of the nucleon. Only this explains the corpuscular-wave duality of elementary particles in quantum theory when the particle simultaneously shows wave and corpuscular properties.

However, most importantly, it was possible to establish that during movement of the particle in the entire speed range, including light, its gravitational field and form remain spherical. This made it possible to formulate the principle of spherical invariance, extending it to other bodies which consist, in the final analysis, of a set of elementary particles. In accordance with the principle of spherical invariance, the speed of light on the Earth's surface in the local region of space remains identical with respect to directions in the entire speed range. This was experimentally observed in the experiments of Michaelson and Morley. It was established that the principle of relativity is the fundamental property of the quantised space-time. This made it possible to formulate a new fundamental principle of the relative-absolute dualism.

The properties of the quantised space-time as weightless matter do not have any analogues with the known material media: solid, liquid, gaseous. Possessing superhard and superelastic properties, the quantised space-time is characterized by superpermeability, freely making possible for real matter to penetrate without friction through the quantised medium. Light, as the wave motion of photons, also freely propagates in the quantised medium. Outwardly this enables us to perceive the quantised space-time as a void. The quantised space-time reacts by force only on the acceleration of the particle and the body. This fact was established already by Newton. Now this fact has theoretical explanation. No real medium possesses such unique properties.

To complete the analysis of the posthumous Einstein's article, I have come to a conclusion that he in vain, probably due to desperation and fatigue, forewent his scientific heritage, since his ideas work wonderfully inside the quantised space-time. Simply, one human life was not sufficient to solve such a global issue. Nevertheless, he had time to indicate the direction towards the quantisation of space-time on the way to the unification of quantum theory and the theory of relativity. Einstein accepted only the deterministic nature of quantum theory, and he was confident that the problems of quantum theory lie inside the space-time.

1.5. Conclusion to chapter 1

In the popular form it is shown that the basis of the theory of Superunification are the fundamental discoveries of the quantum of space-time (quanton) and superstrong electromagnetic interaction (SEI) the carrier of which is the quantised space-time.

The quanton is the real carrier of space-time and it is the uniting particle, uniting at first electricity and magnetism into electromagnetism and then electromagnetism and gravity.

The electromagnetic quantisation of space is the process of the filling of space with quantons, forming the quantised space-time where every particle has its own ticking clock. The quanton as an elastic electromagnetic resonator is the real carrier of time and determines the lapse of time and the rate of electromagnetic processes.

The quantised space-time possesses the maximum energy level and, as shown later, it is the only energy carrier in the universe and all the remaining forms of energy are only the methods of the extraction of energy of superstrong electromagnetic interaction (SEI).

The theory of Superunification covers the study of processes both in the ultra-microworld of quantons and as a whole of the entire Universe.

2
Electromagnetic nature and structure of cosmic vacuum

2 .1. Introduction

The discovery of the space-time quantum (quanton) and the superstrong electromagnetic interaction (SEI) was used as the basis for developing the Superunification theory combining, in the first stage, electromagnetism and gravitation. A very simple equation with a deep physical meaning was derived for the general description of magnetism and gravitation:

$$\Delta x = \pm \Delta y \tag{2.1}$$

where Δx and Δy is the displacement of the electrical e and magnetic g elementary charges – quarks from the equilibrium state inside the quanton in the quantised space-time, m. The sign (–) in (2.1) determines the electromagnetic interactions caused by electromagnetic polarisation of the quantised space-time. Equation (2.1) can be transformed quite easily into the main equations of the electromagnetic field in vacuum together with solutions to these equations. The sign (+) in (2.1) corresponds to gravitation interactions caused by spherical deformation and, according to Einstein, by the 'bending' of the quantised space-time.

Electromagnetism and gravitation can be combined as a result of the application of two global Einstein concepts: 1) the concept of the united field, combining electromagnetism and gravitation, 2) the concept of determinism of quantum theory in the path of unification with the theory of relativity. For this purpose, it was necessary to return to physics the absolute space-time, as an elastic quantised medium whose fundamental property is the principal relativity. The quantised space-time is the united Einstein field, the field form of weightless primary matter, which is a carrier of the superstrong electromagnetic interaction (SEI). The elementary particle of this united field is the space-time quantum (quanton) which is also the carrier of electromagnetism and gravitation interactions.

To discuss further the problems and properties of quantised space-time in the path of unification of electromagnetism and gravitation, it is necessary to evaluate the current state of physical science which was described very accurately by Academician S.P. Novikov in a discussion at the Presidium of the Russian Academy of Sciences: ‘I think that we can now talk about the crisis in world theoretical physics. The point is that many extremely talented scientists, well-prepared for solving the problems of the physics of elementary particles and the quantum theory of the field, have become in fact pure mathematicians. The process of mathematisation of theoretical physics will not have the happy end for science [1]. The well-known English theoretical physicist, Nobal Prize Laureate S. Weinberg note: ‘basically, physics is entering some era in which the experiments are no longer capable of casting light on fundamental problems. The situation is very desperate. I hope that the sharp of experimentators will find some solution to the situation’ [2].

The solution was found when the following were discovered in 1996: the space-time quantum (quanton) and superstrong electromagnetic interaction (SEI). New fundamental discoveries have made it possible within 10 years to complete work on the development of the theory of the elastic quantised medium (EQM) and the theory of Superunification of fundamental interactions.

The new fundamental discoveries were made ‘om the tip of the feather’ as a result of analysis of a large number of experimental data in the area of electromagnetism, photon radiation, gravitation, the physics of elementary particles and the atomic nucleus, neutrino physics, astrophysics. From the theoretical viewpoint, the Superunification theory is the theory of open quantum-mechanical systems which could not previously been investigated in theoretical physics but which has made it possible to combine quantum theory with the theory of relativity. The physics of the open quantum-mechanics systems is the physics of the 21st century which provides a large amount of additional information on the universe, without changing the well-known fundamental physical laws, and explains for the first time the mechanisms of their action.

The physics of the 20th century can be characterised basically as the physics of closed quantum-mechanics systems although in reality, as shown by analysis of the discoveries, there are no such systems in nature. In fact, there are only open quantum-mechanics systems. Because of the fact that the physical realities were not realised, a crisis occurs in physics where any elementary particle or solid, including cosmological objects, were regarded as isolated objects, i.e. like matter in itself [3], not linked with the quantised space-time. This approach inhibited the unification of interactions because only the quantised space-time is the carrier of the integrating superstrong electromagnetic interaction (SEI). The SEI is the fifth unification force, more accurately the Superforce. Only the large force can sunjugate a smaller force. This is the golden rule of mechanics, including quantum mechanics.

Attempts to find the fifth force started in physics long time ago [4], and there were no united views on this subject. Russian physicists assumed that the fifth force is 'something incredibly weak' [5]. The views in the West are opposite. The well-known English theoretical physicist and science populariser Paul Davis in his book Superforce says: 'the entire nature, in the final analysis, is governed by the effect of some superforce, reflected in different 'hypostases'. This force is sufficiently powerful to create our universe and provide it with light, energy, matter and give it a structure. However, the Superforce is something greater than something creating the beginning. In the Superforce, matter, space-time and interaction are combined into an inseparable harmonious body generating such unity of the universe which was not assumed by anybody' [2]. Later, using the Superunification theory, Davies formulated the concept of the Superforce which fully corresponds to the new fundamental discoveries of the quanton and the SEI.

However, even earlier, at the beginning of the 20th century, H. Lorentz, developing the theory of electrons on the basis of the aether consideration of weightless matter, predicted 'that it is the medium which is the carrier of electromagnetic energy and transporter of many, probably all forces, acting on the matter with a mass' [6]. However, this was only the brilliant forecast of the integrating 'superforce', and the search for this Superforce had lasted almost a century.

Further, attempting to combine electromagnetism and gravitation, Albert Einstein formulated the scientific concept of the united field, determining the new direction of investigations [7, 8]. It is unjustifiably assumed that Einstein did not exceed in the development of the united theory of the field. It is sufficient to quote Academician A.F. Ioffe: 'Einstein was also convinced that there is a united field, and that gravity and electromagnetism are different manifestations of this field. He worked constantly on the development of the united theory of the field but he could not develop this theory. However, Einstein could not leave this serious problem. He spent more than 30 years of his life, up to his death, working on this problem and could not study any other problem for 30 years' [9].

This was the opinion of Einstein's followers and they were very wrong.

Einstein specified a direction to uniting interactions and this path has proved to be the only correct direction. Naturally, having colossal scientific intuition, Einstein could not return from this path. No persuasion could stop him from working on the problem of combining gravitation and electromagnetism within the framework of the general theory of relativity (GTR). Einstein himself characterises the state of general theory of relativity as follows, analysing the metrics of space-time: 'now, we can see how the transition to the general theory of relativity has changed the concept of space... The empty space, i.e., the space without the field, does not exist. The space-time does not exist on its own, but only as a structural property of the field. Thus, Descartes was not far from the truth when he assumed that the existence of the empty space must be ignored. A concept of a field as a real object in combination with the general principal relativity was missing, in order to show the true concept of the Descartes idea: there is no space 'free from the field' [10].

The current speculations regarding the scientific heritage of Einstein which suggest that he left to physics only the metrics of the empty space-time do not correspond to reality. Yes, he bravely substituted the concept of the old-fashioned mechanistic aether by a more universal concept of space-time. Analysis of Einstein studies shows that his main effort was directed to the discovery of the field structure of space-time as some universal form of the united field, combining gravitation and electromagnetism. Quite simply, one human life was not sufficient to solve such a global scientific problem. However, his devotion to the very concept of combining interactions, his scientific bravery and will, will remain examples of true service to science for many generations of investigators. No scientist has had such an effect on the development of the thery of EQM and Superunification as Einstein.

In his last scientific study, Einstein clearly defined that the solution of the problem of unification must be associated with the quantisation of the spatial field, transferring to it from the geometry of continuous space-time: 'it can be proven convincingly that the reality cannot be represented by a continuous field. Obviously, quantum phenomena show that a finite system with finite energy can be fully described by a finite set of numbers (quantum numbers). Apparently, this cannot be combined with the theory of continuum and a purely algebraic theory is necessary for describing the actual situation. However, at present, nobody knows how to find a basis for such a theory' [11].

To understand the meaning of these considerations, it is necessary to comment on the above Einstein quote and clarify the concept of quantisation and discreteness of space-time. Quantisation is an energy process and discreteness is a geometrical concept. The attempt for discrete representation of space-time within the framework of the four-dimensional geometry and the conventional coordinate systems have been made many times in studies of well-known scientists V. Ambartsumyan, D. Ivanenko, H. Snyder and others, but they have not been successful [12–15]. It is evident that the applicability of the conventional coordinate systems in the area of the ultra-microworld of the individual quantum of space-time is not fully justified. Different approaches should be used to quantisation of space-time which exclude coordinate systems on the level of the space-time quantum which is regarded as some volume which cannot further be divided and accumulates enormous finite energy.

If we accept the concept of quantised space-time, it may be asserted that some 'finite system with finite energy' should exist in nature. There is no doubt that the phenomenon of quantisation of space-time, as an energy process, is linked strongly with its fundamental length. Thus, 'the finite system with finite energy' in description of the structure of space-time leads to the concept of the energy space-time quantum and defines at the same time the discreteness of space. This is the posthumous will of Einstein, left to his followers.

It can be seen that when solving the given problem Einstein arrived to the general quantum representations of the nature of matter through the 'finite system with finite energy' which can be observed only in the quantised space-time. On the other hand, he was worried about the deterministic approaches to the solution of the phenomena. For this reason, he did not accept the statistical nature of quantum mechanics, regardless of the fact that he laid the foundations of quantum mechanics. He saw the solution of the problem in combining the interactions through space-time. Undoubtedly, the main task of integrating interactions is the unification of the quantum theory of the field and the theory of relativity. Einstein defined accurately the main direction of investigations. The solution of the problem is in the area of the field quantised structure of space-time and is determined by the 'finite system with finite energy'. He referred to the 'finite system with finite energy' as the space-time quantum and only characterised its properties. The space-time quantum as the 'finite system with finite energy' should have finite dimensions regarded as the fundamental length and should also be a bunch of finite energy.

With the introduction of the space-time quantum (quanton), the quantum theory received the most powerful analytical apparatus for matter because the radiation quantum (photon) did not make it possible to propose the total picture of energy interactions in the quantised space-time. At the same time, the radiation quantum is only a secondary formation inside the quantised space-time, having the form of a wave-corpuscule. On the other hand, the discovery of the quanton has enabled the deterministic base to be returned to the quantum theory. Einstein insisted on this base in his dispute with Bohr.

The problems of quantised space-time are associated not only with the problem of the fundamental length and the magnetic monopole and are associated with the entire spectrum of the problems which can be regarded as a 'Ginzburg list' within the limits of the physics of closed quantum mechanics systems [16]: if we consider the fundamental interactions: gravitation, electromagnetism, physics of elementary particles and the atomic nucleus (strong interactions), electroweak interactions associated with the participation of the neutrino, then the reasons for fundamental interactions are not known in modern physics. In particular, I have specified four singular points of the most important problems which have not been included in the 'Ginzburg' list:

1. **In the gravitation region.** Principles of **gravitation and inertia** are not known.
2. **In the region of electromagnetism.** The reasons for magnetism and its link with electricity are not known. The **Maxwell** equations are written in the purely empirical form and still have no analytical conclusions.
3. **In the area of the physics of elementary particles.** The structure of no elementary particles, including the main particles: electron, positron, proton, neutron, photon, neutrino, is known. The reasons for the formation of mass at the particles are not known.
4. **In the area of physics of the atomic nuclei.** The nature of the nuclear forces and the reasons for the defect of the mass of the atomic nucleus, as the basis of energy generation, are not known.

It is gratifying that all these problems of physical science have been solved in the Superunification theory. At the present time, these two theories are the most powerful analytical apparatus for the investigation of matter.

Prior to transferring to the problem of electromagnetic quantisation of space-time, it is necessary to mention briefly the principle of the relative-absolute dualism. Previously, it was erroneously assumed that relativity is not compatible with the absolute space. Now, in the Superunification theory it has been proven that the principle of relativity is the fundamental property of the absolutely quantised space-time. It has been established that during movement in a quantised vacuum medium the particle is not subjected to Lorentz shrinking in the direction of motion and remains spherically invariant in the entire range speed, including relativistic ones. Lorentz shrinking is the effect of relative measurements observed by an exterior observer.

The principle of spherical invariance is the fundamental property of the quantised space-time not only for elementary particles but, in accordance with the principle of superposition of the fields, it extends to the cosmological objects. For this reason, no aether wind was detected in interference experiments carried out by Michaelson and Morley during movement of the Earth since the principle of spherical invariance excludes the aether wind as such, and quantised space-time is a quantum medium with the unique properties and has no analogues with the known matter media, excluding the mechanistic gas-like aether.

Electromagnetism and gravitation are different states of the united electromagnetic field represented, in accordance with (1), by the quantised space-time which is a carrier of the superstrong electromagnetic interaction (SEI). This is the united field, mentioned by the Einstein. At present, physics faces the dilemma of replacing the concept of the field by exchange of virtual particles and elongated objects – strings. Figure 2.1 shows the stages of development of gravitation theory, described by M, Kaku, an expert in the area of the theory of superstrings [17]. The gravitation in the form of distortion of the space-time is regarded by Kaku only as Einstein's assumption, believing that the gravity is only the exchange of closed strings, excluding the process of distortion of space-time according to the gravitational theory. In this regard, the theorists not only ahead the events but also profoundly mistaken. Evidently, this is caused by the fact that in their considerations the classic theory of the field appears to be exhausted and not capable of solving the problem of unification of interactions.

However, the theory of EQM and Superunification shows that Einstein was right and that gravitation is based on the distortion (deformation) of the quantised space-time which can be regarded as the united field within

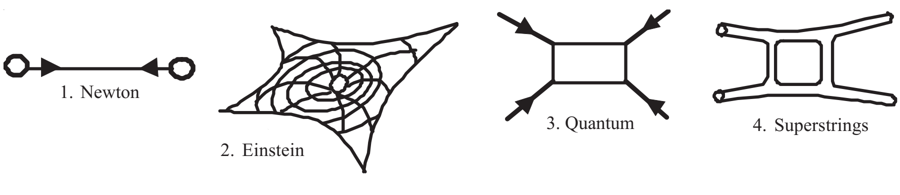


Fig. 2.1. Stages of the development of gravitational theory. Every step, shown in the scheme, is based on the success of the previous step. 1) Newton regarded gravity is a force acting instantaneously at a distance. 2. Einstein assumed that gravity is the curvature of the space-time. 3. The naive unification of the general theory of relativity and quantum mechanics gives a divergent theory, the so-called quantum gravitation, in which it is assumed that gravity is generated by the exchange of unique 'particles' – gravitons. 4. In the string theory, it is assumed that the gravity is caused by the exchange of closed strings (M. Kaku) [16].

the framework of the classic field theory. As regards strings and superstrings, they have a real physical basis, they determine the tension of the quantised space-time but do not solve the problem of unification of interactions as it is solved by the Superunification theory.

Analysing the failures of theoreticians in the area of unification of interactions, it has been established that the first stage of unification has been ignored, i.e., the state which starts with the unification of electricity and magnetism into electromagnetism as a result of electromagnetic quantisation of space-time.

2.2. Electromagnetic quantisation of space-time

2.2.1. Basis of the theory of EQM and Superunification

When discussing the development of the fundamental theory, the scientific basis of the theory is placed in the leading positions. Developing the special theory of relativity (STR), Einstein used the constancy of the speed of light as the basis. It is then true that the speed of light has become a variable quantity already in the general theory of relativity, and the basis is represented by the geometry of the distorted four-dimensional space-time. In quantum chromodynamics (QCD), the basis is represented by quarks, fine electrical charges, which are not detected in experiment. References to single effects, as if they belong to fine charges, are not convincing and can be explained using different approaches.

The basis in the theory of EQM and Superunification is represented by whole elementary electrical and magnetic charges of the monopole. These are whole quarks, i.e., bricks of construction of the universe. It was getting to a point. These four charges – quarks are sufficient to construct from them all the main elementary particles: electron, positron, proton, neutron, neutrino, photon and, hopefully, other investigators will form the structure of all known elementary particles with the appropriate properties and in future will determine the entire variety of inanimate and living nature.

The monopole charges – quarks are the elementary whole charges e and g of weightless matter. These are the most stable constants in the universe and are independent of pressure, temperature, speed, the quantum density of the medium, gravitation, and the entire range of natural factors. The elementary electrical charge $e = 1.6{\cdot}10^{-19}$ C is so stable that it could be measured with the accuracy to e^{-21}. At present, this is the really fantastic accuracy which can be only be achieved in science. No other constant is equal to the elementary electrical charge as regards the measurement accuracy. On the basis of the colossal stability of the electrical charge it may be assumed that such a charge cannot be fractional because this would violate the basic properties of the charge as the most stable constant

No direct measurements have been taken of the value of the elementary magnetic charge. From the procedural viewpoint, these measurements can be taken because magnetic charges do not exist in the free state. They are bonded in a dipole inside a quanton. However, analysing the Maxwell equations and taking into account in them the total symmetry between electricity and magnetism when the elementary electrical and magnetic charges are regarded as equal partners, it may be accepted with a high degree of probability that the stability of the magnetic monopole is not lower than the stability of the elementary electrical charge.

Thus, the basis in the theory of EQM and Superunification is represented by the most stable constants of nature: electrical and magnetic monopoles (quarks – charges). Up to now, none of the currently available series has had such a fundamental basis whose carrier is the space-time quantum (quanton), including these constants.

The attempt for solving similar problems have been carried out for a long time in the framework of quantum chromodynamics (QCD) which was based at the beginning on three quarks, and now the number of parameters in QCD has exceeded 100, increasing the number of problems requiring a solution. I do not want to criticise QCD. QCD fulfilled its role by the introduction of quarks. I would like to only mention that in addition to justification of the charge in adrons, and description of the action of nuclear forces, it is important to solve the problem of formation of the mass of adrons and this can in principle be carried out by QCD. The quarks must be regarded as whole electrical and magnetic charges, and the interaction of whole quarks should be transferred to quantons and the capacity of the electrical monopoles in different combinations to realise spherical deformation of the quantised space-time. In this case, it should be possible to describe the structure and condition of any elementary particle, not only of adrons, but also of leptons determining the presence or absence in them of the non-compensated charge and mass.

The attempts to explain the presence of mass in the elementary particles by introduction to quantum theory of other particles, the so-called Higgs particles, which transfer mass to other particles, have proved to be unsustainable, regardless of the application of the most advanced mathematical apparatus. According to theoretical predictions, the Higgs particles should be detected by experiments in a giant accelerator (super collider) in CERN (Geneva). However, these particles have not been detected. The theory of EQM and Superunification has already saved billions of dollars to the world scientific community, describing the structure of elementary particles and also the nature of the gravitational field and mass. To substantiate this, it was necessary to develop the theory of EQM and Superunification based on whole elementary charges – quarks of the monopole type, and the first stage to unification is the unification of electricity and magnetism into electromagnetism.

2.2.2. Unification of electricity and magnetism into electromagnetism. Structure of the quanton

In order to unify electricity and magnetism into a single substance, i.e. electromagnetism, it is necessary to avoid using the conventional coordinate systems and attempts to separate the elementary volume of the space using the numbers 1, 2, 3 and 4 for only four points in space. One such point does not give anything. Two points can be used to denote a line in space. The surface can already be covered by three points. Only four points can separate the volume in the form of a tetrahedron. Nature is constructed in such a manner that it tries to ensure minimisation and rationalisation. We should mention Einstein's comment: 'evidently, quantum phenomena show that the finite system with finite energy can be described fully by the finite set of numbers' [11].

To transfer from the geometry of numbers to real physics, the numbers, denoting the tips of the tetrahedron must be given physical objects. In nature, there are no random coincidences as regards its fundamental situations. The physical objects are represented by four monopole charges– quarks: two electrical ($+1e$ and $-1e$) and two magnetic ($+1g$ and $-1g$), combined in the electromagnetic quadruple as a singular structure. Already the very fact of introduction of the electromagnetic quadrupole into theoretical physics requires attention because the properties of such a particle, combining electricity and magnetism, have never been analysed. Figure 2.2a shows schematically in projection an electromagnetic quadrupole formed from electrical and magnetic monopoles in the form of spherical formations of finite dimensions with a central point charge. However, in this form the electromagnetic quadrupole does not yet correspond to the properties of the space-time quantum (quanton).

Naturally, it is necessary to ask: 'what links together electricity and magnetism inside the electromagnetic quadrupole?' The answer is a phenomenological, i.e., it is the superstrong electromagnetic interaction (SEI) representing also some sort of adhesive bonding various physical substances: electricity and magnetism. The realias of electromagnetism have been confirmed by experiments.

Figure 2.2b shows the space-time quantum (quanton) in the form of a

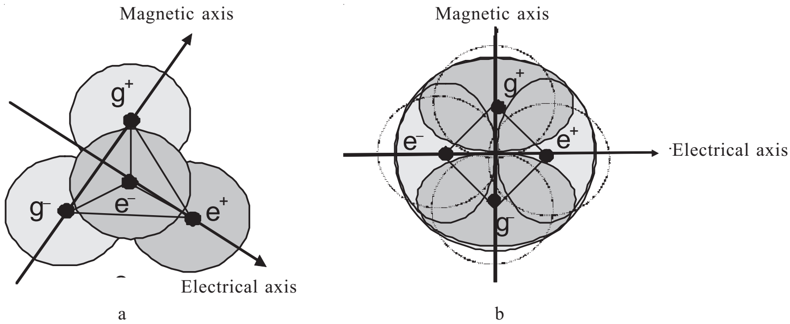


Fig. 2.2. a) Unification of electricity ($e^+ + e^-$) and magnetism ($g^+ + g^-$) into an electromagnetic quadrupole; b) Structure of the space-time quantum, i.e., quanton, in projection.

spherical particle obtained as a result of electromagnetic compression of the quadrupole (see also Fig. 1.2). Taking into account the colossal tensions between the charges inside a quanton, its stable state can be reached only when the quanton is spherical because this symmetry ensures compensation of the charges with opposite signs inside the quanton, determining its the equilibrium state as the electrically and magnetically neutral particles. Thus, the discovery of the quantum as the carrier of superstrong electromagnetic interaction determines the electromagnetic properties of the quantised space-time which in the non-perturbed condition is regarded as a neutral medium.

2.2.3. The charge of the Dirac monopole

The problem of the magnetic monopole was tackled by Dirac as an independent magnetic charge and in his honour it is referred to as the Dirac monopole [18–20]. Naturally, the search for magnetic monopoles and attempts to detect mass in them resulted in the experimental boom in the 60s which, however, has not yielded positive results. The Dirac monopoles have not been detected [20, 21]. The interest in them has been renewed because of the quantisation of space-time in the EQM theory which regards the magnetic monopole as a non-free particle bonded in space-time and this particle cannot be detected in the free state. Only the indirect registration of the manifestation of the properties of magnetic monopoles in disruption of the magnetic equilibrium of the space-time in accordance with the Maxwell equations is possible.

The fact that the role of magnetic monopoles in the structure of the space-time was not understood prevented for a very long period of time the development of a method of determination of the value of the charge g of the magnetic monopole. Dirac himself assumed that taking into account the unambiguity of the phase of the wave function of the electron intersecting the line of n-nodes consisting of magnetic poles, we obtain the required relationship which in the SI system contains the multiplier $4\pi\varepsilon_0$ [18–20]:

$$g = 2\pi\varepsilon_0 \frac{\hbar C_0}{e^2} en = 0.5\alpha^{-1} en = 68.5 en \quad [\mathrm{C}] \tag{2.2}$$

Here $\hbar = 1.054 \cdot 10^{-34}$ J·s is the Planck constant, $\alpha = 1/137$ is the constant of the fine structure; $C_0 = 3 \cdot 10^8$ m/s is the speed of light in the vacuum, non-perturbed by gravitation; $\varepsilon_0 = 8.85 \cdot 10^{-12}$ F/m is the electrical constant; $\varepsilon = 1.6 \cdot 10^{-19}$ C is the electron charge, n is the integer multiplier.

The Dirac relationship (2.2) was improved by the well-known American theoretical physicist J. Schwinger who proved that n in equation (2) should only be an even number, and at $n = 2$ we obtain $g = 137$ e [21].

However, the Dirac method is indirect in which *a line* of nodes can be separated in space from the magnetic charge included in the space-time structure. In reality, in the quantised only a line of quantons can be separated (Fig. 2.2b) in the form of an alternating string from magnetic and electrical dipoles. In particular, Dirac did not take into account the electrical component of the effect. In movement of an electron along such an alternating string, the electron is subjected to the effect of waves from the side of the space-time which is characterised by the constant fine structure α. This was also taken into account nonformally by Schwinger by introducing $n = 2$.

It would appear that there is no basis for doubting Dirac's method which has been accepted by physicists and is regarded as a classic method. From the mathematical viewpoint, the Dirac solutions are accurate. However, from the viewpoint of physics, the Dirac procedure contradicts not only the structure of the quantised space-time but also the solutions of the Maxwell equations for the electromagnetic field in vacuum.

The main problem of the Maxwell equations was the explanation of the realias of bias currents. Until now, the explanation of the electrical bias currents has been contradicting, and we cannot even discuss the magnetic bias currents, although Heaviside attempted to represent the bias points in the total volume. The introduction of the quanton into the structure of the space-time makes the electrical and magnetic bias currents realistic as a result of electromagnetic polarisation of vacuum as the carrier of SEI.

We write the Maxwell equations for the vacuum, expressing the density of the electrical $\mathbf{j}_e$ and magnetic $\mathbf{j}_g$ bias currents in the passage of a flat electromagnetic wave through the space-time by the time dependence t of the strength of the electrical **E** and magnetic **H** fields in the form of the system:

$$\begin{cases} \mathbf{j}_e = \text{rot}\,\mathbf{H} = \varepsilon_0 \dfrac{\partial \mathbf{E}}{\partial t} \\ \mathbf{j}_g = \dfrac{1}{\mu_o} \text{rot}\,\mathbf{E} = -\dfrac{\partial \mathbf{H}}{\partial t} \end{cases} \tag{2.3}$$

where $\mu_0 = 1.26 \cdot 10^{-3}$ H/m is the magnetic constant.

The system (2.3) reflects the symmetry of electricity and magnetism in the quantised space-time. The equations (2.3) are presented in the form published by the outstanding English physicist and mathematician Heaviside who introduced into Maxwell equations additional magnetic bias currents, determined by magnetic charges, giving the equations the completed symmetrical form.

The solution of the system (2.3) will be sought for the real relationship between the magnetic and electrical elementary charges inside a quanton which determines their bias currents in the quantised space-time. For this purpose, the densities of the bias currents $\mathbf{j}_e$ and $\mathbf{j}_g$ in (2.3) are expressed by the speed of displacement $\mathbf{v}$ of the elementary electrical e and magnetic g charges – quarks inside the space-time and the quantum density of the medium ρ_0 which determines the concentration of the quanta of the space-time in the unit volume:

$$\begin{cases} \mathbf{j}_e = 2e\rho_0 \mathbf{v} \\ \mathbf{j}_g = 2g\rho_0 \mathbf{v} \end{cases} \tag{2.4}$$

The multiplier in (2.4) is defined on the basis of the fact that the charges e and g are included in the composition of the space-time inside the quanton by pairs with the sign (+) and (–), forming on the whole a neutral medium. Taking into account fact that in the actual conditions the electromagnetic polarisation of space-time is associated with the very small displacement of the charges in relation to their equilibrium position, the speed of their displacement $\mathbf{v}$ is the same.

The problems of polarisation of the quantum have been examined in greater detail in [22, 23] in analytical derivation of the Maxwell equations. At the moment, it is important to understand that all the electromagnetic Maxwell processes in vacuum are associated with the constancy of the internal energy of the quanton in its electromagnetic polarisation. Extending the quanton (Fig. 2.2b) along the electrical axis, we also observe compression of the quanton along the magnetic axis. This is accompanied by the displacement of the charges inside the quanton which also determines the realias of the currents (2.4) of electrical and magnetic bias.

Attention should be given to the fact that the electrical and magnetic axes of the quanton (Fig. 2.2b) are unfolded in the space of the angle of 90°, determining the space shift between the vectors of the strength of the electrical **E** and magnetic **H** fields in all electromagnetic wave processes, and also determining the direction of the vector of speed **C** of propagation of the electromagnetic wave, the vector of the speed of light $\mathbf{C}_0$ in vacuum, non-perturbed by gravitation, is denoted by the parameters of the electromagnetic field. The ratio of these parameters was obtained in analytical derivation of the Maxwell equations [20, 21]:

$$\frac{1}{\varepsilon_0}\frac{\partial \mathbf{H}}{\partial \mathbf{E}} = \mathrm{C}_0 \qquad (2.5).$$

In fact, (2.5) is also the form of the singular Maxwell vector equation for vacuum in which the vector of speed of light $\mathbf{C}_0$ is situated in the plane of the orthogonal plane of the vectors **E** and **H** and the simultaneous change of the vectors with time also generates the electromagnetic wave.

Substituting (2.4) into (2.3) and taking (2.5) into account, we obtain the true relationship between the magnetic and electrical monopoles in the quantised space-time:

$$g = C_0 e = 4.8 \cdot 10^{-11}\,\mathrm{A{\cdot}m}\ \ (\mathrm{Dc}) \qquad (2.6)$$

In the EQM theory, all the calculations are carried out in the SI system. Therefore, in the SI system the dimension of the magnetic charge is defined as [Am] since the dimension of the magnetic momentum is [Am^2]. According to Dirac and Schwinger, the dimension of the magnetic and electrical charges is the same [C]. This is very convenient because it determines the symmetry between electricity and magnetism which in the ideal case would be expressed in the completely equal values of the magnetic and electrical monopoles. However, in the SI system, the dimensions of magnetism are determined by electrical current. Therefore, the equality between the magnetic and electrical charges in (2.6) is linked by the dimensional multiplier C_0. Taking into account pioneering studies by Dirac in the area of the magnetic monopole, the dimension of the magnetic charge in the SI system [Am] is referred to as Dirac (Dc) in his honour. At the moment, it is an arbitrary dimension but I assume that with time it will be officially accepted.

2.2.4. Dimensions of the quanton

The calculated diameter of the quanton L_{qo} for the non-perturbed quantised space-time, determined from the condition of elastic tensioning of space-time in generation in the quanton of elementary particles (nucleons) with the mass [22,23], is

$$L_{q0} = \left(\frac{4}{3} k_3 \frac{G}{\varepsilon_0} \right)^{\frac{1}{4}} \frac{\sqrt{eR_s}}{C_0} = 0.74 \cdot 10^{-25} \text{m} \tag{2.7}$$

here $k_3 = 1.4$ is the coefficient of filling of vacuum by spherical quantons; $R_s = 0.81 \cdot 10^{-15}$ m is the neutron (proton) radius; $G = 6.67 \cdot 10^{-11}$ Nm^2/kg^2 is the gravitation constant.

It can be seen that equation (2.7) includes the constants and constant parameters. Therefore, in the EQM theory, L_{q0} (2.27) is regarded as a conventional constant which determines the fundamental length of discrete space-time. In the space-time perturbed by gravitation, the diameter of the quanton L_q is a variable quantity and differs from L_{q0} (2.7) by the increment ΔL_q:

$$L_q = L_{q0} \pm \Delta L_q \tag{2.8}$$

The sign (+) in (2.8) determines the effect of gravitation or antigravitation for the external or internal region of the quantised space-time. For the external region of the space-time, the effect of gravitation is determined by the sign (+), the effect of antigravitation by (–). This means that in the region of the space subjected to gravitational perturbation the dimensions of the quantum increase and their concentration (quantum density) decreases.

2.2.5. Symmetry of electricity and magnetism inside a quanton

The uniqueness of the Maxwell equations (2.3) and (2.5) for vacuum is manifested in the complete symmetry between electricity and magnetism. To understand the reasons for this symmetry, we analyse the Coulomb forces inside a quanton (Fig. 2.2b). The fact is that the Coulomb law is a precursor of the Maxwell equations and the most extensively verified fundamental law.

The symmetry of electricity and magnetism inside a quanton (Fig. 2.2) may be demonstrated as follows. Into the Coulomb law we introduce, separately for electrical and magnetic charges, the equation (2.6) at the distance between the charges determined by the side of the tetrahedron equal to 0.5 L_{qo} (2.7). Consequently, Coulomb forces F_e and F_g as the attraction forces inside the quanton for the electrical charges and for magnetic charges, respectively, should be equal, i.e. $F_e = F_g$.

We use the reversed procedure. We write the Coulomb law inside the quanton for electrical charges and for magnetic charges on the condition of the equality of force electrical and magnetic components $F_e = F_g$ and the equality of the distances r_{oe} and r_{og} between the electrical and magnetic charges, respectively:

$$r_{eo} = r_{go} = 0.5L_{qo} = 0{,}37 \cdot 10^{-25}\,\text{m} \tag{2.9}$$

$$\begin{cases} F_e = \dfrac{1}{4\pi\varepsilon_0} \dfrac{e^2}{r_{e0}^2} = 1.6 \cdot 10^{23}\,\text{N} \\ F_e = F_g \\ F_g = \dfrac{\mu_0}{4\pi} \dfrac{g^2}{r_{g0}^2} = 1.6 \cdot 10^{23}\,\text{N} \end{cases} \tag{2.10}$$

The solution of the system (2.10) is obtained under the condition $\varepsilon_0 \mu_0 C_0^2 = 1$

$$g = \sqrt{\frac{1}{\varepsilon_0 \mu_0}}\; e = C_0 e \tag{2.11}$$

It may be seen that only when the parameters of the electrical and magnetic components inside the quanton are equal, in particular for the Coulomb forces (2.10), the relationship (2.11) between the values of the elementary magnetic and electrical charges corresponds to the previously determined relationship (2.6). Shorter distances between the charges inside the quanton determine colossal attraction forces (2.10) which characterise the quantised space-time by colossal elasticity.

Thus, the electromagnetic symmetry of the quanton determines the relationships (2.6) and (2.1) and also the correspondence of these relationships to the Maxwell equations (2.3) and the Coulomb law (2.10). The Dirac relationship (2.2) does not correspond to (2.3) and (2.10), is not written in the SI system and uses the procedure based on the unambiguous yield of the phase of the wave function of the electron whose parameters include not only the elementary electrical charge e but also other parameters, which determine the wave properties of the electron in the quantised space-time. It should be accepted that as regards the procedure, Dirac made an error but this does not reduce role in the investigations of the magnetic monopole. In the pure form, the monopole elementary electrical and magnetic charges are included only in the structure of the quanton, and the analysis of the properties of the quanton yielded the true relationships (2.6) and (2.11).

In fact, the forces (2.10) inside the quanton are colossal in magnitude and comparable with the attraction forces of the Earth to the Sun. These forces determine the colossal elasticity of the quantised space-time in the theory of the elastic quantised medium (EQM) which investigates the structure of vacuum. In particular, when examining the domain of the ultra-microworld of the quanton, the EQM theory has had to face the colossal forces attention and energy concentration.

We verify the energy symmetry of the quantum, analysing the energy of electrical W_e and magnetic W_g components of the charges interacting inside the quanton under the condition (2.9):

$$\begin{cases} W_e = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r_{e0}} = 0.62 \cdot 10^{-2}\,\text{J} \\ W_g = \frac{\mu_0}{4\pi} \frac{g^2}{r_{g0}} = 0.62 \cdot 10^{-2}\,\text{J} \end{cases} \tag{2.12}$$

As indicated by (2.12), the energies of interaction of the electrical charges and the magnetic charges inside the quanton are equal to each other, as are also the Coulomb forces (2.10). This property of the quantum determines the total electromagnetic symmetry of the quantised space-time.

Thus, the introduction into physics of the space-time quantum (quanton) enables us to understand the principle of electromagnetic symmetry and also penetrate into the depth of electromagnetic processes on the level of the fundamental length 10^{-25} m. Prior to the development of the EQM theory, physics did not have these unique procedural possibilities.

2.2.6. The structure of the monopole-quark

Classic electrodynamics shows that the magnetic and electrical charges of the opposite polarity, included in the structure of the quanton, should collapse into a point (annihilate) under the effect of colossal Coulomb forces (2.10). However, this does not take place. The quanton (Fig. 2.2b) has a finite dimension (2.7). This is also confirmed by Maxwell equations (2.3).

The definition of the finite size of the quanton (2.7) shows that the magnetic and electrical monopoles – quarks are not point objects and also have finite dimensions. After all, we cannot look into the microworld of the quanton to the level of the fundamental length of 10^{-25} m. We can construct the model of the quanton only indirectly, analysing physical phenomena. Even using various devices, nobody has been able to examine the structure of larger particles, such as the electron, proton, neutron and others. In this respect, the analytical apparatus of the EQM theory is at present the most powerful tool of nature investigators capable of analysing both the structure of elementary particles and the space-time quantum (quanton) [22–25].

Thus, the monopole should have the property with colossal elasticity and a finite size. The electromagnetic collapse of charges of the opposite polarity inside the quanton can be restricted in this case only. These properties of the monopole–quarks are described most efficiently by the model in the form of a berry (ovule), shown in Fig. 2.3. This model resembles a biological ovule whose centre contains the nucleus 1 of the monopole charge, surrounded by protoplasma 2 with the shell 3.

In particular, the nucleus 1 is the source of the field (electrical or magnetic) in the form of a point charge which is capable of moving to some extent in relation to the centre of the monopole. It may be assumed that the dimensions of the monopole nucleus are determined by the minimum size of the order of Planck length of 10^{-35} m. It has not as yet been possible to substantiate this parameter theoretically. The diameter of the monopole was determined as being of the order of 10^{-25} m on the basis of the diameter of the space-time quanton. The nature of the nucleus 1 as a source of the field is also unclear. At the moment, we can only comment on the very fact of the presence of the nucleus 1 as a source of the field.

The nature of protoplasma 2 with the shell 3 has also not been explained. At the moment, it is clear that the protoplasma may represent only field (immaterial) matter, like the quanton. However, we do not know what this field form of matter on the level of the fundamental length is. It may be assumed that on the level of the fundamental lengths of 10^{-25} m elastic forces of repulsion of the shell, preventing the deformation of the latter, start to act between the monopole charges with opposite polarity.

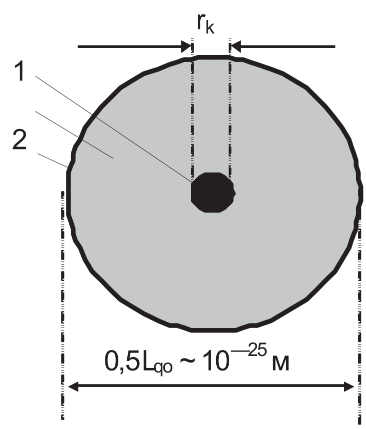


Fig. 2.3. Model of the structure of electrical and magnetic monopoles. 1) the nucleus of the monopole charge, 2) monopole protoplasma, 3) monopole shell.

Consequently, the length 10^{-25} m is the interface in the microworld for the interacting charges.

Regardless of some problems of the berry model of the monopoles (see Fig. 2 .2) which undoubtedly will be solved, the berry model of the monopole answers a large number of problems associated with the structure of the very space-time quantum. Firstly, the presence in the structure of the monopole of elastic protoplasma with the shell 3 prevents collapse of the monopoles into a point when they combine to form an electromagnetic quadrupole, forming electrical and magnetic dipoles inside the quadrupole (Fig. 2.2a). Secondly, the berry model of the monopole explains the unification of electricity and magnetism into a single substance which can take place only through intermediate medium, i.e., through the monopole protoplasma. Consequently, the monopole protoplasma represents some glue bonding together the electrical and magnetic dipoles inside the quanton. Finally, under the effect of the colossal forces of electrical and magnetic attraction, the electromagnetic quadrupole is compressed into a spherical particle whose properties correspond to the quanton (Fig. 2.2b). These properties determined the capacity of the quanton for the orientation and deformation polarisation, determined by the manifestation of the Maxwell equations (2.3) in vacuum. This is proved in the present book.

2.2.7. Electromagnetic quantisation of space

The unification of electricity and magnetism inside a quanton can be described by the following reaction:

$$(e^+ + e^-) + (g^+ + g^-) \rightarrow e^-_+ + g^-_+ \rightarrow q^{2e}_{2g} \rightarrow q_s \qquad (2.30)$$

where e^-_+ and g^-_+ are the electrical and magnetic dipoles, q^{2e}_{2g} is the electromagnetic quadrupole; q_s is the space-time quantum, i.e., quanton.

In (2.13), the electrical monopole is denoted by e^-. In contrast to the monopole, the electron is denoted by two indexes e^-_m, where the index m indicates the presence of mass in the particle carrying the charge with negative polarity.

It may be assumed that the reaction (2.30) consists of several stages. Initially, the monopole charges merge into electrical e^-_+ and magnetic g^-_+ dipoles. Subsequently, the dipoles merge to form the electromagnetic quadrupole q^{2e}_{2g} (Fig. 2.2a). Finally, as a result of electromagnetic compression of the quadrupole q^{2e}_{2g} under the effect of colossal forces (2.7) the electromagnetic space-time quantum q_s, i.e., quanton, forms and has the form of a spherical particle (Fig. 2.2b).

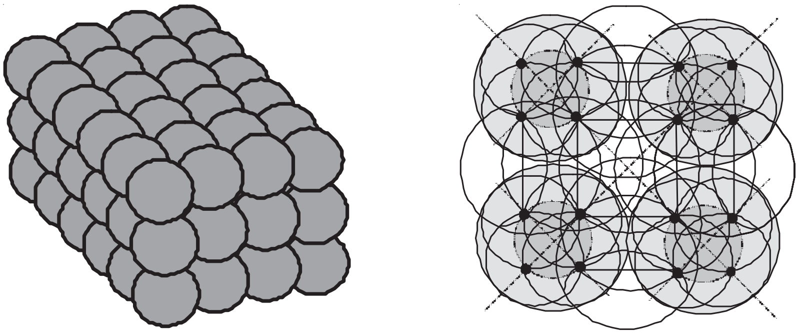
The process of electromagnetic quantisation of the space is reduced to filling the space with quantons. This process has taken place throughout the universe. At present, it is difficult to even propose a hypothesis regarding the primary source of quantisation of the universe. If there was the Big bang, it could have taken only in the quantised universe, and would have to be associated with the formation of matter in all its varieties: from elementary particles to stars and galaxies.

In the quantisation of the universe it is important to obtain the homogeneous and isotropic space-time. Consequently, the structure of the quanton can form. The special feature of this distribution of the charges on the tips of the tetrahedron inside the quanton prevents the formation of the spatial mirror symmetry of the electrical and magnetic axes (Fig. 2.2b). This arrangement introduces the element of chaos into the spatial orientation of the quantons when they fill the volume of the quantised space-time. In the quantised volume we cannot specify any priority direction of orientation along the electrical or magnetic axes of the large group of quantons. The direction of the electrical or magnetic axes of the quantons in the space changes randomly, determining the isotropic properties of the space-time.

Taking into account the small dimensions of the quanton of the order of 10^{-25} m, on the level of the dimensions of the elementary particles 10^{-15} m, the space-time already represents a homogeneous and isotropic medium. The quanton itself is an electrically and magnetically neutral particle ensuring on the whole the electrical and magnetic neutrality of the quantised space-time. All the manifestations of the magnetism and electricity are associated with the disruption of the electrical and magnetic equilibrium of space-time.

There is some analogy between the structure of the space-time and a network of force lines of electrical and magnetic fields, linking the entire universe together (Fig. 2.4a). Taking into account the linear form of the Maxwell equations in space, it may be assumed that the proposed structure of quantised space-time determines its electrical and magnetic constants of vacuum ε_0 and μ_0 whose effect also extends to the internal region of the quanton.

This network can be regarded as some solid-state field structure (Fig. 2.4b) with no analogy with conventional matter but characterised by colossal elasticity (see also Fig. 1.3). Consequently, the motion in the space-time of the elementary particle is determined by the wave transfer of matter [22, 23]. The wave transfer of matter forms the basis of the wave (quantum) mechanics and determines the effect of the principle of corpuscular-wave dualism in which the particle shows both wave and corpuscular properties, being the integral part of space-time.



a b

Fig. 2.4. a) Local section of the EQM consisting of four quantons (simplified in projection), b) The volume of quantised space-time.

2.2.8. Electrical symmetry of space

Quantised space-time, filled only with quantons, is a medium with no material matter and without the entire variety of the observed world. Excess electrical charges must exist to fill the universe with material matter.

The quanton itself ensures the electromagnetic symmetry of the quantised space-time by the fact that the number of magnetic charges inside a quanton is balanced with the number of the electrical charges. To ensure the electrical asymmetry of space, an excess of electrical charges must be supplied to the quantised space-time. It may be assumed that quantisation of the universe was accompanied by the colossal ejection of pairs of electrical ($e^+ + e^-$) and magnetic ($g^+ + g^-$) monopoles. The ejection of the number n_e of pairs of electrical monopoles ($e^+ + e^-$) in the quantitative aspect was slightly greater than the ejection of the number n_g of pairs of magnetic monopoles ($g^+ + g^-$), and this determines the electrical asymmetry A_e of the universe:

$$\frac{n_e}{n_g} = A_e > 1 \tag{2.14}$$

Presumably, A_e (2.14) differs only slightly from unity but the electrical symmetry A_e of the universe was then used as a basis for the formation of the entire variety of material matter, starting with the formation of elementary particles [7, 20, 32].

Possibly, quantisation of the universe took place at $A_e = 1$, without the excess of electrical charges, forming the spherical volume. However, the excess of the electrical charges was packed with displacement from the centre of the future universe in a very small volume expressed in cubic metres. For some reasons, the small volume was activated and this was followed by a big bang which resulted in the ejection of excess electrical charges into the quantised space-time. A cavity with some spatial asymmetry formed in the centre of the universe and the universe started to expand, forming the quantised shell. The scenario explains the enormously high rates of expansion of the universe, without considering the inflation model. In the post-explosion stage, we can use the Friedman shell model of the pulsating universe.

The redistribution of the quantum density inside the asymmetric shell of the universe resulted in the formation of gigantic vortices in the quantised space-time, which explain the formation of helical galaxies. Spherical constellations formed in the absence of these vortices.

However, not all started with the formation of constellations and galaxies, the formation of elementary particles was also important. In particular, the excess of electrical charges – quarks of the monopole types resulted in the formation of the entire spectrum of the elementary particles. For example, the ejection into the quantised space-time of an electrical massless charge with negative polarity resulted in the generation of an electron as a result of spherical deformation of space-time because of the pulling of the quantons to the centre of the charge. The massless monopole charge acquires mass, transforms into the electron – elementary particle – the carrier of mass and charge. The structure of elementary particles and the quantised space-time was examined in [2, 6, 7, 20, 32].

2.2.9. The speed of movement of the spatial clock

The quantum, as an universal integrating particle, is a volume electromagnetic resonator which determines the rate of time in space (Fig. 2.2b) [26]. We examine the vibrational process inside the quanton during the passage of an electromagnetic wave through the quanton. Evidently, the electromagnetic wave, acting simultaneously with the electrical and magnetic fields on the quanton, stretches the quanton in the first half cycle along the electrical axis and at the same time compresses it along the magnetic axis, and vice versa. We can calculate the time (period) T_0 of the given vibrational process which is determined by the duration of passage of the electromagnetic wave with speed C_0 through the quanton with the size L_{q0} (2.7):

$$T_0 = \frac{L_{q0}}{C_0} = 2.5 \cdot 10^{-34}\ \mathrm{s} \tag{2.15}$$

Taking equation (2.15) into account, we determine the intrinsic resonance frequency f_0 of the quanton:

$$f_0 = \frac{1}{T_0} = 4 \cdot 10^{33} \text{ Hz} \tag{2.16}$$

Evidently, equation (2.16) determines the limiting frequency of electromagnetic processes in the quantised space-time. The harmonic components of the entire spectrum of frequencies are reduced in the final analysis to the limiting frequency (2.16).

The EQM theory shows that time changes in steps with a period (2.16), i.e., the time is quantised in its basis.

Naturally, gravitational perturbation of space-time is determined by its distortion under the effect of tensile deformation which increases the parameters of the quanton and reduces the rate of time (15) in space-time. The increase of the quanton diameter results in a decrease of electromagnetic energy forces inside a quanton and, correspondingly, reduces its elasticity in a volume resonator. This leads to a decrease of the resonant frequency (2.16) of intrinsic oscillations.

2.2.10. Stability and energy capacity of the quanton

It may be asserted that the quanton, together with the monopoles, is the most stable particle which cannot be destructed. This is confirmed experimentally by the absence of free magnetic charges in nature. Magnetism belongs completely to the quanton and quantised space-time.

The stability of the quanton can be confirmed by calculations. To split the quanton into compound monopoles, it is necessary to break bonds between the charges inside the quanton which are determined by the forces of the order of 10^{23} N. It is not possible to generate these forces artificially from the external side of the quanton.

We can estimate the energy capacity w_{qv} of the quanton on the basis of the accumulated total energy W_q (12) related to its volume V_q

$$W_q = W_e + W_g = 1.2 \cdot 10^{-2} \text{ J} \approx 10^{17} \text{eV} \tag{2.17}$$

$$w_{qv} = \frac{W_q}{V_q} = 6\frac{W_q}{\pi L_q^3} = 5.7 \cdot 10^{73} \frac{\text{J}}{\text{m}^3} \tag{2.18}$$

The concentration of electromagnetic energy (2.18) inside the quanton is colossal and cannot be produced artificially in order to break the electrical and magnetic bonds inside the quanton. If the energy of the quanton is reduced to the volume of the nucleon (proton), we obtain the value of the order of $1.6 \cdot 10^{28}$ J/nucleon or 10^{47} eV/nucleon. This energy is comparable only with the limiting energy of the proton when the latter reaches the speed of light [22, 23]. In reality it is not possible to reach these energy concentrations in accelerator systems. This means that the quanton is the most stable particle in the universe and is not capable of splitting into free monopoles and determines the stability of the space-time.

The electromagnetic space-time quanton was introduced for the first time in [27] and its discovery was used as a basis for the development of the EQM and Superunification theories; main assumptions of these theories can be found in [22–23].

2.3. Disruption of electrical and magnetic equilibrium of the quantised space-time

The common feature of the classic and existing quantum electrodynamics is that they are of the phenomenological nature and do not examine the reasons for electromagnetic processes taking place in the quantised space-time. The classic electrodynamics and the existing quantum electrodynamics have common problems, regardless of the fact that they affect different areas of knowledge. Naturally, the existing contradictions of the classic electrodynamics delay the development of quantum electrodynamics. Therefore, in this chapter we investigate the main problems of classic electrodynamics, and the problems of quantum electrodynamics of elementary particles will be investigated in the next chapter because they are linked directly with the unification of electromagnetism and gravitation through the superstrong electromagnetic interaction.

The main problems of classic electrodynamics remain: the nature of magnetism, analytical derivation of the Maxwell rotor equations (2.3), and the reasons for electromagnetic induction in vacuum, transformation of the Maxwell rotor equations (2.3) into the wave equations of a flat electromagnetic wave without excluding the rotors, the nature of rotors in vacuum, and others.

It is gratifying that these problems of electrodynamics are solved in the elementary manner by the Superunification theory. Prior to examining these problems, it is necessary to mention the extensive possibilities provided by the new theory. It is possible for the first time to investigate the topology of the space-time which was not investigated previously and ogy provides structural heterogeneities and introduces the element of additional internal anisotropy. This additional anisotropy can be detected only by analysing the disruptions of magnetic and electrical equilibria of quantised space-time.

2.3.1. The state of electromagnetic equilibrium of quantised space-time

Figure 2.4 shows the models of quantised space-time in the form of a field grid (a) and a solid-state structure (b). These two models are equivalent to each other. The solid state model (b) is in no way the analogue of the solid with the properties of material matter. The two models realise the field form of weightless matter whose properties differ from material (real) matter. However, in the model in Fig. 2.4a, the quantons are in complete electromagnetic equilibrium, whereas in the model in Fig. 2.4b their electromagnetic equilibrium is not determined.

Prior to analysing further the state of space-time, we sdefine the individual terms. The macroworld is the world of linear dimensions perceived by the naked human eye of the order of 10^{-5} m. The microworld of the elementary particles is the world of the linear dimensions of the electron, proton, neutron, of the order of 10^{-15} m. The ultra-microworld is the world of linear dimensions of the fundamental length determined by the quanton diameter, 10^{-25} m. The Planck length is the world of linear dimensions of point objects of the order of 10^{-35} m.

It may be seen that there is a very large interval up to 10 orders between the different worlds of the linear dimensions. This means that around us there are worlds (microworld, ultra-microworld, Planck length) which we do not completely detect and do not control, and indirect information on these worlds can be obtained only as a result of theoretical and experimental investigations.

The Newton classic mechanics could not penetrate deeper than the macroworld. The theory of relativity and quantum mechanics have penetrated into the microworld of relativistic particles, but a large number of unsolved problems has remained. The theory of EQM and Superunification theory have penetrated into the region of the ultra-microworld of quantised space-time. Every penetration into the depth of matter provides new results in understanding the phenomena in the nature.

On the level of the fundamental length determined by the quanton diameter of 10^{-25} m, the quantised space-time is a discrete structure of highly heterogeneous fields with an anisotropy in the volume of the quanton in the presence of electrical and magnetic axes (Fig. 2.2). In the region of the microworld of the elementary particles and in the macroworld, the quantised space-time already represents a continuous homogeneous and isotropic medium which may be both in the completely balanced state and in the state displaced from equilibrium.

Figure 2.2 showed the structure of the quanton in the completely balanced electrical and magnetic states. The orthogonality in the projection of the electrical and magnetic axes of the quanton enabled the introduction of a right-angle coordinate system with the axes *X* and *Y* which in reality do not intersect because of the tetrahedral arrangement of the charges inside the quanton. The *X* axis corresponds to the electrical axis, the *Y* axis to the magnetic axis. The distance between the charges on the electrical and magnetic axes is denoted by r_{ex} and r_{gy}. Consequently, the electromagnetic equilibrium of the quanton can be written in the form of the quality of its electrical and magnetic components for Coulomb forces $F_e = F_g$ (2.10) and energies $W_e = W_g$ (2.12)

$$F_e = F_g = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{ex}^2} = \frac{\mu_0}{4\pi}\frac{g^2}{r_{gy}^2} \tag{2.19}$$

$$W_e = W_g = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{ex}} = \frac{\mu_0}{4\pi}\frac{g^2}{r_{gy}} \tag{2.20}$$

The equations (2.19) and (2.20) determine the electromagnetic equilibrium of the quanton. In a general case, the electromagnetic equilibrium of the quanton can be described in the following form, taking into account (2.19) and (2.20):

$$\frac{W_e}{W_g} = \frac{F_e}{F_g} = \frac{r_{ex}}{r_{gy}} = 1 \tag{2.21}$$

The difference between (2.21) and unity displaces the quanton from the electromagnetic equilibrium state.

It should be mentioned that the equilibrium state of the quantum can be obtained only if the symmetry of its charges is fulfilled (+1*e*, –1*e*) and (+1*g*, –1*g*) (2.13)

$$\begin{cases} (+1e) + (-1e) = 0 \\ (+1g) + (-1g) = 0 \end{cases} \tag{2.22}$$

$$\begin{cases} |+1e| + |-1e| = |2e| \\ |+1g| + |-1g| = |2g| \end{cases} \tag{2.23}$$

The excess or shortage of the charge in the quanton disrupts the symmetry of charges. Equation (2.22) establishes the electrical and magnetic neutrality of the quanton which in the case of a large distance from the quantum treats the latter as a completely neutral particle. There is no neutrality inside the quanton and in its immediate vicinity, and the number of charges is described by the sum of the moduli of the charges (2.23).

The equilibrium state of the quanton is fully transferred to the equilibrium state of the quantised space-time on the condition that in the investigated region of the space all the quantons are in the equilibrium condition. To evaluate mathematically the equilibrium state of some specific region of the quantised space-time, it is necessary to use a calculation model which would reflect the aggregate of a large number of the quantons subject to their electromagnetic equilibrium.

Figure 2.5 shows the averaged-out calculation model of some region of quantised space-time. This model is idealised in the form of a flat projection system of quantons which in reality, because of the tetrahedral arrangement of the charges inside the quanton, is in fact distorted in a small group of the quantons. However, if it is assumed that the model includes a very large number of quantons, then the statistically average calculation model, shown in Fig. 2.5, may reflect the equilibrium state of the quantised space-time which can be efficiently described mathematically.

The following assumptions were used in the construction of the averaged-out model (Fig. 2.5).

1. The electrical and magnetic axes of the quantons are orthogonal in relation to each other. Consequently, the investigated system of the quantons can be written into the rectangular coordinate system *X*

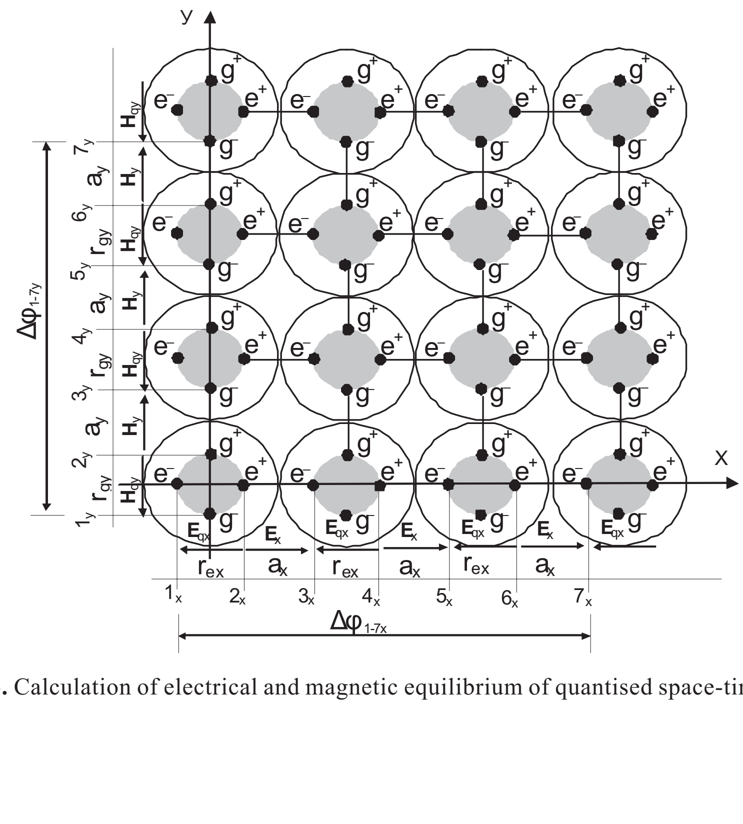


Fig. 2.5. Calculation of electrical and magnetic equilibrium of quantised space-time.

and Y, placing the electrical axes of the quantons along the X axis, and the magnetic axes along the Y axis.

2. The quantons are attracted to each other, forming external bonds between themselves. The external bonds are determined by the mutual attraction of only dissimilar electrical charges and only dissimilar magnetic charges. The external bonds cannot form by interaction between electrical and magnetic charges.
3. Between quantons, there are cavities which form a medium characterised by the constants ε_0 and μ_0. In this case, all the calculations carried out on the level of the ultra-microworld of the quantons are transferred in a linear manner into the region of the microworld of elementary particles and the macroworld.

A shortcoming of this average model is that it is more or less identical with the isotropic crystal lattice of the solid characterised. In its nature, the quantised space-time is anisotropic because of the tetrahedral arrangement of the charges inside the quanton. In a flat averaged-out model, Fig. 2.5, the isotropy is found initially as a result of the orientation of the electrical and magnetic axes of the quantons along the axes X and Y, respectively. However, this isotropy does not disrupt the electromagnetic equilibrium of quantised space-time. Therefore, the average model is fully suitable for solving the given task.

We investigate separately the conditions of electrical and magnetic equilibrium of quantised space-time. It is evident that the condition of electrical equilibrium is the absence in the quantised space-time of the difference of electrical potentials $\Delta\varphi$ over a specific length. As regards the model in Fig. 2.5, the length over which we calculate the difference of the electrical potentials $\Delta\varphi_{1-7x}$ is represented by the distance between the points 1_x and 7_x.

Consequently, the difference of the electrical potentials $\Delta\varphi_{1-7z}$ is determined by the integral of the strength of the electrical field $\mathbf{E}(x)$ in the path between the points 1_x and 7_x

$$\Delta\varphi_{1-7x} = \int_{1x}^{7x} \mathrm{E}(x)dx \qquad (2.24)$$

In the unification path 1_x–7_x the function of the strength $\mathbf{E}(x)$ at the points of distribution of the charges shows breaks. In addition, at the points of distribution of the charges it is necessary to deal with the boundary conditions related to the specific diameter of the nucleus of monopole charges (Fig. 2.3). As the radius (diameter) of the nucleus of the charge we can accept approximately and without proof the Planck length $\ell_p \sim 10^{-35}$ m. However, this approach is not suitable for calculations because it results in a very high concentration of the strength of the field on the surface of the nucleus of the monopole charge. Therefore, it is more logical to surround the point charge of the monopole nucleus by some sphere with a radius r_k 10–100 times smaller than the diameter of the quanton L_{q0}. This sphere represents the equipotential surface. Consequently, the integral (2.24) can be determined as the sum of two integrals along the unification path, determining the unification ranges taking into account the boundary conditions for the radius r_k

$$\Delta\varphi_{1-7x} = \sum_{1x}^{7x} \left(\int_{r_k}^{ax-r_k} \mathbf{E_x}\, dx - \int_{r_k}^{rex-r_k} \mathbf{E}_{q\mathbf{x}} dx \right) = 0 \tag{2.25}$$

where $\mathbf{E}_x$ is the function of the strength of the electrical field between the quantons on the X axis, $\mathbf{E}_{qx}$ is the function of the strength between the electrical charges inside the quanton along the X axis, a_x is the distance between the electrical charges of the adjacent quantons, r_{ex} is the distance between the electrical charges inside the quanton.

As shown by equation (2.25), the electrical equilibrium of space-time is determined by the absence of the difference of the electrical potentials over a specific distance, i.e., at $\Delta\varphi_{1-7x} = 0$. The point is that the consecutive distribution of the quantons on the X axis generates an alternating string from charges with alternating signs (Fig. 2.5). At the same distance between the charges of the alternating string, the pattern of the field is fully symmetric in every interval. This means that at $r_{ex} = a_x$ the functional dependence of the vector of the strength of the field inside adjacent intervals between the charges of the alternating string differs only in the sign of the direction of the vector, i.e. $\mathbf{E}_x = -\mathbf{E}_{qx}$. Therefore, the sum of the two identical integrals along the path 1_x-2_x-3_x with different signs is equal to 0 because it is determined by the identical unification ranges:

$$\Delta\varphi_{1-3x} = \int_{r_k}^{ax-r_k} \mathbf{E_x} d\,x - \int_{r_k}^{rex-r_k} \mathbf{E}_{q\mathbf{x}} dx = 0 \tag{2.26}$$

Taking into account that the intervals 1_x–3_x are repeated many times with $\Delta\varphi_{1-3x} = 0$ along the X axis in the equalised quantised space-time, this space as a whole remains electrically balanced. In this case, the upper summation limit in equation (2.25) is practically unlimited in n intervals for the balanced discrete space-time.

It should be mentioned that inside the quanton and between the quantons, the strength of the electrical field and the potential have extremely high values although, on the whole, the quantised space-time remains electrically balanced.

The identical considerations may also be applied for the magnetic equilibrium of the quantised space-time which is analysed along the *Y* axis, and in a general case may be represented by the sum of the path in *n* intervals of discrete space (Fig. 2.5):

$$\Delta\varphi_{1-n_y} = \sum_{1x}^{n}\left(\int_{r_k}^{a_y - r_k} \mathbf{H}_y dy - \int_{r_k}^{r_{gy} - r_k} \mathbf{H}_{qy} dy\right) = 0 \tag{2.27}$$

where $\mathbf{H}_y$ is the function of the strength of the magnetic field between adjacent quantons along the *Y* axis, $\mathbf{H}_{qy}$ is the function of the strength between the magnetic charges inside the quanton along the *Y* axis, a_Y is the distance between the magnetic charges of the adjacent quantons.

Taking into account (2.25) and (2.27), the condition of electrical and magnetic equilibrium of the quantised space-time can be expressed by a simple geometrical relationship:

$$\frac{r_{ex}}{a_x} = \frac{r_{ey}}{a_y} = 1 \tag{2.28}$$

We can also investigate other variants of electromagnetic equilibrium in the quantised space-time but this results in a more complicated problem. For example, introducing other parameters of electrical and magnetic permeability into the region restricted by the sphere of distribution of the charges inside the quanton results in the situation in which the charges are represented by spheres with the finite dimensions which differ from the Planck length. In the final analysis, calculations in this direction can be carried out using the renal diameter of the charges. I have so far analysed the simplest variant.

The equilibrium state of the quantised space-time is referred to as tyhe zero state or zero level, and the disruption of the equilibrium state is associated with a deviation the from zero level [34–36].

2.3.2. Disruption of electrical and magnetic equilibrium in statics

If the condition of magnetic equilibrium of the quantised space-time is described by the relationship (2.28), disruption of its equilibrium is described by the inequality:

$$\frac{r_{ex}}{a_x} \neq \frac{r_{ey}}{a_y} \neq 1 \tag{2.29}$$

In fact, the inequality (2.29) determines the displacement of the charges inside the quanton in relation to their equilibrium state. This results in the difference between the electrical and magnetic potentials in the quantised space-time manifested in the form of external electrical and magnetic fields. It is gratifying that the disruption of electromagnetic equilibrium of the quantised space-time is associated with actual points of displacement of the charges from their equilibrium state.

Figure 2.6 shows the pattern of disruption of the electrical equilibrium of the quantised space-time as a result of displacement of the charges in an alternating string under the effect of the external uniform electrical field, directed along the X axis. The source of the external perturbing field is not shown in Fig. 2.6. The transitional process of displacement of the charges is not investigated here and we analyse the disrupted equilibrium in the steady state.

As indicated by Fig. 2.6, the displacement of the charges disrupts the previously established electrical equilibrium of the system. The effect of the external field resulted in the deformation polarisation of the quantons in the string. The charges inside the quanton moves away from each other, and on the outside they came closer together, determining the inequality (2.29). The electrical field has been redistributed in the medium. The functions of the strength of the electrical field inside the quanton and outside it, along the X axis, have become equivalent, i.e. $\mathbf{E}_x \neq -\mathbf{E}_{qx}$. This was accompanied by changes in the unification limits $r_{ex} \neq a_x$, in accordance with (2.29). The external defects in the quantised space-time resulted in the establishment of the difference of the potentials, with the difference differing from zero:

$$\Delta\varphi_{1-nx} = \sum_{1x}^{n}\left(\int_{r_k}^{ax-r_k} \mathbf{E_x}dx - \int_{r_k}^{rex-r_k} \mathbf{E}_{q\mathbf{x}}dx\right) \neq 0 \tag{2.30}$$

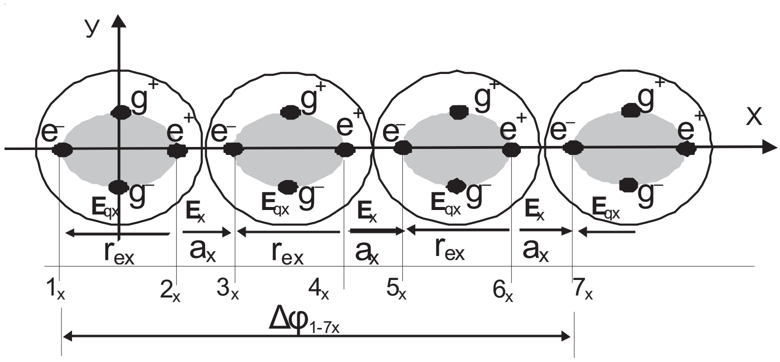


Fig. 2.6. Calculation of disruption of electrical equilibrium of quantised space-time.

The solution of the problem can be made more complicated by using the perturbation method for the function of the vector of the strength of the field of alternating charges along the x_{1-nx} axis and, in the final analysis, we obtain the result (2.30):

$$\Delta\varphi_{1-nx} = \sum_{1x}^{n}\left(\int_{r_k}^{ax-r_k} \mathbf{E}_{\mathbf{x}}dx - \int_{r_k}^{rex-r_k} \mathbf{E}_{q\mathbf{x}}dx\right) = \mathbf{E}\cdot x_{1-nx} \quad (2.31)$$

Equation (2.31) determines the relationship between the manifestation of the external field and the disruption of the internal electrical equilibrium of the quantised space-time. Thus, the EQM theory returns the concept of short-range interaction to physics in which the external field may show itself only as a result of the ionisation of quantised space-time. This was confirmed in experiments by Faraday by demonstrating the manifestation of lines of force whose external component is the vectors of the strength of the fields of quantised space-time.

It is necessary to pay attention to the fact that the strength of the electrical field inside the quantum is very high and incommensurable in comparison with the strength of the external field of the quantised space-time. However, the variation of the strength of the field inside the quanton is commensurable in comparison with the strength of the external field of the quantised space-time.

Figure 2.7 shows the disruption of magnetic equilibrium of the quantised space-time as a result of the displacement of charges in the alternating string under the effect of an external uniform magnetic field directed along the *Y* axis (with the axis rotated in the horizontal direction).

Identical considerations also apply to the disruption of the magnetic equilibrium of quantised space-time. If the strength **H** of the uniform external perturbing magnetic field on the length y_{1-ny} is specified, the balance with the internal field is determined in accordance with (2.31):

$$\Delta\varphi_{1-ny} = \sum_{1x}^{n}\left(\int_{r_k}^{a_y-r_k} \mathbf{H}_{y}dy - \int_{r_k}^{r_{gy}-r_k} \mathbf{H}_{qy}dy\right) = \mathbf{H}\cdot y_{1-ny} \quad (2.32)$$

Thus, the effect of the external electrical or magnetic field leads to the displacement of the charges inside the quantum and disruption of the electrical and magnetic equilibrium of the quantised space-time. From the mathematical viewpoint, the equations (2.31) and (2.32) can be conveniently described by the linear dependence between the variation of the parameters of the primary field of the quanton $\Delta\mathbf{E}_{qx}$ and $\Delta\mathbf{H}_{qy}$ and the external perturbing field **E** and **H**:

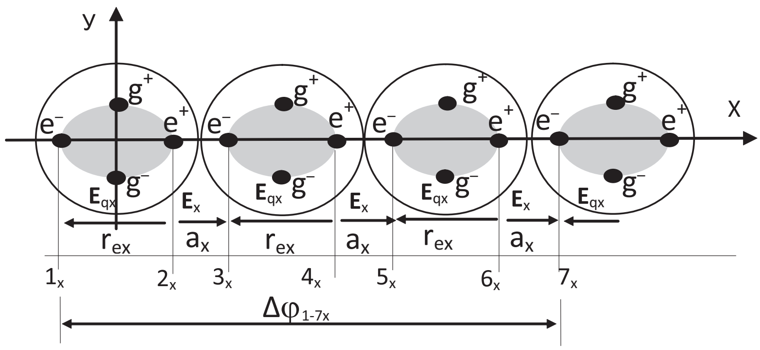


Fig. 2.7. Calculation of the disruption of magnetic equilibrium of quantised space-time.

$$\begin{aligned} \Delta\mathbf{E}_{qx} &= -k_{\mathrm{E}}\mathbf{E} \\ \Delta\mathbf{H}_{qy} &= -k_{H}\mathbf{H} \end{aligned} \tag{2.33}$$

where k_E and k_H are the proportionality coefficients.

2.3.3. Disruption of electromagnetic equilibrium in dynamics. Maxwell equations

Analysis of the disruption of the electrical and magnetic equilibrium in the quantised space-time has made it possible to determine the proportionality (2.33) between the changes of the parameters of the primary field of the quanton $\Delta\mathbf{E}_{qx}$ and $\Delta\mathbf{H}_{qy}$ and the external perturbing field **E** and **H**. Since the electromagnetic processes in the space-time are reversible, it may be asserted that the variation of the parameters of the primary field of the quanton $\Delta\mathbf{E}_{qx}$ and $\Delta\mathbf{H}_{qy}$ leads to the appearance of the external secondary field **E** and **H**. Consequently, we can investigate the dynamics of disruption of electromagnetic equilibrium in the conditions of passage of the electromagnetic wave through the quantised space-time and analyse the processes of electromagnetic polarisation of the quanton.

Without having the model of the electromagnetic ionisation of the quanton we cannot penetrate deeply into the principle of electromagnetic processes. This is the further development of concepts proposed by Faraday and Maxwell, the founders of dynamic electromagnetism [37, 38]. However, only in the theory EQM and Superunification theory has it been possible to combine electricity and magnetism in a single substance – electromagnetism, whose carrier is a new particle, i.e., the quanton and the superstrong electromagnetic interaction (SEI) in the form of the quantised Einstein space-time.

We consider the processes taking place in electromagnetic polarisation of the quanton as a result of the passage of an electromagnetic wave through the quanton. Experimental investigations of the propagation of electromagnetic waves show that the wave electromagnetic processes in vacuum are not associated with the extraction of excess energy from the vacuum. This means that the quanton retains its energy when the electromagnetic wave passes through it (2.17)

$$W_q = \text{const} \tag{2.34}$$

Since the energy of the quanton (2.34) in the electromagnetic processes remains constant, the energy capacity of the quantised space-time does not change. This means that there is no change in the concentration of the quantons (quantum density) in the medium and, correspondingly, the quanton diameter L_q also remains constant

$$L_q = \text{const} \tag{2.35}$$

Therefore, all further calculations of the electromagnetic polarisation of the quantum will be carried out taking the conditions (2.34) and (2.35) into account.

Figure 2.8 shows the different stages of electromagnetic polarisation of quantum in projection on the plane during the passage of an electromagnetic wave through the quanton. In the absence of electromagnetic perturbation (Fig. 2.8a), the quanton is in the equilibrium state. The dark part of the quanton represents its core. Inside the core of the quanton there is a tetrahedron whose tips carry the nuclei of the monopole charges (Fig. 2.2). Thus, the surface of the core of the quanton contains the nuclei of the monopole charges – quarks. The concept of the core of the quanton is introduced for the first time and is determined by the fact that in particular the core is subjected to deformation and orientation polarisation in

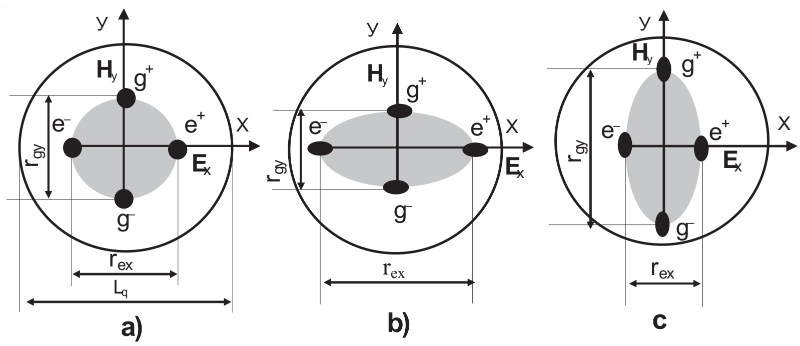


Fig. 2.8. Electromagnetic polarisation of the quantum during the passage of an electromagnetic wave.

electromagnetic processes ensuring the stability of the quanton diameter in accordance with the condition (2.35).

It is evident that when an electromagnetic wave passes through the quanton, in the first half cycle the core of the quanton should be stretched along the electrical axis *X* and should be compressed along the magnetic axis *Y*, or vice versa (Fig. 2.8b). In the second half cycle, the core of the quanton is stretched along the magnetic axis *Y* and compressed along the electrical axis *X*, or vice versa (Fig. 2.8c). The order of stretching and compression of the core of the quanton is determined by the direction of polarisation of the electromagnetic wave. After passage of the wave, the quanton returns to the equilibrium state (Fig. 2.8a). The charges are displaced in all cases of disruption of equilibrium of the quantum and this displacement determines the current of electrical and magnetic displacement of the electromagnetic field in the quantised space-time.

Figure 2.8 shows an idealised case of deformation polarisation of the quanton. Because of the tetrahedral arrangement of the charges inside a quanton, the electrical and magnetic axes of the quanton are randomly oriented in the real space-time. Therefore, when the electromagnetic wave passes through the quanton, both the deformation and orientation polarisation of the quantons take place, with polarisation determined by rotation of the axes of the quanton in space.

It should be mentioned that the displacement of the charges inside the quanton during the passage of the electromagnetic wave is extremely small leading to linearity (2.33). The EQM theory offers a method of calculating the displacement of the charges inside a quanton and this method will be described later.

On the other hand, the quantised space-time is a carrier of the electromagnetic wave, resulting in electromagnetic resonance of the quantum as a highly elastic element. It may be assumed that the quanton, as a volume resonator, has ideal properties ensuring the transfer of electromagnetic energy almost without any losses. If it would be possible to separate the quanton from the quantised space-time, then the quanton, once started, would oscillate for ever ensuring the exchange of electrical and magnetic energies (2.12). The presence of the electrical and magnetic elastic interaction between the charges of adjacent quantons inside the space-time ensures the transfer of electromagnetic energy of perturbation in the form of an electromagnetic wave. This means that the space-time is an elastic quantised medium capable of wave perturbations.

Therefore, it is very convenient to analyse the properties of the quanton under the effect of external perturbation. The value of the energy of external perturbation is not important in this case, it is important that the quanton retains its intrinsic energy (2.17), (2.34). This capacity of the quanton to retain its intrinsic energy determines the nature of electromagnetic processes resulting in the transformation of electricity to magnetism, and vice versa.

Because of the unique properties of the quanton, the transformation of electric energy to magnetic energy and back was carried out for the first time by the analytical derivation of the Maxwell equations for the electromagnetic wave in vacuum. The Maxwell equations are based on the processes taking place inside the quanton during the displacement of charges by a small value in relation to each other Δx and Δy, which is considerably smaller than the distances between the charges r_{qx} and r_{qy} inside the quanton (Fig. 2.8a):

$$\begin{aligned} \Delta x &<< r_{qx} \\ \Delta y &<< r_{qy} \end{aligned} \tag{2.36}$$

The displacement of the single charge in the quanton in relation to the equilibrium state is determined by the value 0.5 Δx and 0.5 Δy. The distance between the charges in the equilibrium state of the quanton is the same and equal to half the quanton diameter of $0.5L_q$. Consequently, we can describe the oscillatory electromagnetic processes of displacement of the charges inside the quanton by a harmonic function as the function of the distances between the charges r_{qx} and r_{qy} inside the quanton:

$$\begin{cases} r_{qx} = 0.5L_q + \Delta x \cdot \sin \omega t \\ r_{qy} = 0.5L_q - \Delta y \cdot \sin \omega t \end{cases} \tag{2.37}$$

where $\omega = 2\pi f$ is the cyclic resonance frequency of oscillations of the quanton, s^{-1}.

In the space-time non-perturbed by gravitation, the resonance frequency f of the oscillations of the quanton is determined by the equation (2.16) for f_0.

The displacements of the charges in the quanton are reduced to the system (2.37) because the small displacements Δx and Δy are equal to each other but their signs differ (2.1):

$$\Delta x = -\Delta y \tag{2.38}$$

The condition (2.38) determines the linearity of the electromagnetic processes in vacuum. Evidently, in reality, the displacements of the charges are so small that the regions of the non-linear electromagnetic processes in vacuum cannot be reached. Undoubtedly, the functional dependences of the parameters of the field between the charges inside a quanton are non-linear functions, but in the region of small displacements of the quanton in relation to equilibrium the section of the increase of the functions can be regarded as linear.

The difference in the sign in front of the displacements of the charges in (2.37) shows that the oscillatory processes of the charges inside the quanton along the axes X and Y take place in the counterphase. If the quanton nucleus is stretched along the X axis, then it is compressed along the Y axis and, vice versa, ensuring on the whole the constancy of the quanton energy (2.34). The equality of the increments of the electrical energy ΔW_e and the magnetic energy ΔW_g along the axes X and Y is expressed by the equation

$$\Delta W_e = -\Delta W_g \tag{2.39}$$

The increments of the energies (2.39) can be related to the displacement of the charges (2.38):

$$\frac{\Delta W_e}{\Delta x} = -\frac{\Delta W_g}{\Delta y} \tag{2.40}$$

The equations (2.39) and (2.40) describe the processes of conversion of electricity to magnetism and vice versa, through the increments of the energy (2.39) and the variation of the energy as a result of displacement of the charges (2.40). Since the expression (2.40) is determined by the very small displacement of the charges, it is fully justified to transfer from (2.40) to partial derivatives

$$\frac{\partial W_e}{\partial x} = -\frac{\partial W_g}{\partial y} \tag{2.41}$$

The partial derivatives (2.41) are determined from (2.2) taking into account that R_{qx} is situated on the X axis, and r_{qy} is on the Y axis:

$$\begin{cases} \dfrac{\partial W_e}{\partial x} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{e^2}{x^2}\mathbf{1}_x = \mathbf{F}_e \\[2ex] \dfrac{\partial W_g}{\partial y} = -\dfrac{\mu_0}{4\pi}\dfrac{g^2}{y^2}\mathbf{1}_y = \mathbf{F}_g \end{cases} \tag{2.42}$$

where $\mathbf{1}_x$ and $\mathbf{1}_y$ are the unit vectors on the X and Y axes, respectively.

It may be seen that the partial derivatives (2.42) determine the forces (2.10) acting on the charges inside the quanton.

Expression (2.42) enables us to transfer from the energy parameters of the field to the parameters of the strength of the field $\mathbf{E}_x$ and $\mathbf{H}_y$ taking into account that in the region of small displacement of the charges, the strength of the field is determined by the strength of the field in the immediate vicinity of the charge, and the effect of other charges is very small, i.e.:

$$\mathbf{E}_x = -\mathbf{E}_{qx}, \quad \mathbf{H}_y = -\mathbf{H}_{qy} \tag{2.43}$$

Taking equation (2.43) into account, we can write equations of the strength for the single charge in the region of small displacements inside the quanton:

$$\mathbf{E}_x = \frac{\mathbf{1}_x}{4\pi\varepsilon_0}\frac{e}{x^2}$$
$$\mathbf{H}_y = \frac{\mathbf{1}_y}{4\pi}\frac{g}{y^2} \tag{2.44}$$

From (2.44) we obtain partial derivatives:

$$\frac{\partial\,\mathbf{E}_x}{\partial\, x} = -\frac{\mathbf{1}_x}{2\pi\varepsilon_0}\frac{e}{x^3}$$
$$\frac{\partial\,\mathbf{H}_y}{\partial\, y} = -\frac{\mathbf{1}_y}{2\pi}\frac{g}{y^3} \tag{2.45}$$

We introduce the partial derivatives (2.45) into (2.42), multiplying the right-hand part of (2.42) by *x*/*x* and *y*/*y*:

$$\begin{cases} \dfrac{\partial\, W_e}{\partial\, x} = \dfrac{ex}{4\pi\varepsilon_0}\dfrac{e}{x^3}\mathbf{1}_x = -\dfrac{1}{2}ex\dfrac{\partial\,\mathbf{E}_x}{\partial\, x} \\ \dfrac{\partial\, W_g}{\partial\, y} = -\dfrac{\mu_0 g y}{4\pi}\dfrac{g}{y^3}\mathbf{1}_y = \dfrac{1}{2}\mu_0 g y\dfrac{\partial\,\mathbf{H}_y}{\partial\, y} \end{cases} \tag{2.46}$$

Using the equality (2.41) for (2.46), we determine the relationship between the partial derivatives of the strength of the electrical and magnetic fields in electromagnetic polarisation of the quanton in the conditions of a small displacement (2.38) of the charges and constant quanton energy (2.34) at $x = y$ (x and y in this case represent the distance between the charges in the conditions of small displacements of the charges):

$$e\frac{\partial\,\mathbf{E}_x}{\partial\, x} = -\mu_0 g\frac{\partial\,\mathbf{H}_y}{\partial\, y} \tag{2.47}$$

Equation (2.47) can be expressed by the increments (2.39) and (2.40):

$$e\frac{\Delta\mathbf{E}_x}{\Delta x} = -\mu_0 g\frac{\Delta\mathbf{H}_y}{\Delta y} \tag{2.48}$$

In principle, the expression (2.47) and (2.48) are the final equations forming the basis of the laws of electromagnetic induction and Maxwell equations.

In fact, taking into account (2.38) and (2.6), from (2.47) we obtain

$$\Delta \mathbf{E}_x = -C_0 \mu_0 \Delta \mathbf{H}_y \tag{2.49}$$

$$\Delta \mathbf{H}_y = -C_0 \varepsilon_0 \Delta \mathbf{E}_x \tag{2.50}$$

The equations (2.49) and (2.50) show that any change in the electrical parameters of the strength of the field of the quanton results in the automatic disruption of the magnetic equilibrium of the quanton and vice versa, linking the increments $\Delta \mathbf{E}_x$ and $\Delta \mathbf{H}_y$. Taking into account (2.43) and returning to (2.33), it should be mentioned that any disruption of the internal equilibrium of the quantum results in the interaction of the secondary field **E** and **H** in the quantised space-time:

$$\Delta \mathbf{E}_x = -C_0 \mu_0 k_H \mathbf{H} \tag{2.51}$$

$$\Delta \mathbf{H}_y = -C_0 \varepsilon_0 k_E \mathbf{E} \tag{2.52}$$

Substituting (2.36) into (2.43) and taking into account electromagnetic symmetry of the quanton, when $k_E = k_H$, we obtain the required relationship:

$$C_0 \varepsilon_0 \mathbf{E} = -\mathbf{H} \quad \text{at} \quad \mathbf{E} \perp \mathbf{H} \tag{2.53}$$

Equation (2.53) corresponds to the experimentally observed equality of the vectors **E** and **H** in a flat electromagnetic wave. The vectors completely coincide in time but are shifted in space by 90°. Taking into account the harmonic nature of displacement of the charges (2.37) of the quanton during the passage of the electromagnetic wave, equation (2.53) can be conveniently written in the complex form, writing the harmonic functions of the strength with the point

$$C_0 \varepsilon_0 \dot{\mathbf{E}} = -\dot{\mathbf{H}} \quad \text{at} \quad \mathbf{E} \perp \mathbf{H} \tag{2.54}$$

Taking into account the fact that the speed of light in (2.54) is the vector $\mathbf{C}_0$ of the speed of propagation of the electromagnetic wave, the equation (2.54) should be presented in the accurate form of the vector products where all the three vectors $\mathbf{C}_0$, **E** and **H** are orthogonal in relation to each other in the quantised space-time:

$$\varepsilon_0 \left[\mathrm{C}_0 \dot{\mathbf{E}} \right] = -\dot{\mathbf{H}} \tag{2.55}$$

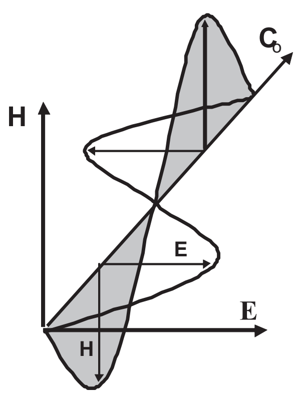
The equations (2.54) and (2.55) are well-known in electrodynamics and describe the flat electromagnetic wave (Fig. 2.9 and Fig. 1.1). Most importantly, the expressions (2.54) and (2.55) have not been derived as a result of formal transformations of the Maxwell equations (2.3) but they have been derived on the basis of the analysis of the electromagnetic transition processes taking place inside the quanton and quantised space-time. This means that the interaction of the quanton as a carrier of electromagnetic interactions is justified.

In fact, the equations (2.47), (2.48), (2.54), (2.55) are another form of writing the Maxwell equations (2.3) and, in the final analysis, have been derived as a result of transformation of the Coulomb laws (2.10) and (2.42), acting inside the quanton. The distinguishing feature of (2.47), (2.48), (2.54) and (2.55) is the absence of rotors, forming the basis of the Maxwell equations (2.3). It should be mentioned that the Maxwell equations (2.3) were modified to the current form by Heaviside. Maxwell did not attribute any importance to the rotors. His effort was directed to deriving wave equations obtained on the basis of analysis of the electromagnetic properties of the elastic electromagnetic aether. The wave equation of the electromagnetic field in the form presented by Maxwell [34] and shown in Fig. 2.9 is:

$$\frac{d^2\,\mathrm{F}}{dz^2} = K\mu \frac{d^2\,\mathrm{F}}{dt^2} \tag{2.56}$$

where F is the electromagnetic amount of motion – the generalised parameter of the electromagnetic field from which the magnetic field $(1/\mu)$ (dF/dz) and electrical force (dF/dt) (according to Maxwell) originate [34].

The scientific concept used by Maxwell for deriving the equation (2.56) will now be discussed: 'in the theory of electricity and magnetism, accepted at present, we assume the existence of two types of energy – electrostatic and electrochemical, and it is also assumed that they are situated not only in electrified and magnetised solids but also in every part of the surrounding space where the effect of electrical and magnetic forces is detected. Consequently, our theory agrees with the wave theory in that this theory assumes the existence of a medium capable of being the receptacle of two



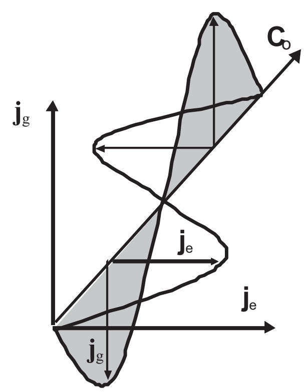


Fig. 2.9. A flat electromagnetic wave in quantised space-time in the coordinates **H** and **E**.
Fig. 2.10 (right)**.** A flat electromagnetic wave in the quantised space-time in the coordinates $\mathbf{j}_0$ and $\mathbf{j}_e$.

types of energy' [38]. Using the method of electromagnetic perturbation of the medium, Maxwell derived the equation (2.56) and other equations which were subsequently transformed to the form (2.3). In fact, equation (2.55) has also been transformed to the form (2.56).

The scientific concept of the Maxwell electromagnetic field is in complete agreement with the fundamentals of the EQM theory. Only the EQM theory has described the structure of the vacuum field as the quantised space-time being the 'receptacle of two types of energy'. Later, the theory of electromagnetism deviated from the Maxwell concept, formalising the Maxwell equations, and the electromagnetic wave in itself ceased to be regarded as an independent substance not requiring a carrier. As a result, the nature of the electromagnetic phenomena in vacuum remained on the Maxwell level for almost half a century.

If we analyse the generally accepted studies of the theory of electromagnetism, we detect the same repetition of the formal approach to the Maxwell equations in vacuum [39–45]. Whilst the physicists try not to go into the reasons behind the wave nature of electromagnetism, electricians prefer the vortex approach: 'Today, we prefer to consider the formation of the basic properties of the electromagnetic field as a result of changes over time in the electrical field, just as the formation of vortices of the electrical field due to changes over time in the magnetic field' [45]. However, this has not been confirmed by the experiments with the flat electromagnetic wave, Fig. 2.9. The vectors **E** and **H** of this wave (2.54) can exist only together and at the same time without any phase shift in time. If one of the vectors is removed, the electromagnetic wave is disrupted. In practice, this is used in the construction of electrical screens in the form of a conducting mesh which completely screens only the electromagnetic field and does not screen the magnetic field. The removal of the electrical component results in the disruption of the electromagnetic wave and in screening of electromagnetic radiation.

The simultaneous existence of **E** and **H** in (2.55) indicates that the rotors of the field have no direct relationship with the nature of the electromagnetic field in vacuum, although they can be detected as the secondary manifestation of fields which will be discussed later. The equation of the flat electromagnetic wave (2.55) is rotor-free and has been derived from (2.47) on the basis of analysis of the electromagnetic polarisation of the quanton and the quantised space-time which is easily reduced to the form (2.3), determining the real nature of the displacement currents in vacuum.

2.3.4. Displacement of the charges in the quanton and displacement currents

A paradoxic situation formed in the electrodynamics where the Maxwell equations (2.3) formally determine the density of currents of electrical $\mathbf{j}_e$ and magnetic $\mathbf{j}_g$ displacements which the theory of the field treats as virtual and which do not exist in nature. The presence of the quantised structure of space-time confirms for the first time that the displacement currents are the currents which actually exist in nature.

A distinguishing special feature of the displacement currents in vacuum is that these currents are determined by the simultaneous displacement from equilibrium in the counter phase of electrical and magnetic charges of the opposite polarity. Figure 2.5 shows in projection the region of quantised space-time which enables the vacuum to be regarded as a specific elastic medium filled with charges and capable of electromagnetic ionisation as a result of displacement of the charges from the equilibrium state (Fig. 2.8).

To determine the relationship between the displacement currents, we return to (2.47) presenting it in the following form:

$$C_0\varepsilon_0 \frac{\partial \mathbf{E}_x}{\partial x} = -\frac{\partial \mathbf{H}_y}{\partial y} \tag{2.57}$$

The equation (2.47) is converted to the form (2.3), expressing the density of the displacement currents. For this purpose, we transfer from the derivatives in respect of the coordinates X and Y to derivatives in respect of time t, taking into account the fact that the speed of displacement v of the charges in relation to the equilibrium state remains the same along the axes X and Y because of the small value of the displacement:

$$\mathbf{v} = \frac{\partial x}{\partial t}\mathbf{1}_x = -\frac{\partial y}{\partial t}\mathbf{1}_y \tag{2.58}$$

Taking (2.58) into account, we transform equation (2.57)

$$C_0\varepsilon_0 \frac{\partial \mathbf{E}_x}{\partial t} = \frac{\partial \mathbf{H}_y}{\partial t} \tag{2.59}$$

Equation (2.59) includes the densities of the currents of electrical $\mathbf{j}_e$ and magnetic $\mathbf{j}_g$ displacements (2.3). Consequently, (2.59) can be described by the vector product:

$$\left[C_0\mathbf{j}_e\right] = -\mathbf{j}_g \tag{2.60}$$

Like (2.55), expression (2.60) describes the flat electromagnetic wave (Fig. 2.10) in the coordinates $\mathbf{j}_g$ and $\mathbf{j}_e$. The wave in Fig. 2.10 is equivalent to the wave in Fig. 2.9 in the coordinates **H** and **E**. However, the displacement currents (2.60) are the primary currents and determine the strength of the field **E** and **H** in (2.55) as a result of the disruption of the electromagnetic equilibrium of the quantised space-time. This produces a specific phase shift between the vectors $\mathbf{j}_g$ and **H**, $\mathbf{j}_e$ and **E**, which will be discussed later.

The dimension of electrical current is [A = C/s]. The magnetic current also has the dimension [Dc/s] (2.6) but it has no name. It was proposed to call the magnetic current in honour of Heaviside [Hv = Dc/s]. Ampere [A] and Heaviside [Hv] are linked by the relationship [Hv] = C_0 [A]. The electrical current of 1 A is equivalent to the magnetic current of $3\cdot10^8$ Hv. We can construct a system of measurements in which the electrical and magnetic currents and also charges are measured in the same units. However, this would require violating the conventional SI system.

The dimension of the density of electrical displacement currents is determined as follows [$A/m^2 = C/m^2$ s]. We determine the dimension of the density of magnetic displacement currents [$Hv/m^2 = Dc/m^2$ s].

2.3.5. Displacement of the charges in the quanton in statics

After defining the dimensions, we can calculate the displacement of the electrical charges and the quanton, the speed of displacement of the charges, and current densities. For this purpose, we combined the equations (2.3) and (2.4). Number 2 in (2.4) indicates that in the quanton, the charges are considered in pairs

$$2e\rho_0\mathbf{v} = \varepsilon_0\frac{\partial\,\mathbf{E}}{\partial\,t} \tag{2.61}$$

$$2e\rho_0\frac{\partial\,x}{\partial\,t}\mathbf{1}_x = \varepsilon_0\frac{\partial\,\mathbf{E}}{\partial\,t} \tag{2.62}$$

Initially, the solution of (2.62) is determined for the linear function (the solution for the harmonic function will be different)

$$2e\rho_0\Delta x\mathbf{1}_x = \varepsilon_0\mathbf{E} \tag{2.63}$$

The resultant solution (2.63) makes it possible to link the linear displacement Δx in (2.37) of electrical charges in the quanton which induces the secondary external field in the space with the strength E.

From equation (2.62) we determine the displacement Δx of charges inside the quanton, for example, for an electrostatic field with the strength equal to the electrical strength of air of 30 kV/cm = 3×10^6 V/m (ρ_0 = $3.55\cdot10^{75}$ m^{-3} [7, 20])

$$\Delta x = \frac{\varepsilon_0 E}{2e}\frac{1}{\rho_0} = \frac{\varepsilon_0 E}{2e}\frac{L_{q0}^3}{k_3} = 2.3 \cdot 10^{-62}\,\text{m} \qquad (2.64)$$

where ρ_0 is the quantum density of the space-time unperturbed by the gravitation; $k_3 = 1.44$ is the coefficient of filling of vacuum with spherical quantons

$$\rho_0 = \frac{k_3}{L_{q0}^3} \qquad (2.65)$$

From equation (2.64) we determine the disruption of the electrical equilibrium in the quantised space-time as a result of the displacement of electrical charges in the quanton as the strength **E** of the secondary field:

$$\mathbf{E} = \frac{2ek_3\mathbf{1}_x}{\varepsilon_0 L_{q0}^3}\Delta x \qquad (2.66)$$

As indicated by (2.64) and (2.66), disruption of the electrical equilibrium as a result of displacement of the electrical charges in the quanton by approximately 10^{-62} m induces in the space-time a strong electrical field with the strength characterised by the electrical strength of air. This confirms that the quantised space-time is a highly elastic medium, taking into account the fact that the distance between the charges in the quanton is determined by the value of the order of 10^{-25} m, and the diameter of the nucleus of the point charges in the quantons at the moment is defined by the Planck length of 10^{-35} m. Displacement of the charges in the quanton by 10^{-62} m is incommensurably small even in comparison with the Planck length. Regardless of this, this small displacement results in a significant disruption of the electrical equilibrium of the quantised space-time.

The secondary field **E** (2.66) is determined by the displacement Δx (2.64) of the charges of the quanton as a result of the superposition of the fields of a number of quantons included in the investigated region of the space. As shown previously, the relationship between the elements of the primary field $\Delta\mathbf{E}_{qx}$ of the quanton and the secondary induced field **E** is determined by the coefficients k_E and k_H (2.33), and $k_E = k_H$ (2.53). The further solution of the problem is reduced to the determination of the coefficients k_E and k_H. However, to find these coefficients, it is necessary to determine the variation of the strength of the field inside the quanton during displacement of the charges.

This can be carried out by solving (2.31). However, this solution is purely mathematical. We shall use a different procedure and examine the purely physical model whose mathematical solution is very simple and also describes the very physics of the phenomenon. Equation (2.31) shows that the disruption of the electrical equilibrium should be investigated on the elementary level, studying a section of length not smaller than the diameter of the quanton L_{q0}. Consequently, the solution of the problem should be found as the displacement of an entire charge between two adjacent charges with the same polarity. The displaced charge has the opposite polarity in comparison with the two stationary charges. Instead of the strength of the field we study the variation of force during displacement of the charge since it is quite easy to transfer to the parameter of the strength of the field if we know the force.

Figure 2.11 shows the calculation diagram of the displacement of a pair of electrical charges in the quanton from the equilibrium state in Fig. 2.5 by the value Δx in different directions from the origin of the coordinates, Fig. 2.6. To simplify calculations, the origin of the coordinates is transferred to the charge 1_x with negative polarity, assuming that the charge is stationary. Consequently, the displacement of the charge 2_x with positive polarity inside the quanton along the axis X is determined by the distance $2\Delta x$. The charge 2_x is situated between two charges with negative polarity 1_x and 3_x. The distance between the charges 1_x and 3_x remains equal to the quanton diameter $L_{q0} = L_{qx}$ in the displacement of the charge 2_x by $2\Delta x$. The distance r_{ex} between the charges 1_x and 2_x inside the quanton increases by $2\Delta_x$ and becomes equal to $(0.5\, L_{qo} + 2\Delta x)$. The distance a_x between the charges $2x$ and $3x$ outside the quantum decreases by $2\Delta x$ and becomes equal to $(0.5\, L_{qo} - 2\Delta x)$. Consequently, we can calculate the forces acting on the charge 2_x. From the side of the charge 1_x it is the force - $\mathbf{F}_{1x}$, from the side of the charge 3_x it is the force $+\mathbf{F}_{3x}$. The resultant force is $\mathbf{F}_{2x} = \mathbf{F}_{3x} - \mathbf{F}_{1x}$. We determine the resultant force $\mathbf{F}_{2x}$, taking into account that $\Delta x \ll L_{q0}$ and retain the significant terms:

$$\mathbf{F}_{2x} = \mathbf{F}_{3x} - \mathrm{F}_{1x} = \frac{e^2}{4\pi\varepsilon_0}\left(\frac{1}{a_x^2} - \frac{1}{r_{ex}^2}\right)\mathbf{1}_x =$$
$$= \frac{e^2}{4\pi\varepsilon_0}\left(\frac{1}{(0.5L_{q0} - 2\Delta x)^2} - \frac{1}{(0.5L_{q0} + 2\Delta x)^2}\right)\mathbf{1}_x = \frac{16e^2\mathbf{1}_x}{\pi\varepsilon_0 L_{q0}^3}\Delta x \tag{2.67}$$

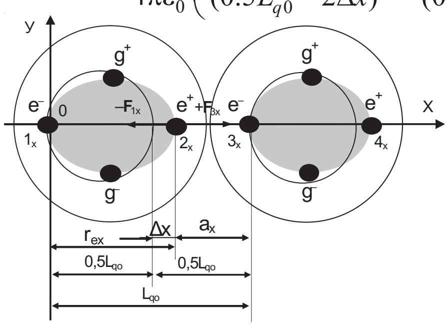


Fig. 2.11. Calculation of the displacement of the electrical charge from the equilibrium state in the quanton.

As indicated by (2.67), the resultant force $\mathbf{F}_{2x}$, acting on the charge 2_x, is proportional to the displacement Δx in the range of small displacements $\Delta x << L_{qo}$. In the equilibrium conditions at $2\Delta x = 0$, force $\mathbf{F}_{2x} = 0$. Force $\mathbf{F}_{2x}$ is completely equivalent to the force acting on an elastic spring when the force of tensile loading of the spring is proportional to its extension X. In the present case, the elongation is represented by the displacement $2\Delta x$ of the charge 2_x from the equilibrium state. The analogy between the properties of the elastic spring and the equivalent properties of the quantised space-time is referred to as the theory of the elastic quantised medium (EQM).

In order to determine the variation of the strength $\Delta\mathbf{E}_{qx}$ of the internal field inside the quantised medium we use the results obtained from (2.67) examining the charge 2_x as a testing charge, and the force $\mathbf{F}_{2x}$ acting on the charge is proportional to the variation of strength $\Delta\mathbf{E}_{qx}$ of the field as a result of disruption of electrical equilibrium of the medium:

$$\Delta\mathbf{E}_{qx} = \frac{1}{e}\mathbf{F}_{2x} = \frac{16e\mathbf{1}_x}{\pi\varepsilon_0 L_{q0}^3}\Delta x \qquad (2.68)$$

When the charges are displaced by $\Delta x = 2.3\cdot10^{-62}$ m (2.64), from equation (2.68) we determine the variation of the strength of the primary field inside the quanton which is $\Delta\mathbf{E}_{qx} = 5.3\cdot10^6$ V/m. Comparing the result with the strength of the primary field for $E = 3\cdot10^6$ V/m for the displacement of the charges by $\Delta x = 2.3\cdot10^{-62}$ m (2.64), it is important to note that even the approximate solutions do not result in any large scatter of the parameters of the strength of the fields $\Delta\mathbf{E}_{qx}$ and $\mathbf{E}$. It should be mentioned that the parameters ΔE_{qx} have been calculated in the region of the ultra-microworld of the quantons, and the parameters E were taken from the region of the macroworld, using completely different approaches to solution of the problem. Now it can already be mentioned that this agreement is extremely unique and shows convincingly that the parameters of the ultra-microworld are directly linked with the macroworld.

The results obtained from (2.67) and (2.16) are slightly too high because they do not take into account the reduction of the strength of the field in the alternating string (Fig. 2.5) as a result of the effect of other charges taken into account by coefficient $\pi^2/12$ [4]. We improve the accuracy of (2.67) and (2.68):

$$\mathbf{F}_{2x} = \frac{\pi^2}{12}\frac{16e^2\mathbf{1}_x}{\pi\varepsilon_0 L_{q0}^3}\Delta x = \frac{4\pi}{3}\frac{e^2\mathbf{1}_x}{\varepsilon_0 L_{q0}^3}\Delta x \qquad (2.69)$$

$$\Delta\mathbf{E}_{qx} = \frac{4\pi}{3}\frac{e\mathbf{1}_x}{\varepsilon_0 L_{q0}^3}\Delta x \qquad (2.70)$$

Finally, from (2.33) we determine the coefficient k_E, dividing (2.70) by (2.66)

$$k_E = \frac{\Delta E_{qx}}{E} = \frac{4\pi}{3\varepsilon_0} \frac{e\Delta x}{L_{q0}^3} \frac{\varepsilon_0 L_{q0}^3}{2e\Delta x k_3} = \frac{2\pi}{3k_3} \approx 1.4$$
$$\cos\alpha_x = 1/k_E \approx \pm 0.7, \quad \alpha_x \approx \pm 45^{\circ} \qquad (2.71)$$

The result (2.70) describes quite accurately the field of the alternating string. The field can be determined with greater accuracy by taking into account the effect of adjacent strings, however, the improvement is only slight. The image of the field in the string in Fig. 2.6 is idealised. Inside a quanton, the charges are distributed on the tips of the tetrahedron. Therefore, in polarisation of the quantons, the direction of the vectors $\Delta\mathbf{E}_{qx}$ of the set of the quantons does not correspond with the direction of the axis *X*. It should be mentioned that the result (2.63) is averaged out for the vector **E** situated completely on the axis *X*. In fact, coefficient k_E (2.71) takes into account the projections of vector $\Delta\mathbf{E}_q$ on the *X* axis. The averaged-out angle α_x of inclination of the vector $\Delta\mathbf{E}_{qx}$ is determined by cos $\alpha_x = 1/k_E \sim\pm 0.7$. Consequently, we determine the required average angle $\alpha_x \sim\pm 45°$.

Thus, the calculations fully confirm the scientific concept of the quantised space-time. Analysis was made of the displacement of the electrical charges inside the quanton and disruption of electrical equilibrium of the space-time in the statics. These processes are reversible. In the presence of the external field, the charges are displaced in the quanton in relation to the equilibrium state. On the other hand, in the case of internal displacements of the charges in the quanton in relation to the equilibrium state, the electrical equilibrium in the quantised space-time is violated. This results in the appearance in the quantised space-time of the electrical field with the strength **E** formed as a result of the superposition of the fields from the set of quantons in the region of the electrically perturbed space.

The results and conclusions also fully relate to the displacement Δy of the magnetic charges *g* inside the quanton in the case of disruption of the magnetic equilibrium of space-time. Since the magnetic processes are identical with electrical processes, they can be described on the basis of the previously mentioned calculations using (2.61)–(2.71) by replacing the electrical constants with the equivalent magnetic constants along the *Y* axis:

$$2g\rho_0\mathbf{v} = -\frac{\partial\,\mathbf{H}}{\partial\,t} \qquad (2.72)$$

$$2g\rho_0 \Delta y \mathbf{1}_y = -\mathbf{H} \tag{2.73}$$

$$\Delta y = \frac{H}{2g}\frac{1}{\rho_0} = \frac{H}{2g}\frac{L_{q0}^3}{k_3} \tag{2.74}$$

$$\mathbf{H} = -\frac{2gk_3\mathbf{1}_y}{L_{q0}^3}\Delta y \tag{2.75}$$

$$\mathbf{F}_{2y} = -\frac{4\pi}{3}\mu_0 \frac{g^2\mathbf{1}_y}{L_{q0}^3}\Delta y \tag{2.76}$$

$$\Delta\mathbf{H}_{qy} = -\frac{4\pi}{3}\frac{g\mathbf{1}_y}{L_{q0}^3}\Delta x \tag{2.77}$$

$$k_H = \frac{\Delta H_{qy}}{H} = \frac{4\pi}{3}\frac{g\Delta y}{L_{q0}^3}\frac{L_{q0}^3}{2g\Delta y k_3} = \frac{2\pi}{3k_3} \approx 1.4$$
$$\cos\alpha_y = 1/k_H \approx \pm 0.7, \quad \alpha_y \approx \pm 45^{\circ} \tag{2.78}$$

The analysis results show that disruption of the electrical and magnetic equilibrium inside the quanton in the region of the ultra-microworld of the fundamental length results in automatic disruption of the electrical and magnetic equilibrium of the quantised space-time in the region of the microworld of the elementary particles and in the macroworld. Therefore, the derivation of the Maxwell equations (2.55) and (2.60) for a flat electromagnetic wave, Fig. 2.9 and 2.10, obtained as a result of analysis of electromagnetic polarisation of the quanton, Fig. 2.8, can also be extended to any region of the quantised space-time.

On the other hand, analysis shows that the manifestation of the electrical and magnetic fields in the quantised space-time is associated with the disruption of its electrical and magnetic equilibrium. This means that any electrical or magnetic fields can exist in space due to the electrical and magnetic ionisation of the quantons which play the role of electrical and magnetic dipoles, carriers of fields, and their polarisation results in the pattern of the field.

The field of a flat condenser between the plates and inside them is filled with quantons resulting in the disruption of electrical equilibrium of the space-time in such a manner that the field between the plates is uniform and at the edges it is non-uniform. This can also be found in the magnetic gap of a magnetic circuit. It is now important to note that any configuration of the complex field is described in the statics by the Poisson or Laplace equations because of the internal properties of the orthogonality of the quantised space-time (Fig. 2.5) which has the form in the final analysis of a network of lines of force with equipotentials orthogonal to them.

Faraday and Maxwell attributed a real physical meaning to the lines of force. However, up to now, the actual nature of the lines of force has not been confirmed, regardless of the fact that they have been visualised using iron shavings and other methods. This is because physics can understand the principle of the phenomenon only by penetrating into the region of the ultra-microworld of the quantons, analysing the field on the level of the fundamental length of 10^{-25} m. Only in the EQM theory has it been possible to show that the lines of force as real objects do in fact form as a result of the electrical and magnetic polarisation of the quantised space-time. The simplest form of representation of the lines of force as a real object are the electrical (Fig. 2.6) and magnetic (2.7) strings made from quantons.

2.3.6. Polarisation energy of the quanton

Examining the electromagnetic polarisation of the quantum during the passage of an electromagnetic wave, it was possible to determine the condition (2.34) of constancy of quanton energy. This results in the simultaneous transition of electrical energy to magnetic energy, and vice versa. However, in static polarisation the condition (2.34) is not filled and is determined by the increase of electrical ΔW_e or magnetic ΔW_g energy (2.12) and (2.17) fulfilling the conditions of the electrostatic of magnetic regime:

$$W_q = W_g + W_e \pm \Delta W_e \neq \text{const} \tag{2.79}$$

$$W_q = W_e + W_g \pm \Delta W_g \neq \text{const} \tag{2.80}$$

In the transition regime which is characterised by a very high speed (2.15) for a single quanton the condition (2.34) is fulfilled at $\Delta W_e = \Delta W_g$ and is characterised by the interaction of the components $(-\Delta W_e)$ and $(-\Delta W_g)$

$$W_q = W_g - \Delta W_g + W_e + \Delta W_e = \text{const} \tag{2.81}$$

$$W_q = W_e - \Delta W_e + W_g + \Delta W_g = \text{const} \tag{2.82}$$

Possibly, this transition is associated with damped oscillations of the quanton, treating the quanton as a volume electromagnetic resonator.

Since the disruption of the induced equilibrium $(-\Delta W_e)$ and $(-\Delta W_g)$ in (2.81) and (2.32) is not maintained in the steady regime, $(-W_e)$ and $(-W_g)$ change to 0, establishing the electrical (2.79) or magnetic (2.80) static field as displacements (2.70) and (2.77) of the charges in the quanton in relation to the equilibrium state. It should be mentioned that a source of the external static field is required for the displacement of the charges (2.70) and (2.77).

The continuous electromagnetic wave is generated by harmonic variation of ΔW_e or ΔW_g for a large group of quantons in some volume of the space which is regarded as the radiation zone. This is realised using the generators of the electromagnetic field and antennae.

2.3.7. Nature of electromagnetic oscillations in vacuum

In section (2.3.4) we analysed the derivation of the Maxwell equations for the electromagnetic wave in vacuum which is reduced, in the final analysis, to a single vector equation (2.55) or to an equivalentequation (2.60). It would appear that this work has been sufficient to understand the principle of wave phenomena taking place in vacuum, regarding the quanton as a real carrier of the electromagnetic field. At the same time, the EQM theory provides additional possibilities for investigating the nature of electromagnetic oscillations in vacuum based on the capacity of the quanton to carry out elementary oscillatory cycles.

In particular, it should be noted that the continuity of the electromagnetic wave is determined by the superposition of the oscillations of the individual quantum during the passage of an electromagnetic wave through the quantised space-time. Consequently, it can be claimed that any electromagnetic field (wave) is quantised in its basis.

The quantised nature of the electromagnetic field becomes especially evident when the frequency of the field in the region of photon radiation is increased, when the electromagnetic radiation has discrete properties and energy is emitted in portions – radiation quanta. This was used as the starting point of the quantum theory in which the classic electrodynamics, supported by the continuity of the electromagnetic field, clashed with the disruption of continuity, with discrete photon radiation [12].

The characteristic feature of the continuous electromagnetic wave is that the intensity of radiation is independent of wavelength. The intensity of radiation of a continuous wave may smoothly change in the entire range of electromagnetic continuous waves by the smooth variation of the parameters **E** and **H**.

Photon radiation is of the discrete nature and its intensity is proportional to radiation frequency. The nature of this phenomenon is not known in modern physics. The introduction of the action quanton h (or $\hbar$) purely empirically by Planck was used as a basis for developing the calculation apparatus of quantum theory but has not helped in studies of its principle.

The assumption on the photon nature of radiation enabled Einstein to determine the equivalence of the mass m (or the mass defect Δm) and radiation energy $\hbar v$, which is proportional to frequency ν:

$$\Delta m C_0^2 = \hbar \nu \tag{2.83}$$

Thus, equation (2.83) shows that the nature of phonon radiation differs from that of radio waves, including microwaves. Radio waves are produced by electromagnetic resonators which are artificially produced oscillatory circuits LC, where L is inductance, C is capacitance. In the oscillatory circuit, electrical energy is converted to magnetic energy and vice versa. The discharge of electromagnetic energy from various oscillatory circuits and resonators into space takes place by different mechanisms. However, in the final analysis, the quantised space-time is characterised by the formation of an electromagnetic wave from orthogonal vectors **H** and **E** which is described by the vector product (2.55) for a flat wave.

Resonator systems are not used for producing photon radiation. Einstein showed that photon radiation is based on the mass defect phenomenon (2.83). This is the primary method. All other methods of investigating photon radiation are secondary methods and are not without contradictions.

For example, the radiation of an atomic system is regarded as a jump of the electrical energy of the system in transition of an orbital electron to a lower orbit. However, there is a contradiction in this. A decrease of the distance between the atomic nucleus and the orbital electron at the moment of the jump increases the electrical energy of the system, as the binding energy. If the situation were reversed, the energy of the system would decrease in comparison with the initial energy, and its excess would be transformed to radiation. However, in this case, the energy of the system increases and photon radiation forms at the same time. The removal of this contradiction by the method of re-normalisation of energy is only the removal of contradictions in the calculation variant, it is not the solution of the problem.

The solution of the problem of photon radiation is based on the nature of transfer of the mass defect to electromagnetic radiation. This fundamental problem cannot be solved without combining gravitation and electromagnetism, and this is also investigated in this book. The EQM and Superunification theories describe the electromagnetic nature of gravitation and the mechanism of formation of the mass of an elementary particle as a result of spherical deformation of quantised space-time [22, 23]. In particular, the energy of deformation of the space-time is released as a result of the mass defect of the elementary particle and generates a radiation quantum in the form of a photon.

It is important to understand that, regardless of different nature of the formation of photon radiation and radio waves, the common feature of these two types of radiation is the common carrier – quanton and quantised space-time. However, it can already be asserted that radio waves are characterised by a variable (var) value of displacement Δx (2.70) and Δy (2.77) of the charges in the quanton:

$$\Delta x = \Delta y = \text{var} \tag{2.84}$$

In particular, the variable value of the displacements Δx and Δy of the charges in the quanton leads to a change of the parameters **E** and **H** of the electromagnetic wave and to changes of their intensity which is not directly linked with frequency.

The intensity of photon radiation is proportional to frequency (2.83). This is possible only if the displacements Δx (2.70) and Δy (2.77) of the charges in the quanton, which takes part in the transfer of photon radiation, remain constant

$$\Delta x = \Delta y = \text{const} \tag{2.85}$$

Only if the condition (2.85) is fulfilled, when it is not simple to change the intensity of radiation as a result of the parameters **E** and **H**, there remains a single method of changing the energy transferred by the photon – the method of variation of the frequency (2.83) of the electromagnetic field for the radiation quantum. It can already be assumed that the condition (2.83) is fulfilled for the photon only if the photon occupies a small limited region of the quantised space-time which includes a constant number of quantons, and the condition (2.85) is fulfilled for every quanton. Consequently, inside the region of the space-time limited by the volume of the photon there can only be a certain number of waves determining the discrete nature of photon radiation.

As already mentioned, the nature of photon radiation is associated with the nature of gravitation and is outside the framework of only electromagnetism. On the other hand, photon radiation, like the radiation of radio waves, is linked by its nature with the quanton and the quantised space-time. Therefore, we continue analysis of the properties of the quanton.

It is surprising to see that everything in nature is linked harmonically with the system of knowledge described by the EQM theory and Superunification theory. It would appear that some monopole charges e and g of different nature enter the quanton (Fig. 2.2b) and determine the single substance – electromagnetism. However, if g is formally divided by e, we obtain the speed of light (2.6)

$$C_0 = \frac{g}{e} \tag{2.86}$$

In fact, equation (2.86) has a specific physical meaning. Figure 2.5 shows the model of the quantised space-time which can be regarded as some spatial field with the distributed parameters $\pm e$ and $\pm g$. Because of the presence of the distributed parameters $\pm e$ and $\pm g$, the space-time represents a unique volume waveguide, a medium capable of carrying electromagnetic radiation.

In radioelectronics, electromagnetic radiation is transferred by double-wire lines (or coaxial cables, waveguides) regarded as lines with the distributed LC parameters. Drawing an analogy between the distributed parameters LC and $\pm e \pm g$, it can be shown that the electrical charge e is an analogue of capacitance C and the magnetic charge g is an analogue of inductance L.

The quanton contains two electrical charges and two magnetic charges (Fig. 2.2 and 2.8). Electrical capacitance C_e of two charges $\pm e$ included in the quanton is determined by the radius r_k of the sphere (2.25) around the nucleus of the monopole charge (Fig. 3), taking into account that $r_k < r_{ex}$, where r_{ex} are the distances between the centres of the charges (sphere r_k is the equipotential surface)

$$C_e = \frac{2e}{\Delta\varphi_e} = 4\pi\varepsilon_0 r_k \tag{2.87}$$

where $\Delta\varphi_e$ is the difference of the electrical potentials between the spheres r_k around the nuclei of monopole charges at $r_k \ll r_{ex}$

$$\Delta\varphi_e = \frac{e}{2\pi\varepsilon_0}\left(\frac{1}{r_k} - \frac{1}{r_{ex} - r_k}\right) \approx \frac{1}{2\pi\varepsilon_0}\frac{e}{r_k} \tag{2.88}$$

Equation (2.87) determines the electrical capacitance of the quanton as a distributed parameter of the quantised space-time. It is interesting to note that the capacitance of the quanton is determined by the radius r_k of the sphere around the nucleus of the electrical monopole and by the electrical constant ε_0. This is noteworthy due to the fact that this makes it possible to calculate constant ε_0 as the electrical parameter of vacuum filling the entire space, including the space between the quantons.

On the other hand, the magnetic monopole charge g (Fig. 2.3) can be characterised by inductance L_g which by analogy with (2.87) is determined by the ratio of $2\mu_0 g$ to the difference of the magnetic potentials $\Delta\varphi_g$ between the spheres r_k around the nuclei of the monopole charges at $r_k \ll r_{gy}$ (Fig. 2.8):

$$L_g = \frac{2\mu_0 g}{\Delta\varphi_g} = 4\pi\mu_0 r_k \tag{2.89}$$

$$\Delta\varphi_g = \frac{1}{2\pi}\frac{g}{r_k} \tag{2.90}$$

Equation (2.89) determines the inductance of the quanton as a distributed parameter of quantised space-time. It is interesting to note that the inductance of the quanton is determined by the radius r_k of the nucleus of the magnetic monopole and magnetic constant μ_0. This is noteworthy due to the fact that it enables us to regard the constant μ_0 as a magnetic parameter of vacuum, filling the entire space, included the space between the quantons.

It should be mentioned that the EQM theory makes it possible to examine for the first time the inductance as some analogue of a magnetic condenser capable of storing magnetic energy in the statics. Consequently, knowing inductance L_g (2.89) and capacitance C_e (2.87), the quantum can be regarded as a volume electromagnetic resonator in which the resonance condition is the quality of the capacitance X_C and inductance X_L resistances:

$$\frac{1}{\omega C_e} = \omega L_g \tag{2.91}$$

Taking into account (2.87) and (2.89), from (2.91) we determine the resonance frequency $\omega = 2\pi f_0$ of electromagnetic oscillations of the quanton

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{L_g C_e}} = \frac{1}{8\pi^2 r_k}\sqrt{\frac{1}{\mu_0\varepsilon_0}} = \frac{C_0}{8\pi^2 r_k} \tag{2.92}$$

Equation (2.92) includes the unknown parameter r_k. This is a very important parameter and can be determined using (2.16) and (2.17)

$$f_0 = \frac{C_0}{L_{q0}} = 4\cdot 10^{33} \text{ Hz} \tag{2.93}$$

The frequency parameter f_0 (2.93) determines the transmission capacity of the quanton in passage of an electromagnetic wave through the quanton with the speed C_0, forming the time delay of $T_0 = 2.5\cdot 10^{-34}$ s at the quanton. If time T_0 is longer than $2.5\cdot 10^{-34}$ s in length L_{q0}, this would result in the mismatch between speed C_0 and frequency parameter (2.93). To avoid this situation, the resonance frequency of the quanton completely coincides with the frequency (2.16) which determines the passage of the electromagnetic wave through the quanton. In particular, the resonant frequency of the intrinsic oscillations of the quanton defines the speed of light in vacuum

$$C_0 = f_0 L_{q0} \tag{2.94}$$

The diameter of the quanton determines the minimum length $\lambda = L_{q0}$ of the electromagnetic wave which can form in vacuum.

Equating (2.92) with (2.93) and determining the radius r_k of the sphere of the equipotential surface around the nucleus of the monopole charge:

$$r_k = \frac{L_{q0}}{8\pi^2} = \frac{0.74 \cdot 10^{-25}}{78.9} = 0.94 \cdot 10^{-27}\,\mathrm{m} \tag{2.95}$$

Substituting (2.95) into (2.87) and (2.89), we determine the capacitance and inductance of the quanton:

$$C_e = 4\pi\varepsilon_0 r_k = \frac{1}{2\pi}\varepsilon_0 L_{q0} = 10^{-37}\,\mathrm{F} \tag{2.96}$$

$$L_g = 4\pi\mu_0 r_k = \frac{1}{2\pi}\mu_0 L_{q0} = 1.5 \cdot 10^{-32}\,\mathrm{H} \tag{2.97}$$

From (2.96) and (2.97) we determine the wave resistance Z_0 of the quanton

$$Z_o = \sqrt{\frac{L_g}{C_e}} = \sqrt{\frac{\mu_0}{\varepsilon_0}} = 377\ \text{ohm} \tag{2.98}$$

Equation (2.96) determines the well-known value of the wave resistance of the vacuum. To the well-known situation we can now add that the wave resistance starts to characterise the vacuum, including of the vacuum inside the quanton, which can be regarded as the wave resistance element $L_g C_e$ with the internal wave resistance Z_0 = 377 ohm.

On the other hand, the wave resistance (2.19) of vacuum is determined by the parameters ε_0 and μ_0. Equation (2.98) does not include the radius r_k (2.95) of the sphere around the charge of the monopole nucleus. However, r_k determines the capacitance (2.96) and inductance (2.97) of the quanton which in turn characterise the resonance parameters of the quanton (2.91). It should be mentioned that the ultra-microworld of the quanton has been described using the characteristics typical of the macroworld, such as capacitance and inductance. These are calculation characteristics for the quanton. In fact, the wave properties of the quantised space-time are characterised by its electrical and magnetic tension. This is the primary fact. Nevertheless, the introduction of the parameters capacitance and inductance of the quanton helps to characterise its resonance properties in conventional terms.

Previously, it was assumed that the nucleus of the monopole quanton should be regarded as a point charge with the size of the order of Planck length 10^{-35} m [22, 23]. This assumption has not been supported by calculations. Calculations carried out using equation (2.94) show that radius r_k of the sphere around the charge of the monopole nucleus is of the order of 10^{-27} m (2.95) which is two orders of magnitude smaller than the quanton diameter of 10^{-25} m. At the same time, it can be assumed that the determined radius r_k (2.95) is nothing else but the upper limit of the radius of the charge of the monopole nucleus which cannot be exceeded. Otherwise, the wave characteristics of the vacuum will not match.

Quanton can be treated as a time delay element T_0 (2.16):

$$T_0 = 2\pi\sqrt{L_g C_e} \leq \frac{L_{q0}}{C_0} \tag{2.99}$$

Equation (2.99) is the formula for matching the parameters of the quanton with vacuum as a waveguide medium. If the parameters $L_g C_e$ exceed (2.96) and (2.97), the electromagnetic wave would not be capable of propagating in vacuum with speed C_0. On the other hand, the actual displacement of the monopole nucleus when the electrical equilibrium is disrupted is determined by the values of the order of 10^{-62} m (2.64). This shows that the monopole nucleus itself is in all likelihood point-shaped, and the radius r_k of 10^{-27} m (2.95) determines some additional sphere which characterises the parameters $L_g C_e$. Therefore, the problem of the radius of the monopole nucleus, as the Planck length (point source), remains unsolved.

In any case, the results of calculations can no longer be associated with the Planck length but we can use the determined parameters $L_g C_e$. Figure 2.12 shows the scheme of substitution of the quanton which includes the oscillatory contour $L_g C_e$ and the sources of electrical W_e and magnetic W_g energies. All this forms a unique resonant element with no analogues in technology. The uniqueness of this resonant element is represented by the fact that in addition to the oscillatory contour $L_g C_e$ it contains two sources of energy of different types which are however equivalent as regards the magnitude of energy. This determines the equilibrium state of the resonant element. The exit from the equilibrium state is takes place by the disruption of the quality of the electrical W_e and magnetic W_g energies (2.79)...(2.82), producing oscillations of the charges and energies inside the quanton.

We examined the oscillatory processes are the quantum during the passage of an electromagnetic wave through the quanton (Fig. 2.8). In the electromagnetic wave the quanton charges carry out oscillations in accordance with the harmonic law (2.37) in relation to the equilibrium state, determining the instantaneous displacements x_e and y_g of the electrical and

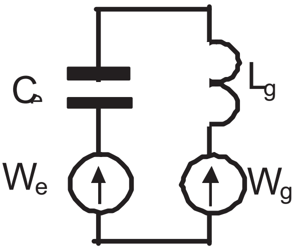


Fig. 2.12. Substitutional scheme of the quanton.

magnetic charges, respectively, for the amplitude displacements Δx (2.70) and Δy (2.77) of these charges:

$$\begin{cases} x_e = \Delta x \cdot \sin \omega t \\ y_g = -\Delta y \cdot \sin \omega t \end{cases} \tag{2.100}$$

The speeds $\mathbf{v}_{echo}$ and $\mathbf{v}_{golf}$ of displacement of the charges are determined by the first derivative of (2.100), and their accelerations $\mathbf{a}_e$ and $\mathbf{a}_g$ by the second derivative at $\mathbf{v} = \mathbf{v}_e = \mathbf{v}_g$ and $\mathbf{a} = \mathbf{a}_e = \mathbf{a}_g$

$$\begin{cases} \mathbf{v}_e = \dfrac{\partial\, x_e}{\partial\, t} = \omega \Delta x \mathbf{1}_x \cos \omega t = \omega \Delta x \mathbf{1}_x \sin(\omega t + \dfrac{\pi}{2}) \\ \mathbf{v}_g = \dfrac{\partial\, y_g}{\partial\, t} = -\omega \Delta y \mathbf{1}_y \cos \omega t = \omega \Delta y \mathbf{1}_y \sin(\omega t - \dfrac{\pi}{2}) \end{cases} \tag{2.101}$$

$$\begin{cases} \mathbf{a}_e = \dfrac{\partial^2 x_e}{\partial\, t^2} = -\omega^2 \Delta x \mathbf{1}_x \sin \omega t \\ \mathbf{a}_g = \dfrac{\partial^2 y_g}{\partial\, t^2} = \omega^2 \Delta y \mathbf{1}_y \sin \omega t \end{cases} \tag{2.102}$$

The equations (2.64) and (2.75) can be written in the following form taking into account (210) and the new coefficients k_x and k_y:

$$\begin{cases} \mathbf{E} \cdot \sin \omega t = k_x \mathbf{1}_x \Delta x \cdot \sin \omega t \\ \mathbf{H} \cdot \sin \omega t = -k_y \mathbf{1}_y \Delta y \cdot \sin \omega t \end{cases}. \tag{2.103}$$

As indicated by (2.103), **E** and **H** are completely identical in phase with the sinusoidal displacement Δx and Δy of the charges in the quanton during the passage of the electromagnetic wave. The accelerations of the charges $\mathbf{a}_c$ and $\mathbf{a}_g$ in (2.102) are also in phase with the changes of **E** and **H** in (2.101). The densities of the displacement currents $\mathbf{j}_e$ and $\mathbf{j}_g$ (4) are determined by the cosinusoidal velocity of displacement of the charges (2.100) and are phase-shifted by the angle $\pi/2$:

$$\begin{cases} \mathbf{j}_e = 2e\rho_o \dfrac{\Delta x \mathbf{1}_x}{\omega} \sin(\omega t + \dfrac{\pi}{2}) \\ \mathbf{j}_g = 2g\rho_o \dfrac{\Delta y \mathbf{1}_y}{\omega} \sin(\omega t - \dfrac{\pi}{2}) \end{cases} \tag{2.104}$$

Comparing (2.103) and (2.104) it should be noted that the vector of density $\mathbf{j}_e$ of electrical current outstrips the vector of the strength **E** of the electrical field of the electromagnetic wave by the phase angle π/2. This corresponds to the nature of capacitance current. The vector of the density of the magnetic current $\mathbf{j}_g$ lags behind the vector **H** of the strength of the magnetic field of the electromagnetic wave by the phase angle π/2. This is shown in the graphs in Fig. 2.13. The calculations may be presented in the complex form more efficiently, but in this case it is required to show the nature of elementary electromagnetic cyclic processes and the role of the quanton in the formation of electromagnetic radiation.

In the existing solutions of the wave equations of the electromagnetic field the functions **E** and **H** are described by the cosinusoidal variation law. This is determined by the origin of the cyclic process in the chosen refgerence system.

Finally, we can estimate the amplitude of speed (2.101) and acceleration (2.102) of charges in the quanton in the displacement $\Delta x = 2.3 \cdot 10^{-62}$ m (2.64) for $E = 3 \cdot 10^6$ V/m and the limiting frequency of oscillations of the quanton $4 \cdot 10^{33}$ Hz (2.93)

$$\begin{aligned} v &= \omega \Delta x = 2\pi f_0 \Delta x = 0.6 \cdot 10^{-27} \,\text{m/s} \\ a &= \omega^2 \Delta x = (2\pi f_0)^2 \Delta x = 1.5 \cdot 10^7 \,\text{m/s}^2 \end{aligned} \tag{2.105}$$

Actually, in the range of superhigh frequency (SH F) for the limiting strength of the field $E = 3 \cdot 10^6$ V/m and the frequency of 10^8 Hz (wavelength

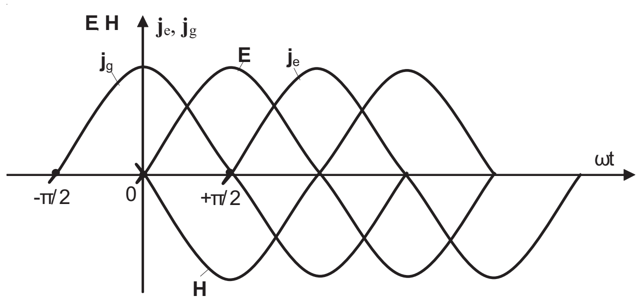


Fig. 2.13. Graphs of the variation of **E** and **H**, $\mathbf{j}_e$ and $\mathbf{j}_g$ in the electromagnetic wave in electromagnetic polarisation of the quanton.

3 cm), the speed of displacement of the charges of the quanton is $v = 1.4 \cdot 10^{-53}$ m/s, acceleration $a = 0.9 \cdot 10^{-44}$ m/s^2. It can be seen that the speed and acceleration of the charges in the quanton are extremely small in the range of actual electromagnetic radiation. Regardless of this, the rate of transfer radiation is very high and equal to the speed of light. However, the increase of the radiation frequency is associated with a large increase of the acceleration (2.105) of the charges in the quanton. This is important for the development of powerful emitters in x-ray and gamma ranges.

2.3.8. Quantisation of the electromagnetic wave

At present, the concepts of the electromagnetic field and the electromagnetic wave are not strictly separated. Figure 2.5 shows the region of the quantised space-time. This static electromagnetic field with a discreteness of 10^{-25} m determines the superstrong electromagnetic interaction (SEI) and the structure of vacuum. The electromagnetic wave in vacuum is associated with the electromagnetic disruption of the equilibrium of the superstrong electromagnetic interaction, i.e., with the disruption of the equilibrium of the static electromagnetic field as a carrier of the electromagnetic wave. As already mentioned, the quantised space-time is an elastic quantised medium (EQM) whose tension is determined by the grid (Fig. 2.5) of the static electromagnetic field. When examining the wave processes, it is natural that the base for any wave is represented by the medium, the elastic quantised medium in the present case.

The presence of the elastic quantised medium with a discreteness L_{q0} (7) suggests that any electromagnetic wave is quantised in its basis. The discovery of the quantum of the space-time (quanton) in 1996 in the EQM theory together with the discovery of the radiation quantum by Planck in 1900 enables us to transfer to the non-formal examination of the quantum phenomena, including quantisation of the electromagnetic wave. The primary factor is the space-time quantum because only the population of the quantons can form both the radiation quantum in the form of a discrete particle-wave in the elastic quantised medium and also a continuous electromagnetic wave.

It may be assumed that the quanton, as an elementary volume resonator (Fig. 2.8), is characterised by the intrinsic resonance frequency of the electromagnetic oscillations of $4 \cdot 10^{33}$ Hz (2.93). As a resonator, the quanton can be highly stable and the frequency of its intrinsic oscillations can be changed only by placing it in a strong gravitational field. However, at the present time we are interested in how the frequency of quantons is adjusted in the entire spectrum of electromagnetic oscillations in weak terrestrial gravity or free vacuum. Radioelectronics shows that the frequency of the electromagnetic resonator can be changed only by changing its parameters. The parameters of the quanton can be changed by a natural method.

At present, the spectrum of electromagnetic oscillations is found in a relatively wide range of frequencies and wavelength: from radiowaves with a frequency of 10^3 Hz (wavelength $3{\cdot}10^5$ m) to gamma radiation with a frequency of 10^{23} Hz (wavelength $3{\cdot}10^{-15}$ m). The resonance frequency of the quanton is of the order of 10^{33} Hz for the wavelength of 10^{-25} m. This means that the resonance parameters of the quanton exceed the parameters of gamma radiation by 10 orders of magnitude. It can be assumed that during excitation the quanton carries out oscillations at the intrinsic resonance frequency represented by high harmonics with a lower frequency along the entire length of the transmitted electromagnetic wave. In this case, the oscillations of all the quantons, included in the restricted volume of the wave, are added and phased in some manner in accordance with the principle of superposition of the fields and form the observed wave whose length is many orders of magnitude greater than the length of the quanton.

However, the simplest explanation is based on the assumption that the quantons can adjust themselves automatically to the required wavelength in merger into wave groups. This follows logically from the analysis of the substitutional scheme of the quanton, Fig. 2.12. It is evident that a group consisting of two quantons (Fig. 2.14a) can be regarded as parallel connection of the quantons with doubling of the capacitance and inductance parameters L_gC_e. Consequently, in accordance with (2.29), the delay time T_0 is doubled. This is in agreement with the time parameters of the electromagnetic wave during its passage through a group consisting of two quantons.

In a general case, a successive chain of n_q quantons has the form of a two-wire line (Fig. 2.14b), consisting of elements L_gC_e, connected in parallel, with either element ensuring the time delay of the signal for the period T_0 (2.99). Wave resistance Z_0 (2.98) of the entire line is equal to the wave resistance of vacuum, 377 ohm. This ensures matching of the passage of the signal with the speed of light C_0 in a wide range of the frequency spectrum of the electromagnetic waves. Most importantly, any electromagnetic signal, in the form of period T or wavelength λ in the entire frequency range can be regarded as equal to the multiple of the number of the quantons n_q

$$T = n_q T_o$$
$$\lambda = n_q L_{qo} \qquad (2.106)$$

Equation (2.106) shows that any electromagnetic signal is quantised. To

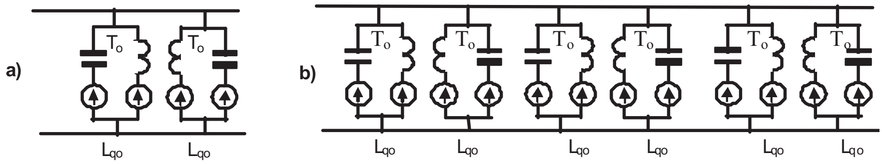


Fig. 2.14. Conventional scheme of substitution of a string of quantons in the form of a two-wire line.

transfer from the signal to a free electromagnetic wave in the quantised space-time, it is necessary to transfer from the substitutional scheme (Fig. 2.14) to analysis of electromagnetic processes in the string consisting of quantons (Fig. 2.15)

Thus, the volume of the quantised space-time has the form of a waveguide region with the distributed parameters of the resonance elements $L_g C_e$ and with the matched wave resistance. These unique properties of vacuum as the quantised structure enable the vacuum to be used as a volume waveguide for the entire spectrum of the electromagnetic waves, adjusted to any wavelength as a result of the merger of quantons into resonance groups of any length and volume. There is an analogy with a stretched string (membrane) when the variation of the length of the string determines its setting to resonance frequency. In the quantised space-time this takes place automatically as a result of including the required number of the quantons in the wave. In this case, the resonance frequency of the group of the quantons is determined by the length of the wave of the quantons taking part in this process.

However, it is necessary provide additional explanation of the basis of the substitutional scheme of the two-wire line (Fig. 2.14). Two conductors in the scheme can be ignored, and it can be explained that the signal is transferred from quanton to quanton through inductance–capacitance links. In a real string the transfer of electromagnetic perturbation from quantons takes place as a result of displacement Δx (2.64) and Δy (2.74) of charges in quantons.

Figure 2.15 shows the average scheme of an electromagnetic string consisting of quantons in the direction Z of wave propagation. It should be mentioned that in transfer from the analysis of the processes in a separately considered quanton to a group of quantons acting in the electromagnetic wave, we are concerned with the statistical indeterminacy of the orientation of the quantons in the string. In fact, equation (2.106) shows that to transfer an electromagnetic wave with the length of, for example, 1 m it is necessary to act upon the wavelength in the group of the order of $n_q = 10^{25}$.

Taking into account the fact that the charges of the monopoles inside a

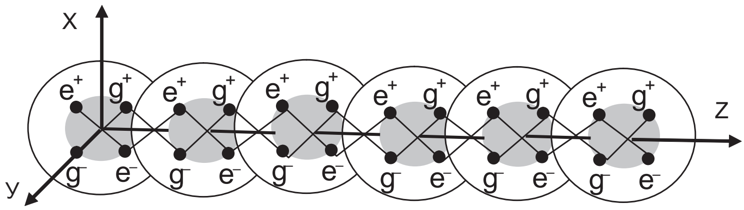


Fig. 2.15. Electromagnetic string consisting of quantons.

quanton are positioned on the tips of the tetrahedron, we introduce the element of randomness into the orientation of the quanton by the electrical and magnetic axes in space (Fig. 2.2). The orientation of the quantons is determined by the interaction of charges of adjacent quantons at the unchanged orthogonality of the electrical and magnetic axes in the quanton. If we select a completely random direction in space, the electrical and magnetic axes of the quantons, being the vectors, form some angle in relation to the selected axis. The statistical law of distribution of these angles of inclination is not yet known. However, taking into account the fact that we are concerned with a very large number of quantons per wavelength, it can be assumed that this angle is governed by the law of normal distribution in relation to some mean angle (mathematical expectation).

The results of determination of coefficient k_E in (2.71) were used to determine the mean angle of orientation of the axes of the quanton $\alpha_x \sim \pm 45°$ in relation to the selected axis. The statistical electromagnetic string cannot be demonstrated visually. Therefore, Fig. 2.15 shows the conventionally averaged electromagnetic string in which the axes of the quantons are inclined under the angle of $\Delta x \sim \pm 45°$ in relation to the Z axis whilst maintaining the orthogonality of the axes inside the quanton. Consequently, the displacements Δx (2.64) and Δy (2.74) of the charges in the large group of the quantons in the string can be regarded as averaged-out projections onto the axes X and Y.

Figure 2.16 shows the formation of a running longitudinal electromagnetic wave in direction Z as a result of longitudinal displacement Δx and Δy of the charges in the wave group of the quantons. The wave group (wave packet) is the group of quantons which takes part in the transfer of a single electromagnetic wave with length λ. For comparison, we should mention Fig. 2.5 which shows the idealised (averaged) orientation of the quantons in a line, perpendicular to the Z axis in Fig. 2.16. In particular, the disruption of the electrical and magnetic equilibrium of the quantised space-time (Fig. 2.5) determines the displacement of the charges (Fig. 2.8) as a result of the wave perturbation of vacuum.

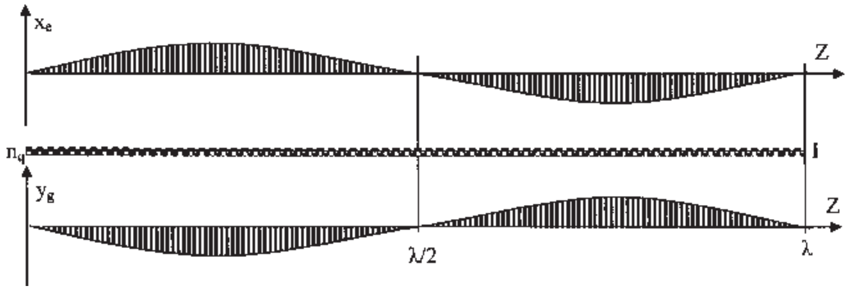


Fig. 2.16. Formation of a running transverse electromagnetic wave in the quantised space-time with quantons taking part.

In the electromagnetic string (Fig. 2.15) the first quanton is linked successively by the superstrong electromagnetic interaction with the subsequent quantons in the string. Therefore, in passage of the electromagnetic wave through the string, longitudinal displacement Δx and Δy of charges in the quanton results in the longitudinal wave displacement of the charges in the entire string, shown in Fig. 2.16. Every longitudinal line segment in the wave denotes the magnitude of displacement of the charges in the quanton, and the entire crosshatched region of the wave shows its discrete quantised structure. The positive region of displacement of the charges in the string denotes their stretching in the quanton, and the negative region denotes the compression in relation to the equilibrium state. The stretching along the *X* axis corresponds to the compression of the charges on the *Y* axis, and vice versa.

The propagation of the running wave along the *Z* axis determines its harmonic character which is described by the sinusoidal law of the variation of the displacement of charges along the way. In fact, if the transverse displacement of the charges in the quanton is described by the harmonic law (2.101), (2.102), (2.103) with respect to time *t*, the longitudinal propagation of the wave along the length *z* is also described by a harmonic law and is linked functionally with the transverse displacement of the charges. Consequently, we can write an elementary equation of the harmonic wave, linking displacement x_e and its amplitude Δx with wavelength λ and coordinate *z* (Fig. 2.16):

$$x_e = \Delta x \sin\left(2\pi \frac{z}{\lambda}\right) \tag{2.107}$$

On the other hand, the displacement x_e of the charges is determined by the harmonic function of time *t* for the period *T* (2.100)

$$x_e = \Delta x \sin\left(2\pi \frac{t}{T}\right) \tag{2.108}$$

Equating (2.107) with (2.108), we obtain an elementary wave equation of a flat electromagnetic wave, linking the coordinates of the wave and time

$$\Delta x \sin\left(2\pi \frac{z}{\lambda}\right) = \Delta x \sin\left(2\pi \frac{t}{T}\right) \tag{2.109}$$

The solution of (2.109) is very simple $z = C_0 t$, taking into account that $\lambda = C_0 T$

$$\frac{z}{\lambda} = \frac{t}{T} \quad \text{or} \quad \frac{z}{C_0 T} = \frac{t}{T} \tag{2.110}$$

The wave equation (2.109) can be presented in the differential form, for example, in partial derivatives with respect of t and z of the second order. The second derivative with respect to t is determined in (2.102)

$$\frac{\partial^2 x_e}{\partial t^2} = -\left(\frac{2\pi}{T}\right)^2 \Delta x \sin\left(\frac{2\pi}{T} t\right) \tag{2.111}$$

The second derivative with respect to z is determined from (2.107)

$$\frac{\partial^2 x_e}{\partial z^2} = -\left(\frac{2\pi}{TC_o}\right)^2 \Delta x \sin\left(\frac{2\pi}{\lambda} z\right) \tag{2.112}$$

Taking into account the equivalence of the arguments (2.110) in (2. 111) and (2.112), from (2.110) and (2.112) we obtain the wave equation of the electromagnetic wave in partial derivatives of the second order

$$\frac{\partial^2 x_e}{\partial t^2} = C_o^2 \frac{\partial^2 x_e}{\partial z^2} \tag{2.113}$$

The wave equation (2.113) is equivalent to the Maxwell wave equation (2.56) which was used in the analysis of the flat electromagnetic wave. The wave equation (2.113) is the generally accepted wave equation of the flat electromagnetic wave [34–38], only it is expressed through the displacement of the charges. In electrodynamics, the wave equation of the electromagnetic wave can be derived on the basis of complex transformations of the Maxwell rotor equations. The quantisation of the electromagnetic wave enables us to derive the wave equation (2.113) by elementary methods, retaining the physical meaning of the wave electromagnetic processes in vacuum for the running wave (Fig. 2.16). The solution of (2.112) is represented by the equation (2.109).

The wave equation (2.113) can be represented in the form of a differential equation in partial derivatives of the first order, reducing the order of (2.113):

$$\frac{\partial x_e}{\partial t} = C_o \frac{\partial x_e}{\partial z} \tag{2.114}$$

Equation (2.114) has a physical meaning, for example, for the harmonic function, showing that the sinusoidal transverse displacement x_e (2.108) of the charges inside a stationary quanton with speed $\mathbf{v}_e$ (2.101) transfers this displacement from the quanton to quanton with speed of light C_0 along the electromagnetic string (Fig. 2.15) in the direction of the Z axis, forming a transverse electromagnetic wave (2.107) (Fig. 2.16).

The formation of the wave can be described as consisting of stages (Fig. 2.16). In the first stage of analysis we consider only one quanton oriented in accordance with Fig. 2.8. The Z axis is perpendicular to the plane of the figure and directed to the plane. The quanton is perturbed and its electrical charges oscillate harmonically with displacement x_e (2.108) along the axis X (2.110) with speed $\mathbf{v}_e$ (2.101). In accordance with the EQM theory, the quanton is connected with the quantised space-time and is stationary in relation to it. We now use an artificial procedure and assume that the quanton moves and travels away from the plane of the Fig. 2.8 along the Z axis with the speed of light C_0. During a single period T of oscillations of the quanton, displacement x_e (2.107) of electrical charges forms a sinusoid along the Z axis, determining the wavelength λ (Fig. 2.16).

At the same time, the displacement of the magnetic charges y_g of the quanton along the axis Y produces a sinusoid along the Z axis in the antiphase opposite to the displacement x_e of the electrical charges along the X axis (Fig. 2.16). Taking into account that the electrical and magnetic axes of the quanton in the direction Z are situated in different planes with a distance of $0.34L_{q0}$ between the planes (Fig. 2.2), we determine the time delay $0.34\ T_0$ and the phase shift angle φ_{eg} between the oscillations of the electrical $\pm e$ and magnetic $\pm g$ charges in the quanton:

$$\varphi_{eg} = 2\pi \frac{0.34T_0}{T} \tag{2. 115}$$

$$\begin{cases} x_e = \Delta x \cdot \sin \omega t \\ y_g = -\Delta y \cdot \sin(\omega t - \varphi_{eg}) \end{cases} \tag{2.116}$$

The actual spectrum of the electromagnetic oscillations is situated in the frequency range $T \gg 0.34\ T_0$. Therefore, the phase shift angle φ_{eg} is not taken into account for the actual spectrum of frequencies and it is assumed that the displacements of the electrical and magnetic charges in the real waves are completely in phase in accordance with (2.100).

Subsequently, we consider two quantons connected into a successive group along the Z axis. The charges of the first quanton carry out oscillations in accordance with the law (2.107), and the oscillations of the charges of the second quantum lag in respect of the phase φ_{t0} by time delay T_0

$$x_e = \Delta x \cdot \sin\left(\omega t - \varphi_{t0}\right) = \Delta x \cdot \sin\left(2\pi \frac{t}{T} - 2\pi \frac{T_0}{T}\right) \tag{2.117}$$

For a wave group (packet) consisting of n_q quantons and forming a string along the entire wavelength λ (for example, for λ = 1 m and n_q ~10^{25} particles), the charges of each quanton n in the string carry out oscillations x_{en} with the delay in phase $(n - 1)\varphi_{t0}$ along the wave, starting from the first quanton 1 and ending with the last quanton n_q, where n is the sequence number of the quanton in the wave group (Fig. 2 .16)

$$x_{en} = \Delta x \cdot \sin\left\{\omega t - (n-1)\varphi_{to}\right\} = \Delta x \cdot \sin\left\{2\pi \frac{t}{T} - 2\pi (n-1)\frac{T_0}{T}\right\} \tag{2.118}$$

The entire wave group consisting of n_q quantons with the length λ is placed by the quanton 1 in the origin of the coordinates. The tail of the wave group is situated in the negative region along the X axis. Subsequently, the entire wave group of the quantons, starting with the first quanton 1, is transferred to the oscillatory regime in accordance with the law (2.118) and at the same time it is forced to move along the Z axis with the speed of light C_0. After time T, the wave group occupies the position on the Z axis as shown in Fig. 2.16. The displacements of the charges in the quanton on the graphs are represented by the sinusoidal law with respect to the wavelength λ for both electrical and magnetic charges

$$x_{en} = \Delta x \cdot \sin\left\{2\pi \frac{z}{\lambda} - 2\pi (n-1)\frac{L_{q0}}{\lambda}\right\} \tag{2.119}$$

In fact, the wave group consisting of n_q quantons is stationary in space and occupies the position shown in Fig. 2.16. The external running electromagnetic wave initially excites the last quanton n_q in the wave group and subsequently travels to the first quanton 1, exciting the entire wave group of the quantons in accordance with the law (2.119).

Thus, the EQM theory shows that every electromagnetic wave is the result of electromagnetic excitation of a very large number of the space-time quantons. In fact the electromagnetic wave is quantised. When the electromagnetic wave is found in the macroworld, it appears to be continuous.

The wave equation (2.114) in partial derivatives of the first order determines the relationship between transverse speed $\mathbf{v}_e$ (2.101) of the displacement of the charges and the speed of light C_0 and the parameters of the running wave (2.112)

$$\frac{v_e}{C_0} = 2\pi \frac{\Delta x}{\lambda} \cos\left(\frac{2\pi}{\lambda} z\right) \tag{2.120}$$

At $z = 0$ the equation (2 .120) gives the relationship between the amplitude of speed $\mathbf{v}_e$ and the displacement Δx of charges linking them with the wave parameters λ and C_0

$$\frac{v_e}{C_0} = 2\pi \frac{\Delta x}{\lambda} \tag{2.121}$$

The wave equation (2.113) in partial derivatives of the second order determines the relationship between the acceleration a_c (2.102) and the displacement Δx of the charges, linking them with the wave parameters λ and C_0

$$\frac{a_e}{C_0^2} = \left(\frac{2\pi}{\lambda}\right)^2 \Delta x \sin\left(\frac{2\pi}{\lambda} z\right) \tag{2.122}$$

At $z = \lambda/4$, from equation (2 .122) we obtain the ratio of the parameters of the wave for the amplitude values

$$\frac{a_e}{C_0^2} = 4\pi^2 \frac{\Delta x}{\lambda^2} \tag{2 .123}$$

From (2.121) and (2 .123) we obtain another relationship:

$$\frac{v_e}{a_e} = \frac{1}{2\pi} \frac{\lambda}{C_0} \tag{2.124}$$

The wave equations (2.113) and (2.114), written previously for the wave along the Z axis, can be written for the volume wave in the rectangular coordinate system X, Y, Z for the displacements x_e and y_g of the electrical and magnetic charges

$$\frac{\partial^2 x_e}{\partial t^2} = C_0^2 \left(\frac{\partial^2 x_e}{\partial x^2} + \frac{\partial^2 x_e}{\partial y^2} + \frac{\partial^2 x_e}{\partial z^2}\right) \tag{2.125}$$

$$\frac{\partial^2 y_g}{\partial t^2} = C_0^2 \left(\frac{\partial^2 y_g}{\partial x^2} + \frac{\partial^2 y_g}{\partial y^2} + \frac{\partial^2 y_g}{\partial z^2}\right) \tag{2.126}$$

$$\frac{\partial\, x_e}{\partial\, t} = C_0 \left(\frac{\partial\, x_e}{\partial\, z}\mathbf{i} + \frac{\partial\, x_e}{\partial\, z}\mathbf{j} + \frac{\partial\, x_e}{\partial\, z}\mathbf{k} \right) \tag{2.127}$$

$$\frac{\partial\, y_g}{\partial\, t} = C_0 \left(\frac{\partial\, y_g}{\partial\, z}\mathbf{i} + \frac{\partial\, y_g}{\partial\, z}\mathbf{j} + \frac{\partial\, y_g}{\partial\, z}\mathbf{k} \right) \tag{2.128}$$

where **i**, **j**, **k** are the unit vectors in the directions *X*, *Y*, *Z*, respectively.

From (2.63) and (2.73) we can write the relationships between the displacement of the charges and the strength of the fields *E* and *H*

$$\begin{cases} x_e = \dfrac{\varepsilon_0}{2e\rho_0} E \\ y_g = -\dfrac{1}{2g\rho_0} H \end{cases} \tag{2.129}$$

Substituting (2.129) into (2.126) and (2.127) we obtain the well-known (in classic electrodynamics) wave equations of the electromagnetic field in partial derivatives of the second order

$$\frac{\partial^2 E}{\partial\, t^2} = C_0^2 \left(\frac{\partial^2 E}{\partial\, x^2} + \frac{\partial^2 E}{\partial\, y^2} + \frac{\partial^2 E}{\partial\, z^2} \right) \tag{2.130}$$

$$\frac{\partial^2 H}{\partial\, t^2} = C_0^2 \left(\frac{\partial^2 H}{\partial\, x^2} + \frac{\partial^2 H}{\partial\, y^2} + \frac{\partial^2 H}{\partial\, z^2} \right) \tag{2.131}$$

From the wave equations (2.127) and (2.128) in partial derivatives of the first order we easily obtain the Maxwell equations for the electromagnetic wave in vacuum, taking into account the fact that the speeds of displacement of the electrical and magnetic charges, which are determined by the first derivative with respect to time, are equal to

$$\frac{\partial\, x_e}{\partial\, t} = \frac{\partial\, y_g}{\partial\, t} \tag{2.132}$$

Into (2.132) we substitute the values from (2.129) and obtain a singular Maxwell equation for vacuum in the vector form

$$\varepsilon_0 C_0 \frac{\partial\, \mathbf{E}}{\partial\, t} = -\frac{\partial\, \mathbf{H}}{\partial\, t} \tag{2.133}$$

The solution of the singular Maxwell equations (2.133) for vacuum can be presented in a more convenient form of the vector product (2.55)

$$\varepsilon_0\left[\mathbf{C}_0\dot{\mathbf{E}}\right]=-\dot{\mathbf{H}} \tag{2.134}$$

Thus, analysis of the quantisation of the electromagnetic wave makes it possible to obtain, within the framework of classic electrodynamics, the elementary and understandable derivation of the wave equations (2.130), (2.131) and the singular Maxwell equations (2.133), (2.134) of the electromagnetic wave in vacuum. For the first time, the EQM theory explains the reasons for electromagnetic wave processes without using the concept of rotors.

2.3.9. Circulation of electrical and magnetic fluxes in the electromagnetic wave

Analysis of the electromagnetic processes in vacuum shows that the transformation of electricity and magnetism and vice versa, in the electromagnetic wave is based on the unique properties of the quanton as a carrier of unified electromagnetism which enables these transformations to take place. The transformation of electricity into magnetism and vice versa does not require rotor considerations regarding the nature of electromagnetic processes in vacuum.

Nevertheless, the circulation of the vectors of the strength of the electrical and magnetic fields is observed in the electromagnetic wave, and the EQM theory explains for the first time how this takes place.

It should be mentioned that when Maxwell derived his historical equations for the electromagnetic field, he had at his disposal only the Faraday laws of electromagnetic induction and the hydrodynamic analogy with respect to the force tubes of tensioning of electrical and magnetic fields of the aether medium [38]. The electromagnetic induction laws were discovered only for the electrical circuit, including an inductance coil. The prediction of the electromagnetic wave in vacuum was a brilliant foresight by Maxwell and this enabled Hertz to study them in experiments.

The electromagnetic processes in vacuum are causes bt the displacement of the charges in the core of the stationary quanton. The core of the quanton can be compared with the heart whose beating ensures pumping of electrical energy to magnetic, and vice versa. In particular, analysis of the displacement of the charges in the core of the quanton resulted in the derivation of the wave equations (2.130), (2.131) of the electromagnetic field and in derivation of the singular Maxwell equation (2.54), (2.134) for the electromagnetic wave in vacuum.

We shall use the previously discussed results and write the wave equation (2.130) for a spherical electromagnetic wave, propagating along the radius

r and from the origin of the new coordinates X, Y, Z (Fig. 2.17):

$$\frac{\partial^2 E}{\partial t^2} = C_0^2 \frac{\partial^2 E}{\partial r^2} \tag{2.135}$$

$$r^2 = x^2 + y^2 + z^2 \tag{2.136}$$

The order of the derivatives of the equation (2.134) is reduced and the equation is written for the partial derivatives of the vector **E** with respect to time t in radius r, taking into account that the vectors $\mathbf{E} \perp \mathbf{r}$

$$\frac{\partial \mathbf{E}}{\partial t} = C_0 \frac{\partial \mathbf{E}}{\partial r} \tag{2.137}$$

Figure 2.17 shows the increase of the radius r of the wave by the value ∂r as a result of spherical propagation of the wave from the dotted sphere to the continuous sphere

$$\partial r = C_0 \cdot \partial t \tag{2.138}$$

The increase of the strength **E** by the value $\partial\mathbf{E}$ is determined by the partial derivatives (2.137). On the surface of the wave sphere at a large distance from the source which is considerably greater than the wavelength, the electromagnetic field should be regarded as a field of a flat wave when the vector of strength **E** is orthogonal to the vector **r**. Vector $\partial\mathbf{E}/\partial r$ is expanded by the components along the axes X and Y (Fig. 2.17a). In Fig. 2.17b, the triangle of the vectors of increments is enlarged. Vector analysis shows that the given triangle determines the difference of the vectors, describing rot**E** [43]

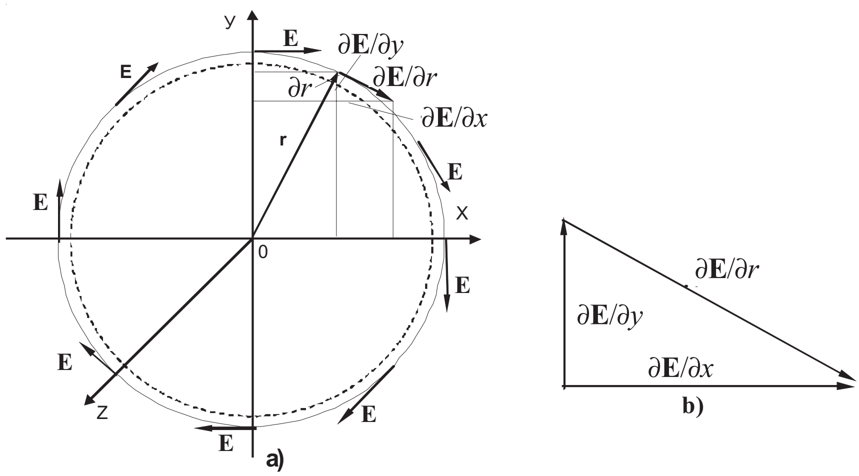


Fig. 2.17. Calculation of the circulation of vector **E** in a spherical electromagnetic wave.

$$\frac{\partial \mathbf{E}}{\partial r} = \frac{\partial \mathbf{E}}{\partial x} - \frac{\partial \mathbf{E}}{\partial y} = \text{rot}\mathbf{E} \tag{2.139}$$

Substituting (2.139) into (2.137) gives the first rotor equation of the electromagnetic wave for the strength vector **E**:

$$\frac{\partial \mathbf{E}}{\partial t} = C_0 \text{rot}\mathbf{E} \tag{2.140}$$

Taking into account the equivalence between the electrical and magnetic processes in the electromagnetic wave, we can write in accordance with (2.140) the second rotor equation of the electromagnetic wave for the strength vector **H**, taking into account that **H**⊥**E**, i.e., it is situated in the orthogonal sections:

$$\frac{\partial \mathbf{H}}{\partial t} = C_0 \text{rot}\mathbf{H} \tag{2.141}$$

$$\text{rot}\mathbf{H} = \frac{\partial \mathbf{H}}{\partial z} - \frac{\partial \mathbf{H}}{\partial y} = \frac{\partial \mathbf{H}}{\partial r} \tag{2.142}$$

Formally, taking (2.133) into account, we can write

$$\varepsilon_0 C_0 \text{rot}\mathbf{E} = -\text{rot}\mathbf{H} \tag{2.143}$$

Replacing in (2.143) the electrical parameters of the rotors by the magnetic ones in (2.140), and the magnetic parameters of the rotor by electrical ones (2.141), we obtain classic Maxwell equations (2.3) for the electromagnetic wave in vacuum

$$\begin{cases} \text{rot}\mathbf{H} = \varepsilon_0 \dfrac{\partial \mathbf{E}}{\partial t} \\ \text{rot}\mathbf{E} = -\mu_0 \dfrac{\partial \mathbf{H}}{\partial t} \end{cases} \tag{2.144}$$

The Maxwell rotor equations (2.144) are valid in the vicinity of the emitter (antenna). In a space-time region away from the emitter, when a free electromagnetic wave has formed, the equations (2.144) loose their physical meaning. The previously mentioned analysis of the electromagnetic perturbation of the quantised space-time shows that in the electromagnetic wave the rotor **H** does not generate **E** and, vice versa, rotor **E** does not generate **H**. This is the case in which the mathematics formally provides an accurate calculation method but does not make it to penetrate into the principle of electromagnetic processes in vacuum. Primary reasons for electromagnetic phenomena in vacuum are hidden in the electromagnetic polarisation of quantons (Fig. 2.8).

In fact, the quantised space-time is a self-organised substance whose behaviour is governed by physical laws based on the very electromagnetic structure of vacuum. In a free electromagnetic spherical wave in vacuum, the variations of the electrical (2.140) and magnetic (2.141) fields take place simultaneously, as shown previously. The electrical and magnetic fields of the wave are self-organised into simultaneous electrical (2.140) and magnetic (2.141) rotors, and the circulation of the strength **E** (and **H**) of these rotors takes place in the sphere of the electromagnetic wave (Fig. 2.17) in orthogonal sections.

The nature of circulation of the vectors of strength **E** and **H** in the sphere of propagation of the electromagnetic wave is explained quite simply by the quantised structure of space-time. For this purpose, the electrical and magnetic components of the quanton are represented in the form of electrical and magnetic dipoles: elementary electrets (+) and magnetics (N) and (s).

Figure 2.18 shows the cross-section of the sphere with elementary dipoles placed on the surface of the sphere. The electromagnetic perturbation of the quantised space-time by the electromagnetic wave results in the disruption of electrical equilibrium of the quantised space-time characterised by the appearance of strength vector **E**. Under the effect of strength vector **E** the electrical dipoles of the quanton try to rotate by their axis along the vector **E**, and the vector **E** tries to close itself through the dipoles of the quanton, circulating in the sphere of the wave and forming rotor **E**.

It should be remembered that this pattern of the circulation of vector **E** in the sphere is a statistically average pattern. In fact, taking into account

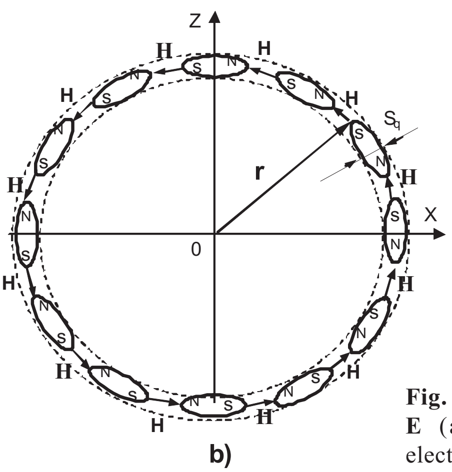


Fig. 2.18. Circulation of the strength of electrical **E** (a) and magnetic **H** (b) fields in the electromagnetic wave.

the small dimensions of the quanton, the number of the quantons taking part in the circulation of vector E is extremely large and they are oriented randomly, resulting only in the disruption of electrical equilibrium of space-time in the wave which is characterised by the averaged parameter of field strength **E**.

Identical considerations also relate to the formation of the strength rotor **H** of the magnetic field circulating in the sphere of the electromagnetic wave (Fig. 2.18b). The only difference is that vector **H** circulates in the cross-section of the sphere, orthogonal to the plane of the circulation section of the strength vector **E** of the electrical field (Fig. 2.19). We can separate two characteristic points **E** and **H**, setting the condition **H**⊥**E**. Taking into account the small dimensions of the quanton, the number of the characteristic points E and B on the wave sphere is extremely large. For any arbitrary coordinate A on the sphere of the wave, there is always coordinate B resulting in the extremely high number of fluxes **E** and **H** on the sphere. This can take place only in the case of the quantised structure of the electromagnetic wave.

Evidently, the circulation of the vectors **E** and **H** in the sphere in the orthogonal sections was detected for the first time in the EQM theory and requires additions to be made in vector analysis. This circulation is not typical of the flows of fluids or gas. The circulation of the magnetic flux around a conductor with a current is characterised by a cylindrical field, not by a spherical one.

Returning to Fig. 2.18, we can separate the elementary 'vortex' closed pipe defined by the cross-section of the quanton S_q. Due to the quantised state, the elementary vortex pipe is characterised by very interesting properties. Its electromagnetic perturbation is transferred by the pipe to the next vortex pipe in the direction of propagation of a spherical wave. Therefore, it may be asserted that the circulation of the strength vector **E** along the length ℓ of the elementary pipe and circulation of the electrical flux Ψ_e through the cross-section of the pipe S_q in its volume V are constants for any elementary vortex pipe, closed on the sphere of the wave

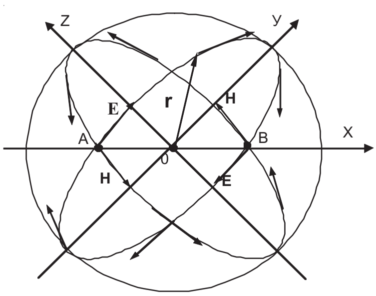


Fig. 2.19. Simultaneous circulation of the vectors **E** and **H** on the sphere of the electromagnetic wave in the orthogonal sections.

$$\oint_{\ell} \mathbf{E} d\ell = 2\pi r E = \text{const} \tag{2.145}$$

$$\oiiint_{v} \Psi_e dV = 2\pi r E S_q = \text{const} \tag{2. 146}$$

These two equations are equivalent. Therefore, we use the simpler expression (2.145) and form an equality for the moduli of two circulation vectors $\mathbf{E}$ and $\mathbf{E}_0$ with respect to the radii r and r_0:

$$2\pi r E = 2\pi r_0 E_0 \tag{2.147}$$

The parameters $\mathbf{E}_0$ and r_0 relate to the nearest zone from the radiation source and they can characterise the radiation source. From (2.147) we determine the nature of variation of the modulus of the strength of the field of the spherical electromagnetic wave, in movement away from the radiation source:

$$E = \frac{r_0 E_0}{r} = \frac{1}{2\pi} \frac{\varphi_{e0}}{r} \tag{2.148}$$

$$\varphi_{e0} = 2\pi r_0 E_0 \tag{2.149}$$

where φ_{e0} is the electrical potential (potential difference), characterising the region of the radiation source, V.

As indicated by (2.148), the strength $\mathbf{E}$ of the electrical field in the spherical electromagnetic wave decreases with the increase of the distance from the radiation source in inverse proportion to the distance $1/r$. This is in agreement with experimental results. However, the resultant dependence (2.148) has not as yet been justified theoretically because the strength of the spherical field, for example, for a point electrical charge (2.44), decreases in inverse proportion to the square of the distance $1/r^2$. It should be taken into account that this potential of the point source decreases on the sphere in inverse proportion to the distance $1/r$. The strength of the electrical field decreases in inverse proportion to the distance $1/r$ for the linear distribution of the charges, forming a cylindrical field.

Consequently, the tension of the spherical electromagnetic wave is changed in relation to the distance from the radiation source in the fashion other than the spherical relationships, propagating on the sphere the cylindrical field circulation of the strength vector. This can be explained quite logically, i.e., by the quantised nature of the electromagnetic wave. Firstly, vector $\mathbf{E}$ of the electromagnetic wave is normal to the propagation radius of the wave, it is not a radial vector, as in the case of the vector $\mathbf{E}$ of the point charge. Secondly, the vector $\mathbf{E}$ of the electromagnetic wave is a statistically averaged-out vector, formed as a result of superposition of the fields of a vast number of quantons, displaced from electrical equilibrium.

If we return to analysis of Fig. 2.18, the elementary vortex pipe produced from quantons, being a statistical category characterised by the rotor (2.140), can merge with the adjacent elementary vortex pipes at the same distance r from the radiation source. In fact, the pipe represents a very narrow cylindrical field (strip). This narrow strip encircles the wave on the sphere and this is the cylindrical section, regardless of the investigated section of the spherical wave. This is the unique property of the vacuum as an elastic quantised medium, which behaves in an inadequate fashion in comparison with the known media when the sphere is encircled by narrow and thin cylinders.

We can analyse in greater detail the processes on the level of the ultra-microworld of quantons, regarding the self-organisation of the elementary vortex pipes as statistical categories of the cylindrical type in the spherical wave. However, now it is important to understand that we are concerned with the unique processes of self-organisation of the elastic quantised medium.

Identical considerations refer to the circulation of the strength vector **H** of the magnetic field along the length ℓ of the elementary pipe and circulation of the magnetic flux ψ_g through the cross-section of the pipe S_q in its volume V, which are constant fine elementary vortex pipe, closed on the sphere of the wave (Fig. 2.18let about):

$$\oint_{\ell} \mathbf{H} d\ell = 2\pi r H = \text{const} \tag{2.150}$$

$$\oiiint_{v} \Psi_g dV = 2\pi r H S_q = \text{const} \tag{2.151}$$

The equations (2.150) and (2.151) are equivalent. Therefore, we use the simpler equation (2.150) and form an equality for the moduli of two circulation vectors **H** and $\mathbf{H}_0$ with respect to the radii r and r_0

$$2\pi r H = 2\pi r_0 H_0 \tag{2.152}$$

The parameters $\mathbf{H}_0$ and r_0 relate to the zone closest to the radiation source, and can characterise the radiation source itself. From (2.152) we determine the variation of the modulus of the strength of the magnetic field of the spherical electromagnetic wave in movement away from the radiation source

$$H = \frac{r_0 H_0}{r} = \frac{1}{2\pi} \frac{\varphi_{g0}}{r} \tag{2.153}$$

$$\varphi_{g0} = 2\pi r_0 H_0 \tag{2.154}$$

where φ_{g0} is the magnetic potential (potential difference), characterising the region of the radiation source, *A*.

As shown by (2.153), the strength **H** of the magnetic field, like the strength **E** (2.148) of the electrical field, in the spherical electromagnetic wave decreases with the increase of the distance from the radiation source in inverse proportion to the distance $1/r$. This is well known in electrodynamics and has been verified many times by experiments. However, the reasons for this phenomenon were found for the first time in the EQM theory.

The fact that the strength moduli **E** (2.148) and **H** (2.153) in the spherical electromagnetic wave change in inverse proportion to the distance $1/r$, like the potential of the point charge, was used as a basis for the purely formal introduction of auxiliary functions of scalar $\varphi = \varphi(\mathbf{r}, t)$ and vector $\mathbf{A} = \mathbf{A}(\mathbf{r}, t)$ potentials for the electromagnetic wave which are used widely in calculations in electrodynamics [39–42].

2.3.10. Transfer of energy by the quanton in the electromagnetic wave

The electromagnetic wave cannot form without participation of quantons. In a general form, the energy balance of the quanton is represented in statics by the equations (2.79) and (2.8), and in dynamics by (2.81) and (2.82).

We examine internal energy processes taking place in the quanton if its electrical and magnetic equilibrium is disrupted in the statics through the effect of the external field *E* (2.63) and *H* (2.73). The fields *E* and *H* are determined by the displacement of the charges Δx and Δy inside the quanton. One of the electrical charges of the quanton is regarded as stationary, and the second charge *e* is displaced by the value Δx. Taking into account that the displacement Δx is an incommensurably small value in relation to the quanton diameter, work ΔW_e (2.79) for the displacement of the charge *e* in the field *E* by the value Δx will have the form of a linear function

$$\Delta W_e = eE\Delta x \tag{2.155}$$

From (2.63) we obtain the product $e\Delta x$

$$e\Delta x = \frac{\varepsilon_0 E}{2\rho_0} \tag{2.156}$$

We introduce (2.156) and (2.155) and obtain the variation of electrical energy ΔW_e (2.79) of the quanton in displacement Δx of the electrical charge but their core in statics under the effect of the external field **E**

$$\Delta W_e = \frac{1}{2\rho_0}\varepsilon_0 E^2 \tag{2.157}$$

The volume density of electrical energy in polarisation of vacuum is determined by the sum of energies (2.157) of all quantons included in 1 m^3 of space-time. For this purpose, (2.157) is multiplied by the quantum density of vacuum ρ_0 and we obtain the well-known equation for the electrostatic volume density W_E of the energy of polarisation by the external electrical field of vacuum

$$W_E = \frac{1}{2}\varepsilon_0 E^2 \tag{2.158}$$

We use the same procedure for the change of the magnetic energy ΔW_g (2.80) of the quanton in displacement Δy of the magnetic charge g in the statics under the effect of the magnetic field **H** (2.73), and also volume density W_H of magnetic energy in the statics

$$\Delta W_g = \frac{1}{2\rho_0}\mu_0 H^2 \tag{2.159}$$

$$W_H = \frac{1}{2}\mu_0 H^2 \tag{2.160}$$

The equations (2.157) and (2.159) are the statistically averaged-out energies of the quanton in determination of the volume density of energies (2.158) and (2.159) of vacuum. Under the simultaneous effect of fields E and H on the vacuum, the variation of the quanton energy is determined by the sum of (2.157) and (2.159) and the volume density of the energy of the vacuum by the sum of (2.150) and (2.160).

In disruption of the vacuum by the electromagnetic wave, the energy processes inside the quanton and in the perturbed vacuum are not adequate. The point is that in transfer of the electromagnetic wave the internal edge of the quanton remains constant and the variations of the internal energy of the quanton are manifested externally in the form of simultaneously acting fields **E** and **H**. These fields characterise the energy of electromagnetic polarisation of vacuum which is described by the volume density of electrical (2.150) and magnetic (2.160) energies.

Let us consider the energy processes inside the quanton and outside it in greater detail. In passage of the electromagnetic wave through the quanton, the quanton energy (2.81) and (2.82) remains constant. The variation of the quanton energy in this case is characterised only by a single component: electrical or magnetic which cannot be added up. The electrical component of quantum energy ΔW_e is twice the energy (2.155) because electromagnetic perturbation the total displacement of the charge e is determined by the double amplitude $2\Delta x$

$$\Delta W_e = 2eE\Delta x \tag{2.161}$$

Taking into account (2.156), from (2.161) we obtain the total energy transferred by the quanton in passage of the electromagnetic wave through the quantum. This energy is determined by the electrical component ΔW_e or, by analogy, by the magnetic component ΔW_g

$$\Delta W_e = \frac{\varepsilon_0 E^2}{\rho_0} \tag{2.162}$$

$$\Delta W_g = \frac{\mu_0 H^2}{\rho_0} \tag{2.163}$$

The equations (2.162) and (2.163) show that in accordance with (2.81) and (2.82), the increase of the electrical component (2.162) by the equivalent value reduces the magnetic component (2.163) inside the quanton or, vice versa, the energy of the quanton during the passage of the electromagnetic wave through the quantum remains constant. In the experiments, this is confirmed on the basis of the absence of excess energy in wave electromagnetic processes which are governed by the energy balances (2.81) and (2.82).

However, the external manifestation of the electrical (2.161) and magnetic (2.163) components in the volume of the quantised space-time, in accordance with the laws of electromagnetic induction, is determined by two component of the volume density of energies (2.150) and (2.160) with the same values. The total density of volume energy W_v [J/m^3] of the electromagnetic wave is determined as the sum of its electrical (2.158) and magnetic (2.160) components

$$W_v = \frac{1}{2}\varepsilon_0 E^2 + \frac{1}{2}\mu_0 H^2 \tag{2.164}$$

Taking into account the equivalence of the electrical and magnetic components in (2.164), the magnetic component is expressed by the electrical parameters of the field, replacing the modulus of the strength H by the equivalent electrical modulus $\varepsilon_0 C_0 E$ from the singular equation (2.55), (2.134) of the electromagnetic wave in vacuum:

$$W_v = \frac{1}{2}\varepsilon_0 E^2 + \frac{1}{2}\mu_0(\varepsilon_0 C_0 E)^2 = \varepsilon_0 E^2 \quad (2.165)$$

It is convenient to express the volume density of energy (2.165) through two components: electrical and magnetic (2.134)

$$W_v = \varepsilon_0 E^2 = \varepsilon_0 E\left(\frac{H}{\varepsilon_0 C_0}\right) = \frac{EH}{C_0} \quad (2.166)$$

Equation (2.166) characterises the polarisation energy of 1 m^3 of vacuum in passage of the electromagnetic wave through it. We determine the time t_v of passage of the electromagnetic wave to the depth of the volume h by the section normal to the vector of the speed of light C_0

$$t_v = \frac{h}{C_0} \quad (2.167)$$

From (2.166) we determine the flux with density **S** (the intensity of the flux) of the electromagnetic energy of the wave in the vacuum passing through the cross-section of 1 m^2 to the depth h in unit time t_v (2.164), writing it in the vector form:

$$\mathbf{S} = \frac{W_v h}{t_v}\mathbf{1}_r = W_v \mathbf{C}_0 = |\mathrm{EH}| \quad \left[\frac{\mathrm{J}}{\mathrm{m^2 s}} = \frac{\mathrm{V \cdot A}}{\mathrm{m^2}}\right] \quad (2.168)$$

where $\mathbf{1}_r$ is the unit vector in the direction **r** of propagation of the electromagnetic wave with respect to the speed vector $\mathbf{C}_0$.

The equation (2.168) is a Pointing vector derived by an elementary procedure on the basis of the equivalence of the electrical and magnetic components of the electromagnetic wave in the quantised space-time. The Pointing vector determines the intensity of the incident energy flux which in the case of vacuum represents only the reactive energy and the power of the flux, because there is no absorption of energy by the quantised space-time in the absence of matter. Expression (2.168) links the density of the volume energy W_v with the intensity of the flux I**EH**I. The vector product I**EH**I determines the plane of the vectors **E**⊥**H** as normal to the direction of the vector of speed C_0 of propagation of the electromagnetic wave and the direction of the Pointing vector **S** (2.168) [39–42].

The equation (2.168) in the integral form is the Ostrogradskii–Gauss theorem

$$C_0 \int \mathrm{div} W_v dV = \oint EHdS_v \quad (2.169)$$

If the radiation source is placed inside the volume V, then the closed integral

(2.169) on the surface S_v of the given volume determines the power of the radiation source.

We introduce (2.148) and (2.153) into (2.166) and (2.168). We obtain the function of attenuation of the volume density of energy W_v and flux intensity **S** = I**EH**I of the spherical electromagnetic wave with the distance from the power source increasing to **r**

$$W_v = \frac{EH}{C_0} = \frac{r_0^2}{C_0}\frac{E_0 H_0}{r^2} = \frac{1}{4\pi^2 C_0}\frac{\varphi_{e0}\varphi_{g0}}{r^2} \tag{2.170}$$

$$\mathbf{S} = W_v \mathrm{C}_o = |\mathbf{EH}| = \frac{r_0^2|\mathbf{E}_0\mathbf{H}_0|}{r^2} = \frac{1}{4\pi^2}\frac{\varphi_{e0}\varphi_{g0}}{r^2}\mathbf{1}_r \tag{2.171}$$

It can be seen that the volume density of energy W_v (2.170) and flux intensity **S** (2.171) decrease with the increase of the distance from the radiation source in inverse proportion to the square of the distance $1/r^2$. This is a sufficiently verified experimental fact.

The equations (2.170) and (2.171) can be used to estimate the parameters of the emitter. Therefore, for calculations in practice it is convenient to use only one component (electrical or magnetic) which excites the electromagnetic radiation in relation to the type of antenna (electrical or magnetic)

$$W_v = \frac{\varepsilon_0 (r_0 E_0)^2}{r^2} = \frac{\varepsilon_0}{4\pi^2}\frac{\varphi_{e0}^2}{r^2} \tag{2.172}$$

$$\mathbf{S} = \frac{\varepsilon_0 (r_0 E_0)^2}{r^2}\mathbf{C}_0 = \frac{\varepsilon_0}{4\pi^2}\frac{\varphi_{e0}^2}{r^2}\mathbf{C}_0 \tag{2.173}$$

$$W_v = \frac{\mu_0 (r_0 H_0)^2}{r^2} = \frac{\mu_0}{4\pi^2}\frac{\varphi_{g0}^2}{r^2} \tag{2.174}$$

$$\mathbf{S} = \frac{\mu_0 (r_0 H_0)^2}{r^2}\mathbf{C}_0 = \frac{\mu_0}{4\pi^2}\frac{\varphi_{g0}^2}{r^2}\mathbf{C}_0 \tag{2.175}$$

The single-component parameters (2.172)–(2.175) characterise the nearest radiation zone in the region of the antenna. In the formation of the electromagnetic wave, the single-component parameter is divided into two equivalent components: electrical and magnetic, as a result of the effect of the laws of electromagnetic induction in the quantised space-time.

The results can be used to estimate the participation of the superstrong electromagnetic interaction (SEI) in the wave transfer of electromagnetic energy. For this purpose, we determine the value of the variation of the quanton energy ΔW_e (2.155) which takes part in the transfer of electromagnetic energy, expressing the tension modulus of the wave E through the variation of the tension modulus of the quantom ΔE_{qx} (2.70)

$$\Delta W_e = eE\Delta x = e\Delta E_{qx}\Delta x = \frac{4\pi}{3}\frac{e^2}{\varepsilon_0 L_{q0}^3}\Delta x^2 \tag{2.176}$$

From equation (2.12) we determine the binding energy W_v of the electrical charges inside the quanton at $r_{e0} = 0.5\ L_{q0}$

$$W_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{e0}} = \frac{1}{2\pi\varepsilon_0}\frac{e^2}{L_{q0}} \tag{2.177}$$

Dividing (2.176) by (2.177), we determine the extent of participation of the superstrong electromagnetic interaction in the classic electromagnetic interaction in transfer of the electromagnetic wave in vacuum which can be estimated quite satisfactorily by the displacement of the charges $\Delta x = 2.3 \cdot 10^{-62}$ m (2.64) for the region of the strong electrical field with the strength of 30 kV/cm

$$\frac{\Delta W_e}{W_e} = \frac{8\pi^2}{3}\left(\frac{\Delta x}{L_{q0}}\right)^2 = 2.6 \cdot 10^{-72} \tag{2.178}$$

The result (2.178) is estimated as being of the order of 10^{-72}. This value is extremely small even for the region of strong electrical (electromagnetic) fields in comparison with the density of the energy which was initially accumulated in the form of SEI in the quantised space-time.

Thus, quantisation of the electromagnetic wave enables us to understand the reasons for electromagnetic phenomena in vacuum, determining the nature of exchange processes between SEI and classic electromagnetism. If appears that the well-known parameters of the electromagnetic wave have been estimated from a completely different point of view. It is important to mention the considerable simplification of the calculation procedure developed on the basis of the analysis of the physical model of quantised space-time as a result of its electromagnetic perturbation. The previously mentioned calculations of the electromagnetic processes can be presented in the complex form, but this would complicated understanding the causality of the physical phenomena which is at present the principal task in explaining of the EQM theory.

2.4. Electromagnetic tensioning of vacuum. Strings and superstrings

2.4.1. Elastic quantised medium (EQM)

Since the Maxwell period, only the EQM theory has made it possible to carry out for the first time the analytical derivation of the main equations of the electromagnetic processors in vacuum, describing the nature of the very phenomena and taking into account only the specific features of the electromagnetic structure of vacuum as the elastic quantised medium. The electromagnetic processes in vacuum have been studied experimentally quite extensively and the explanation of their nature is the most efficient confirmation of the validity of the EQM theory. This was not possible prior to the development of the EQM theory.

All the electromagnetic processes in vacuum are the result of the elastic interaction of electricity and magnetism inside the quanton and, on the whole, the elastic electromagnetic tensioning of the quantised space-time. Taking into account the small size of the quantum, the interaction of the charges inside the quanton is determined by colossal forces (2.10)

$$\begin{cases} F_e = \dfrac{1}{4\pi\varepsilon_0}\dfrac{e^2}{r_{e0}^2} = \dfrac{1}{\pi\varepsilon_0}\dfrac{e^2}{L_{q0}^2} = 1.6\cdot 10^{23}\,\text{N} \\ F_g = \dfrac{\mu_0}{4\pi}\dfrac{g^2}{r_{g0}^2} = \dfrac{\mu_0}{\pi}\dfrac{g^2}{L_{q0}^2} = 1.6\cdot 10^{23}\,\text{N} \end{cases} \tag{2.178}$$

In the quantised space-time (Fig. 2.5), the forces (2.178) are balanced by the interaction of every quanton with the entire population of the quantons in the space, establishing the linear laws (2.69) and (2.76) of the variation of force in displacement Δx and Δy of the electrical and magnetic charges inside the quanton in relation to the equilibrium state

$$\mathrm{F}_{2x} = \frac{4\pi}{3}\frac{e^2 1_x}{\varepsilon_o L_{qo}^3}\Delta x = k_x \Delta x = 3\cdot 10^{49}\,\Delta x \tag{2.180}$$

$$\mathrm{F}_{2y} = -\frac{4\pi}{3}\mu_o \frac{g^2 1_y}{L_{qo}^3}\Delta y = k_y \Delta y = 3\cdot 10^{49}\,\Delta y \tag{2.181}$$

where $k_x = k_y = 3\cdot 10^{49}$ N/m is the coefficient of electromagnetic elasticity of vacuum

$$k_x = \frac{4\pi}{3}\frac{e^2}{\varepsilon_0 L_{q0}^3} = 3\cdot 10^{49}\,\frac{\text{N}}{\text{m}} \tag{2.182}$$

The forces (2.180) and (2.181) are elastic forces, similar to the elastic forces of tensioning of the string. The value of the coefficient (2.182) of electromagnetic elasticity of vacuum is very high, of order of 10^{49} N/m. None of the known media has such a colossally high elasticity is vacuum. In particular, the colossal elasticity of vacuum determines the highest rate of propagation of the electromagnetic wave in the vacuum. The elastic displacement of the charges inside the quantum determines the wave electromagnetic processes in the quantised space-time, characterising it as a light-bearing medium.

We can derive a differential dynamics equation which is the analogue of the mechanical system for the equivalent mass m_x and the elastic forces (2.180) (to simplify considerations, Δx is replaced by x)

$$m_x \frac{d^2 x}{d\,t^2} - k_x x = 0 \tag{2.183}$$

Equivalent mass m_x characterises the inertia of the system. Equation (2.183) is the equation of free oscillations of the point mass under the effect of elastic force. The solution of (2.183), makes it possible to link the elastic parameters (2.182) of the quanton as the inertia system with the frequency of its free oscillations (2.15) and (2.16)

$$k_x = m_x \omega^2 = m_x (2\pi f_0)^2 = 4\pi^2 m_x \left(\frac{C_0}{L_{q0}} \right)^2 \tag{2.184}$$

Equation (2.183) characterises the oscillatory system without losses. This relates to the transfer of energy without losses from one quantum to another during the passage of the electromagnetic wave because in nature there are no free quantons isolated from the space-time in nature.

Using equation (2.184), we determine the equivalent of mass m_x of the system taking into account (2.182)

$$m_x = \frac{k_x}{4\pi^2} \left(\frac{L_{q0}}{C_0} \right)^2 = \frac{1}{C_0^2} \frac{e^2}{3\pi L_{q0}} = \frac{W_x}{C_0^2} \tag{2.185}$$

Equation (2.185) fully confirms the principle of equivalence of energy and mass because (2.185) includes the binding energy W_x of the individual charge inside the quanton with the charges of other quantons

$$W_x = \frac{e^2}{3\pi L_{q0}} \tag{2.186}$$

Energy (2.186) is three times smaller than the binding energy of two electric charges inside the quanton and is averaged-out at this time because the exact solution of the problem of interaction of a large group of charges in the volume of quantised space-time has not been obtained as yet. Taking into account that energy W_x (2.186) relates to a single charge, the total averaged-out energy of two electrical charges in the quanton is:

$$W_e = 2W_x = \frac{2e^2}{3\pi L_{q0}} \tag{2.187}$$

The energy processes inside the quantum and between the quantons determined the inertia of energy transfer and the speed C_0 of propagation of transverse electromagnetic perturbations in vacuum. From (2.185) and (2.184) we obtain

$$C_0 = \sqrt{\frac{W_x}{m_x}} = \frac{L_{q0}}{2\pi}\sqrt{\frac{k_x}{m_x}} \tag{2.188}$$

The wave electromagnetic processes in vacuum were studied examined in detail previously. These processes can be investigated from the viewpoint of elastic tensions of electromagnetic strings (Fig. 2.50) in the volume of quantised space-time, introducing the characteristics of the mechanical systems, such as the modulus of transverse shear and the modulus of longitudinal elasticity. Consequently, we can determine the difference (or the absence of difference) between the speeds of the electromagnetic and gravitational waves. However, this is already a completely different problem and, at the moment, it is necessary to analyse the tensioning of the electromagnetic strings.

However, prior to analysing the elastic properties of the electromagnetic string and superstrings, we return to the history of the process. In a letter to Boyle, Newton wrote: ‘I assume that the entire space is filled with aether matter, capable of compression and stretching, with high elasticity...’ [44]. He supported his concept when completing his excellent ‘Origins’ [45]. However, Newton was not capable of formulating exactly the elastic properties of the aether and made only brilliant guesses. The article by Maxwell ‘Aether’ was also based on guesses, in the sense that the ‘aether has elasticity, similar to the elasticity of the solid’ [48]. Lorentz, who understood correctly the concept of the electromagnetic aether, proposed a relatively contradicting idea regarding its properties as a mechanistic aether [6]. Einstein also expressed doubts regarding the aether, replacing it by the concept of the four-dimensional space-time and at the end of his life he believed that there is no emptiness and defended the concept of the unified field [10,11] which was realised in the EQM theory.

Academician Vavilov evaluated the situation quite accurately: ‘...aether should be the arena of gravitational, electromagnetic and optical phenomena. It was not possible to construct a model of the ether corresponding to all these requirements'. However, most importantly, the concept of mechanistic aether did not explain the 'relativity of translational motions' i.e., but they did not explain the fundamental nature of the relativity principle [46].

The elastic structure of the quantised space-time, described in the EQM theory, explains for the first time without contradiction all the fundamental interactions, including the fundamentality of the relativity principle in the absolute space, determining the principle of relative-absolute dualism [22-33]. It has already been shown in this book that the electromagnetic structure of the quantised space-time explains without contradiction and harmonically the nature of electromagnetic processes in vacuum, proving that there is no emptiness in nature. Prior to developing the EQM theory, nobody was capable of describing the structure of vacuum.

Quantised space-time is the elastic quantised medium (EQM) which is the carrier of superstrong electromagnetic interactions (SEI).

2.4.2. Tensioning of the electromagnetic superstring

In the first approximation, the order of forces in 10^{23} N in (2.178) determines the colossal tensioning of the electromagnetic string made of quantons (Fig. 2.15). To determine the tensioning of the string, it is necessary to take into account the effect of charges of elastic quantons. Taking into account the ambiguous orientation of the electrical and magnetic axes of the quantons, the exact solution of this task is associated with considerable mathematical difficulties. However, the statistically average-out answer can be obtained by elementary methods, taking into account the mean angle 45° (2.71) and (2.78) of the slope of electrical and magnetic axes of the quantons in the direction of any electromagnetic string, penetrating the quantised space-time (Fig. 2.15).

The problem is greatly simplified if we consider separately the magnetic and electrical alternating superstrings. In the EQM theory, the electrical and magnetic superstrings represent an infinite chain of alternating electrical and magnetic charges placed in a line with the alternation of polarity. A section of the chain of the alternating charges represents yhe electrical (a) and magnetic (b) string (Fig. 2.20). The electromagnetic superstring in the EQM theory is an infinite chain consisting of quantons which interact with each other by the attraction forces resulting in tensioning of the superstring. A section of the chain made of quantons represents the an electromagnetic string (Fig. 2.15).

Figure 2.20 shows the calculation scheme of the forces of electrical $\mathbf{F}_e$

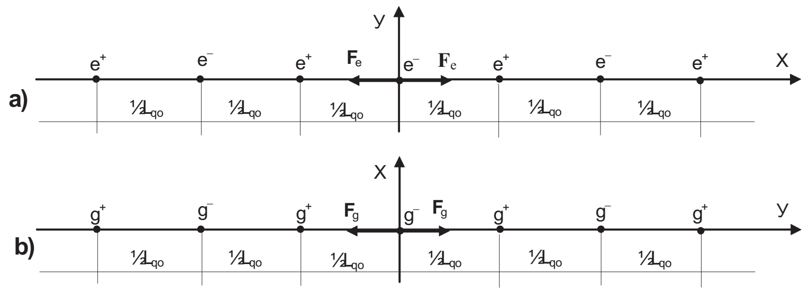


Fig. 2.20. Calculation of the tensioning of alternating electrical (a) and magnetic (b) superstrings.

and magnetic $\mathbf{F}_g$ potentials, acting on the elementary charge e and g inside the electrical (a) and magnetic (b) superstrings. Figure 2.20 is an analogue of Fig. 2.5 on the condition of the same distance between the charges, equal to half the quanton diameter $½L_{q0}$.

The tension of the electrical superstring (Fig. 2.20a) is determined by the pair of electrical forces $\mathbf{F}_e$ acting from the left and right on a test charge, placed in the origin of the coordinates. To calculate force $\mathbf{F}_e$, we determine the strength $\mathbf{E}_e$ of the electrical field in the region of the coordinates which is generated by the charges with alternating signs to the right of the origin of the coordinates along the axis X to infinity. In accordance with the principle of superposition of the fields, strength $\mathbf{E}_e$ is determined by the sum of the fields acting in the region of the coordinates to the right of every charge in only half the superstring. We obtain an infinite series, whose sum is known:

$$\mathbf{E}_e = \frac{\mathbf{1}_x}{4\pi\varepsilon_0}\frac{e}{(0.5L_{q0})^2}\left(1-\frac{1}{2^2}+\frac{1}{3^2}-\frac{1}{4^2}+\cdot\cdot\right) = \frac{\mathbf{1}_x}{\pi\varepsilon_0}\frac{e}{L_{q0}^2}\left(\frac{\pi^2}{12}\right) = \frac{\pi}{12\varepsilon_{00}}\frac{e}{L_{q0}^2}\mathbf{1}_x \quad (2.189)$$

From (2.189) we determine the force $\mathbf{F}_e$ which is slightly smaller than (2.179) because of weakening of the field by the second negative charge in the series (2.189). Taking into account the fact that the charge is subjected to the effect of the pair of the forces $\pm\mathbf{F}_e$ from the left and right, we introduce the concept of the alternating unit vector $\pm\mathbf{1}_x$, which balances the effect of the pair of the forces $\pm\mathbf{F}_e$ on the charge in the superstring (Fig. 2.20a)

$$\mathbf{F}_e = \pm e\mathbf{E}_e = \pm\mathbf{1}_x\frac{\pi}{12\varepsilon_0}\frac{e^2}{L_{q0}^2} = \pm 1.4\cdot 10^{23}\,\text{N} \quad (2.190)$$

The same procedure is used to determine the per of tensioning forces $\pm\mathbf{F}_g$, acting on the magnetic charge g in the magnetic superstring (Fig. 2.20b):

$$\mathbf{F}_g = \pm\mu_0 g\mathbf{H}_g = \pm\mathbf{1}_y \frac{\pi\mu_0}{12}\frac{g^2}{L_{q0}^2} = \pm 1.4\cdot 10^{23}\,\mathrm{N} \tag{2.191}$$

The forces $\pm\mathbf{F}_e$ and $\pm\mathbf{F}_g$ were obtained for ideal superstrings and the directions of the axes X and Y do not coincide. In the electromagnetic superstring (Fig. 2.15) the electrical and magnetic superstrings are combined into a single system. Taking into account the statistical scatter of the orientations of the quantum axes, (2.71) and (2.78) were used previously to determine the average angle of inclination of the axes, which was equal to 45°, including in the direction Z, i.e. $\alpha_z = 45°$.

Figure 2.21 shows the flat scheme of the statistically averaged-out electromagnetic superstring in the direction Z. Actually, the superstring has the volume and chirality and twisted in relation to the Z axis. This is determined by the tetrahedral arrangement of the charges in the quantum which prevents arrangement in the single plane (Fig. 2.2).

In the flat model (Fig. 2 .21), the electrical charges of the quantons are situated in the plane XZ, and the magnetic charges in the plane YZ. The region of the coordinates for the axes X and Y is displaced by the displacement of the electrical and magnetic axes in the quanton. Attention should be given to the fact that the projection of the strength E_z of the electrical field on the axis Z is determined by the difference of the vectors **E**, compensating the electrical field in the direction Z. The projections of the strength E_x of the electrical field on the axis X are determined by the sum of the vectors **E**.

This also relates to the magnetic component. The projections of the strength H_z of the magnetic field on the Z axis are determined by the difference of the vectors **H**, compensating the magnetic field in the direction Z. The projections of the strength H_y of the magnetic field on the axis Y are determined by the sum of the vectors **H**. For this reason, the electrical and

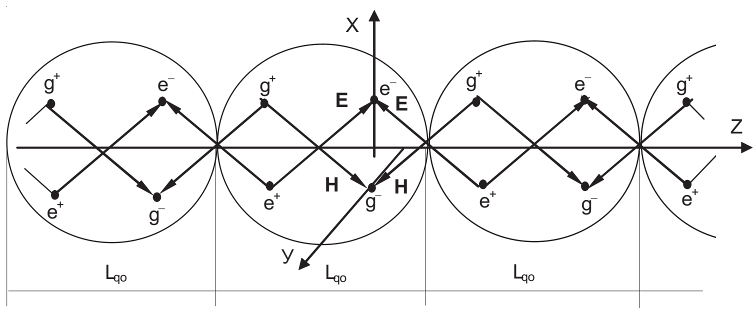


Fig. 2.21. Scheme of the statistically averaged-out electromagnetic superstring.

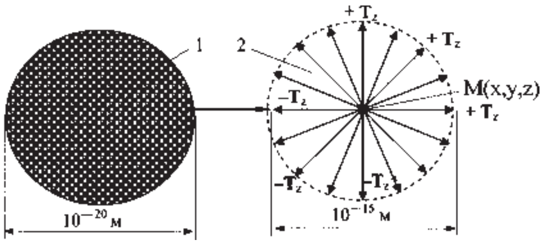


Fig. 2.22. Representation of region 1 of the quantised space-time as a point object M (*x, y, z*) in the region 2.

magnetic components of the strength of the field in the electromagnetic wave are transverse and situated in the plane normal to the direction of propagation of the wave along the electromagnetic superstring.

We determine the projections of the forces $\pm\mathbf{F}_e$ and $\pm\mathbf{F}_g$ on the Z axis and determine the total force $\pm\mathbf{F}_z$ of tensioning the electromagnetic superstring in the direction Z for the unit alternating vector $\pm\mathbf{1}_z$

$$\mathbf{F}_z = \pm\mathbf{1}_z(F_e + F_g)\cos\alpha_z = \pm\mathbf{1}_z \frac{\pi}{12L_{q0}^2}\left(\frac{e^2}{\varepsilon_0} + \mu_0 g^2\right) = \pm 2\cdot 10^{23}\,\mathrm{N} \qquad (2.192)$$

The value of the tensioning force $\pm\mathbf{F}_z$ (2.192) of the electromagnetic superstring is regarded as the calculated value. We determine the tension $\pm\mathbf{T}_z$ of the electromagnetic superstring as the force $\pm\mathbf{F}_z$ per cross-section S_q of the quantum since the cross-section of the quanton determines the cross-section of the electromagnetic superstring (Fig. 2.15)

$$\pm\mathbf{T}_z = \frac{\pm\mathbf{F}_z}{S_q} = 4\frac{\pm\mathbf{F}_z}{\pi L_{q0}^2} = \frac{\pm\mathbf{1}_z}{3L_{q0}^4}\left(\frac{e^2}{\varepsilon_0} + \mu_0 g^2\right) = \pm 4.65\cdot 10^{73}\,\frac{\mathrm{N}}{\mathrm{m}^2} \qquad (2.193)$$

The alternating tension vector $\pm\mathbf{T}_z$ characterises vacuum as an elastic quantised medium with the discreteness equal to the quanton diameter. Attention should be given to the fact that in the region of the quantum ultramicroworld all the vacuum parameters are characterised by very small dimensions and extremely high forces (2.192) and tensioning of the medium (2.193). It may be shown that vacuum is a virtually incompressible substance and any fluctuations of vacuum to be associated with colossal external forces. It would appear that the usual physical laws with low forces should not be valid in such a substance. It is difficult to imagine an analogue of a continuous stretched net (Fig. 2.5) under the effect of colossal forces similar to (2.190) and (2.191). Such a net could not be used for any action using conventional forces acceptable for the macroworld.

However, the point is that the vacuum is not a continuous medium but a quantised medium. In the non-perturbed condition it is a fully balanced medium in which the tension forces $\pm\mathbf{F}_e$ and $\pm\mathbf{F}_g$ act on the charge from the left and right. Consequently, the force of displacement of the charges inside the quanton is determined by the magnitude of displacement Δx and Δy (2.180) and (2.181) and not by tensioning forces. Taking into account the fact that the displacement of the charges can be very small in magnitude, very small external forces would be required to displace the quantised space from the equilibrium condition. For example, to generate a strength of the electrical field of 30 kV/cm, the displacement of the charge in the quanton is only $2.3\cdot10^{-62}$ m (64). This displacement corresponds to the relatively low force (2.180):

$$\mathbf{F}_{2x} = k_x \Delta x = 0.7\cdot 10^{-12}\,\mathrm{N} \tag{2.194}$$

Thus, the vacuum is a unique medium which is characterised by both colossal tension (2.193) and by the capacity for very low forces acting in vacuum (2.194). Force (2.194) is already a derivative force of the equilibrium state of the vacuum determined by the discrete tension (2.193), where the linking term in the string is the elementary charge of the quanton (Fig. 2.20).

2.5.3. Tension tensor in vacuum

The presence of colossal tension $\mathbf{T}_z$ (2.193) makes it possible to use the methods of tensor analysis for the analysis of non-equilibrium forces in the quantised space-time [37, 34]. The specific feature of the quantised space-time is that the super strongelectromagnetic interaction (SEI) acts in the region of the ultra-microworld of the quantons, and this interaction characterises the vacuum space as a highly heterogeneous and anisotropic substance. However, in transition to the region of the microworld of the elementary particles and the macroworld, the quantised space-time is already perceived as a homogeneous and isotropic medium. This is explained by the operation of statistical laws which are determined by the high concentration of the quantons in the volume of space.

We separate a spherical volume of the quantised space-time with the diameter of the order of 10^{-20} m, i.e., up to 10 times greater than the quanton diameter L_{q0}. For the region of the microworld of the elementary particles, the diameter of 10^{-20} m is up to 10^5 times greater than the diameter of the elementary particle 10^{-15} m, and can be regarded as a point object $M(x, y, z)$. In this case, we are concerned with the relativity of perception of the quantised space-time in physical processes. It may be assumed that the concept of relativity in the EQM theory is considerably wider than the relativity of straight and uniform motion.

The relative special feature of quantised space-time is that at any point of space M (x, y, z) the tension forces $\pm\mathbf{T}_z$ (2.193) are balanced in any arbitrary direction governed by spherical symmetry and form a tension field $\pm\mathbf{T}_z$ uniform in all directions (Fig. 2.22).

If a spherical shell is cut out from the quantised space-time (Fig. 2.23a), it may be seen that the shell is subjected to the effect of tension forces on both the external and internal side. In the non-perturbed vacuum, the tension forces on the external side are fully compensated by the tension forces on the internal side of the shell, ensuring the equilibrium of space-time.

The tension, acting in the direction normal to the unit surface dS of the spherical shell from the external side will be denoted by $\mathbf{T}_{n1}$, and from the internal side $\mathbf{T}_{ns}$. Consequently, the resultant of all forces $\Sigma\mathbf{F}$, acting on the shell, will be determined by the difference of the forces $\mathbf{F}_1$ and $\mathbf{F}_2$ on the internal and internal sides of the shell, which are determined by the integral of the surface S of the shell for the function of the tensions $\mathbf{T}_{n1}$ and $\mathbf{T}_{n2}$:

$$\sum\mathbf{F} = \mathbf{F}_1 - \mathbf{F}_2 = \oint_S \mathbf{T}_{n1} dS - \oint_S \mathbf{T}_{n2} dS = \oint_S (\mathbf{T}_{n1} - \mathbf{T}_{n2}) dS = \oint_S \Delta\mathbf{T}_n dS \qquad (2.195)$$

As already mentioned, the quantised space-time is a universal medium in which both the small forces (2.194) can and also colossal stresses $\mathbf{T}_z$ (2.193) can operate or be absent. Consequently, it may be assumed that tension $\mathbf{T}_{n1}$ is the intermediate tension in the range $0 < \mathbf{T}_{n1} < \mathbf{T}_z$ (2.193).

Integral (2.195) is of considerable importance in the EQM theory, and determines the effect of unbalanced forces of the electrical, magnetic in gravitational fields in the quantised space-time, and also their equilibrium condition. The difference of the tensions $\mathbf{T}_{n1}$ and $\mathbf{T}_{n2}$ determines the 'jump' of tension $\Delta\mathbf{T}_n$. If there is no jump of the tension on the surface of the sphere S (Fig. 2.23a) i.e., $\Delta\mathbf{T}_n = 0$, it can be assumed that there is nothing happening in this quantised space-time, i.e., no electrical, magnetic or gravitational perturbation is found in the vacuum, and only one tension at $\mathbf{T}_z$ (Fig. 2.22).

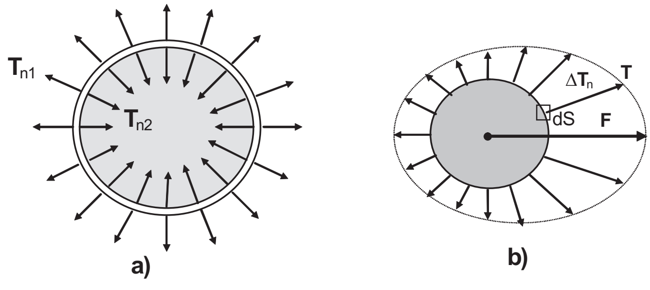


Fig. 2.23. Effect of tension on the spherical shell (a) and the formation of the spherically unbalanced force F (b).

As shown previously, all electrical, magnetic in electromagnetic processes in vacuum are linked only with the displacement of the charges inside the quanton and this results in the disruption of the equilibrium of the quantised space-time without disruption of the quantum density of the medium. In this case, the volume of the quanton remains constant and also there was no change in the concentration of the quantons in the unit volume of the space.

Gravitational perturbation is characterised by the disruption of the quantum density of the medium in the absence of displacement inside the quanton charges in relation to the equilibrium state. More accurately, the charges are displaced not only at the moment of the changes of the gravitational field when the uniform tension or compression of the quanton is associated with the variation of its volume without disrupting its electrical and magnetic equilibrium. In the presence of the gravitational perturbation, the concentration of the quantons in the unit volume of space changes.

The theory of gravitation is strongly linked with the deformation of the quantised space-time and is also investigated in this book. The tasks formulated in this chapter in solving the problems of electromagnetic phenomena in vacuum have been fulfilled. Further investigations are linked with the nature of gravitation as an electromagnetic phenomenon determined by the deformation of the quantised space-time and the interaction of electromagnetism with matter.

Therefore, without discussing the underlying phenomena in the quantised space-time, we examine the general manifestation of tensions in the quantised space-time through the elements of tensile analysis and its application to several aspects of static electromagnetism in interaction with matter.

Returning to analysis of (2.195), we specify two main groups of the interactions:

$$\sum \mathbf{F} = 0, \quad \Delta\mathbf{T}_n > 0 \tag{2.196}$$

$$\sum \mathbf{F} > 0, \quad \Delta\mathbf{T}_n > 0 \tag{2.197}$$

The first group (2.194) characterises the spherically symmetric systems (Fig. 2.23a). If $\mathbf{T}_{n2} > \mathbf{T}_{n1}$, then the jump of the tension $\Delta\mathbf{T}_n$ at the interface is directed into the bulk of the sphere and compresses the latter. Spherical compression of the quantised space-time increases the quantum density of the medium inside the sphere as a result of extension of the sphere on the external side of the interface. This interaction results in the generation of mass as a result of spherical deformation of the quantised space-time. The gravitational interaction is investigated in greater detail in chapter 3.

If the sphere contains (Fig. 2.23a) a free electrical charge, polarisation of vacuum results in the formation of a gradient of the displacement of electrical charges inside the quantons in the radial direction *r*, generating effects in the space-time of the spherical electrical field. The sphere with thickness Δr shows a jump of tension $\Delta \mathbf{T}_n$ and also a jump of strength and difference of the potentials. If the gradient is regarded as a continuous function in the theory of vector analysis, in the EQM theory it is shown that every gradient is quantised on the basis of the discreteness of space-time.

The second group (2.197) characterises the formation of unbalanced force **F** as a result of the non-symmetrical distribution of tension jumps $\Delta \mathbf{T}_n$ on the sphere (Fig. 2.23a). This perturbation characterises the already anisotropic medium whose properties change depending on direction.

In a general case, we can separate the vector of a tension jump $\Delta \mathbf{T}$ (or, to simplify considerations, vector **T**) which is directed under an angle to the interface as a result of complicated interactions in the quantised space-time. In a number of cases this leads to the formation of the unbalanced momentum of forces *M* (Fig. 2.24).

We examine the perturbation of vacuum in the conditions of disruption of spherical symmetry, shown in Fig. 2.23b in the rectangular coordinate system. The area *dS* is specified on the surface of the compressed sphere at an arbitrary point, and the tension vector normal to this area and the surface of the sphere is denoted by **T**. In the rectangular coordinate system, the tension **T** can be expanded with respect to the axes (*x, y, z*) into three vectors $\mathbf{T}_x$, $\mathbf{T}_y$, $\mathbf{T}_z$.

To describe the anisotropic media (Fig. 2.23b), the three previously mentioned vectors $\mathbf{T}_x$, $\mathbf{T}_y$, $\mathbf{T}_z$ are no longer sufficient because the properties of each vector depend on the direction in which these properties are investigated. In the rectangular coordinate system, there are three additional

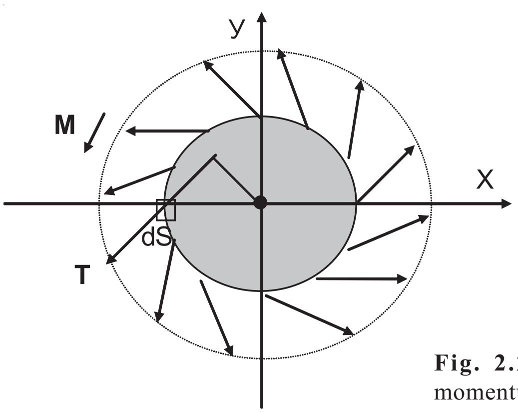


Fig. 2.24. Formation of the unbalanced momentum *M*.

directions denoted by the unit vectors **i**, **j**, **k**. Consequently, writing $\mathbf{T}_x$, $\mathbf{T}_y$, $\mathbf{T}_z$ on the unit vectors **i**, **j**, **k**, we obtain a system of equations for the tension tensor **T**:

$$\begin{cases} \mathbf{T}_x = \mathbf{i}T_{xx} + \mathbf{j}T_{yx} + \mathbf{k}T_{zx} \\ \mathbf{T}_\mathrm{y} = \mathbf{i}T_{xy} + \mathbf{j}T_{yy} + \mathbf{k}T_{zy} \\ \mathbf{T}_\mathrm{z} = \mathbf{i}T_{xz} + \mathbf{j}T_{yz} + \mathbf{k}T_{zz} \end{cases} \tag{2.198}$$

The components of the tensor **T** (2.198) is represented by the matrix:

$$\mathbf{T} = \begin{vmatrix} T_{xx} & T_{xy} & T_{xz} \\ T_{yx} & T_{yy} & T_{yz} \\ T_{zx} & T_{zy} & T_{zz} \end{vmatrix} \tag{2.199}$$

To transfer from the surface tension forces to volume forces acting on every local small volume dV, the density of the volume force is denoted by vector **f** and, using the Gauss theorem, we write a relationship between the surface tension forces of the vacuum field and the volume forces acting inside the defined volume:

$$\mathbf{F} = \oint_S \mathbf{T}\, dS = \int_V \mathbf{f}\, dV \tag{2.200}$$

The Gauss theorem (2.200) can be used to reduce the surface tension forces to volume forces acting inside the specified region, expressing the unbalanced resultant force **F** as a modulus with respect to the axes (x, y, z) through the corresponding components of the tension tensor **T** (2.199) [37]

$$F_x = \oint_S T_{xn} dS = \int_V \left(\frac{\partial T_{xx}}{\partial x} + \frac{\partial T_{xy}}{\partial y} + \frac{\partial T_{xz}}{\partial z} \right) dV \tag{2.201}$$

where T_{xn} is the normal component of T_x in the investigated point on the surface of the sphere.

By analogy, we determine the differential relationships between the density of the volume forces along the three axes (x, y, z) and the components of the tension tensor **T** (2.199)

$$\begin{cases} f_x = \dfrac{R_x}{V} = \dfrac{\partial T_{xx}}{\partial x} + \dfrac{\partial T_{xy}}{\partial y} + \dfrac{\partial T_{xz}}{\partial z} \\ f_y = \dfrac{R_y}{V} = \dfrac{\partial T_{yx}}{\partial x} + \dfrac{\partial T_{yy}}{\partial y} + \dfrac{\partial T_{yz}}{\partial z} \\ f_z = \dfrac{R_z}{V} = \dfrac{\partial T_{zx}}{\partial x} + \dfrac{\partial T_{zy}}{\partial y} + \dfrac{\partial T_{zz}}{\partial z} \end{cases} \tag{2.202}$$

Thus, the interpretation of the perturbations of the quantised space-time by the elements of tensor analysis shows that the quantised space-time is an elastic medium which can be regarded as an analogue of some solid whose properties greatly differ from the molecular solid of substance matter.

The equilibrium condition of the spherically symmetric system is determined by the fact that the surface tension forces in projection on any of the axes should be equal to zero

$$\begin{cases} \dfrac{\partial T_{xx}}{\partial x} + \dfrac{\partial T_{xy}}{\partial y} + \dfrac{\partial T_{xz}}{\partial z} = 0 \\ \dfrac{\partial T_{yx}}{\partial x} + \dfrac{\partial T_{yy}}{\partial y} + \dfrac{\partial T_{yz}}{\partial z} = 0 \\ \dfrac{\partial T_{zx}}{\partial x} + \dfrac{\partial T_{zy}}{\partial y} + \dfrac{\partial T_{zz}}{\partial z} = 0 \end{cases} \tag{2.203}$$

In analysis of the rotational perturbation of the quantised space-time it is important to determine the field of perturbing forces in relation to the point or axis of rotation (Fig. 2.24). Mechanics shows that momentum **M** is determined by the vector product of force **F** by vector of **r** from the centre of rotation to the point of application of force, i.e. **M** = [**Fr**]. In transition to the volume forces, the expression for moment **M** is determined by the integral:

$$\mathbf{M} = \int_v [\mathbf{f}\,\mathbf{r}]\,dV \tag{2.204}$$

We examine moment M_x (2.204) in relation to the x axis in the plane y–z, taking forces f_y and f_z into account (2. 202). It can be seen that the momenta of the forces in relation to the X axis are directed to different sides, and the total moment M_x is determined as the difference of the partial moments along the axes

$$M_x = \int_V \left(f_z y - f_y z\right) dV \tag{2.205}$$

Into (2.205) we substitute from (2.202)

$$M_x = \int_V \left\{ \left(\frac{\partial T_{zx}}{\partial x} + \frac{\partial T_{zy}}{\partial y} + \frac{\partial T_{zz}}{\partial z} \right) y - \left(\frac{\partial T_{yx}}{\partial x} + \frac{\partial T_{yy}}{\partial y} + \frac{\partial T_{yz}}{\partial z} \right) z \right\} dV \tag{2.206}$$

After transformations of (2.206), we finally obtain [137]

$$M_x = \oint_S \left(yT_{zn} - zT_{yn} \right) dS + \int_V \left(T_{yz} - T_{zy} \right) dV \tag{2.207}$$

Equation (2.207) determines the moment of rotation (Fig. 2.24) as a result of the effect of surface tension and volume forces determined by the disruption of the spherical symmetry of the quantised space-time. Evidently, for the spherically symmetric system of the tensions, the components of the tension tensor in (2.207) are equal to each other and the system is fully balanced in relation to any axis of rotation.

As an example, we investigate the effect of elastic tensioning of the quantised space-time on the surface of a dielectric sphere placed in a heterogeneous electrical field formed by a system of sources with different polarity (Fig. 2.25a). The electrical polarisation of the sphere results in the formation of forces which determine the resultant force **F** (2.192) as the difference of tensions $\mathbf{T}_{n1}$ and $\mathbf{T}_{n2}$ on the external and internal sides of the sphere surface, unified over the entire surface. In a general case $\mathbf{T}_{n1}$ and $\mathbf{T}_{n2}$ are expressed as $\mathbf{T}_1$ and $\mathbf{T}_2$.

In electricity theory, the tensor $\mathbf{T}_1$ of the surface tension of electrical forces is determined by man components and [37]:

$$\mathbf{T}_1 = \varepsilon_0 \varepsilon_1 \begin{vmatrix} E_{1x}^2 - \frac{1}{2}E_1^2 & E_{1x}E_{1y} & E_{1x}E_{1z} \\ E_{1y}E_{1z} & E_{1y}^2 - \frac{1}{2}E_1^2 & E_{1y}E_{1z} \\ E_{1z}E_{1x} & E_{1z}E_{1y} & E_{1x}^2 - \frac{1}{2}E_1^2 \end{vmatrix} \tag{2.208}$$

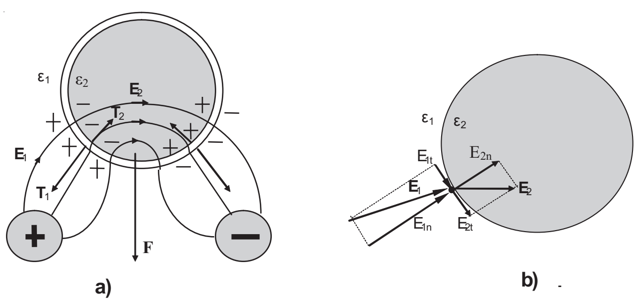


Fig. 2.25. Tensions of a heterogeneous electrical field at the interface of two media (a) and the fraction of the lines of force of the strength E of the electrical field (b).

The tensor is represented in the vector form on the external $\mathbf{T}_1$ and internal $\mathbf{T}_2$ sides of the interface:

$$\mathbf{T}_1 = \varepsilon_0\varepsilon_1\left(E_{1n}\mathrm{E}_1 - \tfrac{1}{2}\mathrm{n}E_1^2\right) \tag{2.209}$$

$$\mathbf{T}_2 = \varepsilon_0\varepsilon_2\left(E_{2n}\mathrm{E}_2 - \tfrac{1}{2}\mathrm{n}E_2^2\right) \tag{2.210}$$

where E_n is the normal component of the vector **n** of strength **E**; ε_1 is the relative dielectric permittivity of the medium on the external side; ε_2 is the relative dielectric permittivity of the sphere.

It is well known that the vector of the strength **E** of the electrical field at the interface of the media 'jumps' only for the normal components E_{2n} and E_{1n}, and its tangential components E_{2t} and E_{1t} do not change (Fig. 2.25b):

$$\begin{aligned} E_{2n} &= \frac{\varepsilon_1}{\varepsilon_2}E_{1n} \\ E_{2t} &= E_{1t} \end{aligned} \tag{2.211}$$

Taking into account (2.211), from 2.25b we obtain:

$$E_2^2 = \left(\frac{\varepsilon_1}{\varepsilon_2}\right)^2 E_{1n}^2 + E_{1t}^2 \tag{2.212}$$

Substituting (2.209) and (2.210) into (2.195) taking (2.212) into account, we obtain the resultant force **F**

$$\mathbf{F} = \oint_S (\mathbf{T}_1 - \mathbf{T}_2)\,dS = \oint_S \varepsilon_0\varepsilon_1 E_{1n}(\mathbf{E}_1 - \mathbf{E}_2) - \frac{\varepsilon_0}{2}\oint_S \left(1 - \frac{\varepsilon_1}{\varepsilon_2}\right)(E_{1n}E_{2n} - E_{1t}E_{2t})\,\mathbf{n}\,dS \tag{2.213}$$

Analysis of (2.213) shows that under the condition $\varepsilon_1 < \varepsilon_2$ the force **F** is directed into the region of the maximum strength of the field, as shown in Fig. 2.25. Conversely, under the condition $\varepsilon_1 > \varepsilon_2$, the force **F** is directed in the opposite direction, and the sphere is displaced from the region with the maximum strength. If $\varepsilon_1 = \varepsilon_2$, then the force $\mathbf{F} = 0$.

The same analysis was carried out for the force **F** acting on a sphere made of a magnetic material and placed in a heterogeneous magnetic field, with the identical magnetic parameters:

$$\mathbf{F} = \oint_S (\mathbf{T}_1 - \mathbf{T}_2)\,dS = \oint_S \mu_0\mu_1 H_{1n}(\mathbf{H}_1 - \mathbf{H}_2) - \frac{\mu_0}{2}\oint_S \left(1 - \frac{\mu_1}{\mu_2}\right)(H_{1n}H_{2n} - H_{1t}H_{2t})\,\mathbf{n}\,dS \tag{2.214}$$

Thus, the analysis shows that all the perturbations of the quantised space-time are described for the medium subjected to elastic perturbations.

2.5. Conclusions for chapter 2

New fundamental discoveries of the space-time quantum (quanton) and superstrong electromagnetic interaction (SEI) determine the electromagnetic structure of quantised space-time.

The quanton is a complicated weightless particle which includes four charges – quarks: two electrical (+1*e* and –1*e*) and two magnetic (+1*g* and – 1*g*) linked by the relationship $g = C_0 e$.

The quanton is the carrier of electromagnetism, space and time, and a carrier of strong electromagnetic interaction. The process of electromagnetic quantisation of space is associated with filling of its volume with quantons. The quanton diameter determines the discreteness of the quantised space-time of the order of 10^{-25} m.

When analysing the electromagnetic perturbation of the quantised space-time, the nature of electromagnetic phenomena, the laws of electromagnetic induction, Maxwell equations and Pointing vector have been described for the first time.

The electromagnetism of quantised space-time is fully symmetric and determines the transfer of electromagnetic energy in accordance with the Maxwell equations. The nature of rotors in the electromagnetic wave has been determined.

It has also been shown that as we move deeper, initially into the region of the microworld of elementary particles and the atomic nucleus (~10^{-50} m) and subsequently into the region of the ultra-microworld (~10^{-25} m) of the quantised space-time, we encounter higher and higher energy concentrations. The energy capacity of the quanton is colossal and estimated at 10^{73} J/m^3. This is sufficient to generate a universe as a result of a big bang in activation of 1 m^3 of vacuum.

It has also been found that the electromagnetic perturbation of the vacuum is described by a simple equation: $\Delta x = -\Delta y$ which can be expanded into the main equations of the electromagnetic field in vacuum. The displacement from the equilibrium deposition of the electrical Δx and magnetic Δy charges – quarks inside the quanton disrupts the electrical and magnetic equilibrium of the quantised space-time. Real bias currents were found in the electromagnetic wave.

Inside the quantised space-time we can find an electromagnetic string or a superstring of quantons which determines the colossal tension of the quantised space-time. Taking into account the fact that the quanton is a volume elastic element similar to some extent to an electronic clock specifying the rate of electromagnetic processes and time, the quantum not only combines electricity and magnetism but, being a space-time quantum, it combines the space and time into a single substance: quantised space-time.

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3
Unification of electromagnetism and gravitation Antigravitation

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]:

$$\Delta x = \pm \Delta y \tag{3.1}$$

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

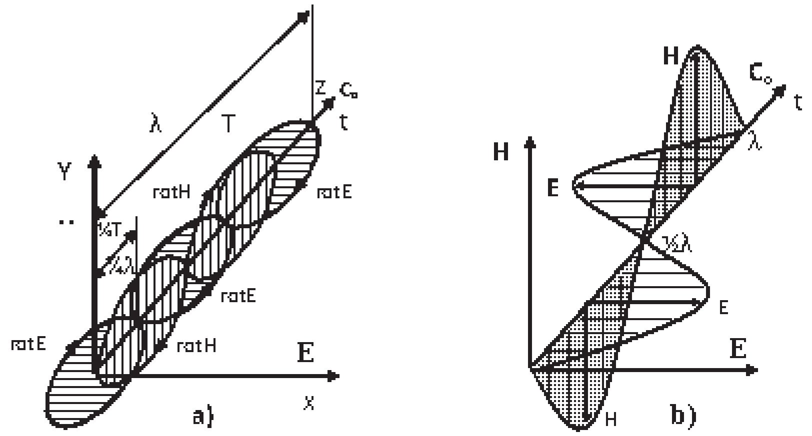

Fig. 3.1. Erroneous representation of the vortex mechanism of propagation of the electromagnetic wave (a) and actual distribution of the vectors of the strength of electrical **E** and magnetic **H** fields in the electromagnetic wave in quantised space-time (b).

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

$$\mathbf{S} = W_v C_0 = |\mathbf{EH}| \tag{3.3}$$

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

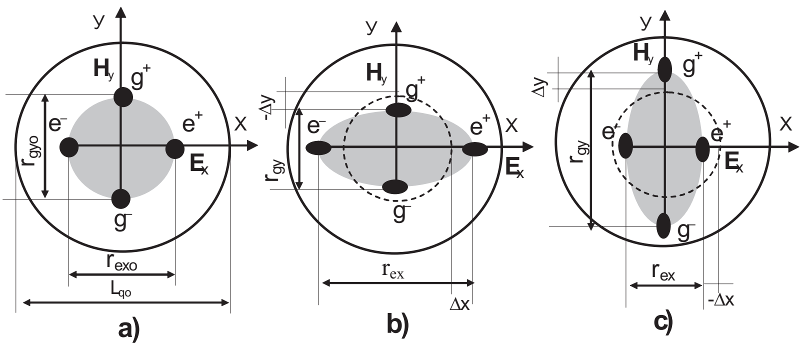

Fig. 3.2. Electromagnetic polarisation of a quanton in passage of an electromagnetic wave. The equilibrium (zero) state of the quanton (a); excited polarised state of the quanton (b) and (c).

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):

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

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] = [Am²], 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 ~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

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

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):

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

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):

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

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]:

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

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

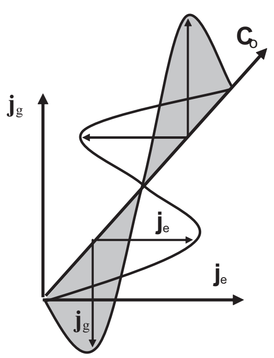

Fig. 3.3. Graphs of the electromagnetic wave in the quantised space-time in the coordinates of the displacement currents $\mathbf{j}_g$ and $\mathbf{j}_e$.

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)

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

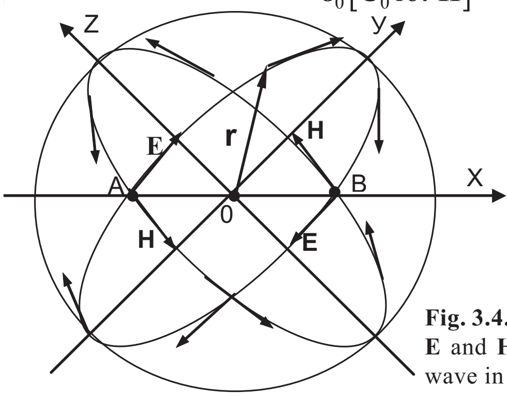

Fig. 3.4. Simultaneous circulation of the vectors **E** and **H** on the sphere of the electromagnetic wave in the orthogonal sections in relation to 0.

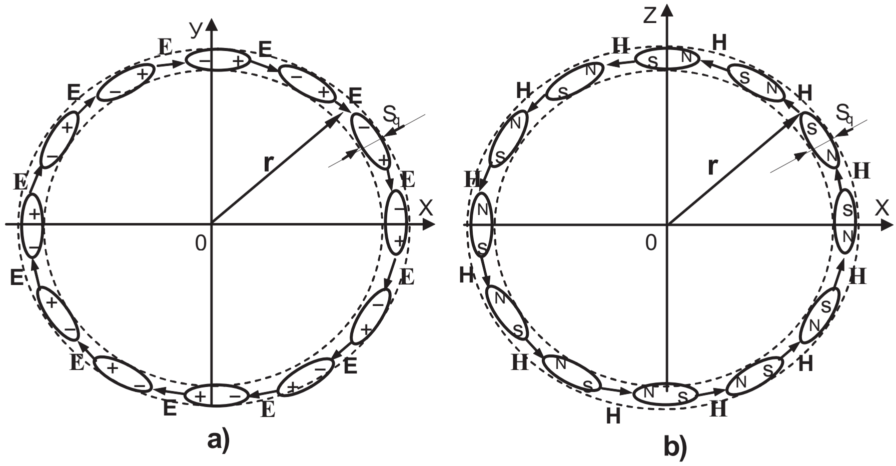

Fig. 3.5. Nature of circulation of the strength of the electrical **E** (a) and magnetic **H** (b) fields in the electromagnetic wave in relation to 0.

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

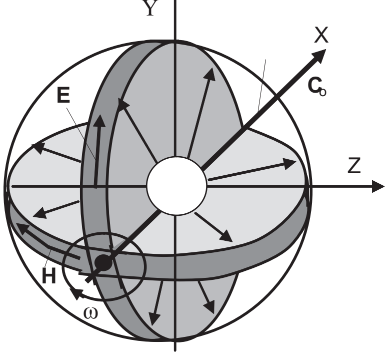

Fig. 3.6. Two-rotors structure of the low-energy photon emitted by the orbital electron.

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...

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

$$C_0 = \text{const} \qquad (3.16)$$

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

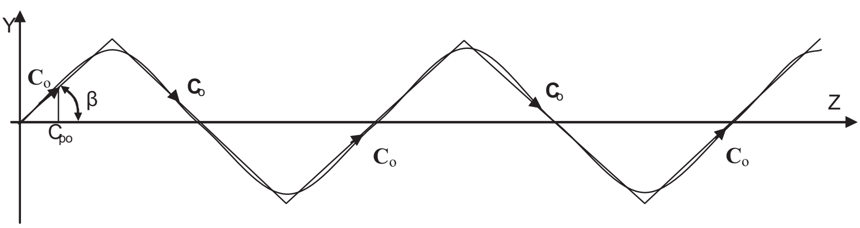

Fig. 3.7. Approximation of the wave trajectory of the movement of the photon in the optical medium by the broken line.

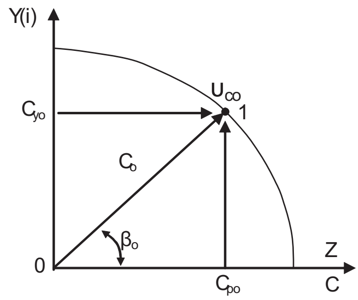

Fig. 3.8. Representation of the speed of light υ_{co} in the optical medium on the phase plane.

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

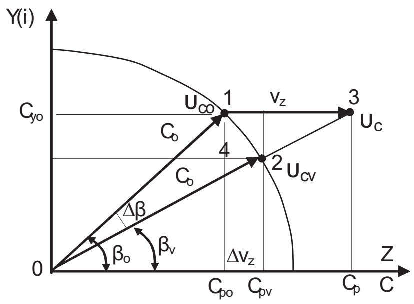

Fig. 3.9. Summation of the speeds in the moving optical medium on the phase plane.

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.

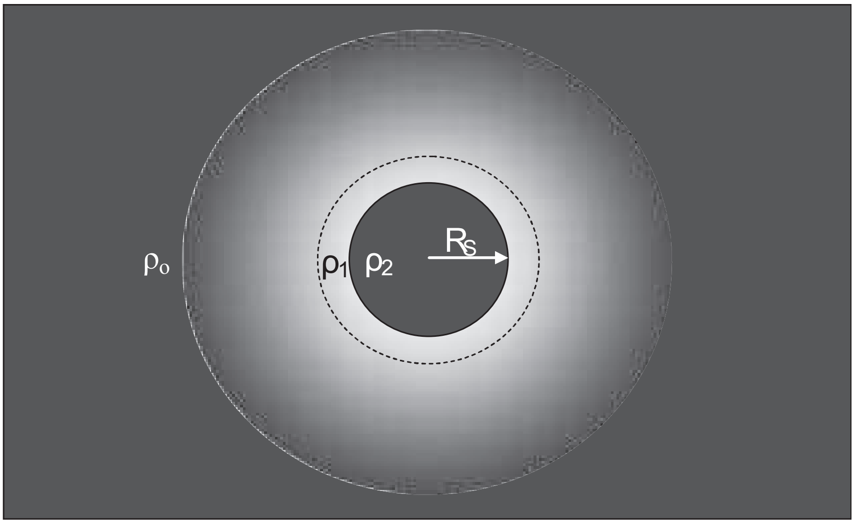

Fig. 3.10. Formation of the gravitation field and the nucleon mass as a result of spherical deformation of the quantised space-time by the shell of the nucleon with radius R_S.

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

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

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

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

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]:

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

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)

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

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

$$\varphi_n=-\frac{Gm}{r} \quad (3.48)$$

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 $\mathbf{F}_n$

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

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

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

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 = m^2/s^2].

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

$$C^2 = C_0^2 - \varphi_n \tag{3.58}$$

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

$$C^2 = C_0^2 - C_0^2 \frac{R_g}{r} \tag{3.59}$$

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

$$\varphi_n = C_0^2 \frac{R_g}{r} \tag{3.60}$$

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

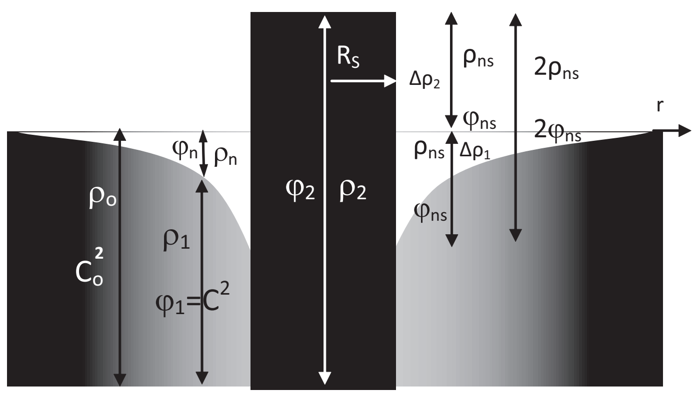

Fig. 3.11. Two-dimensional representation of the Lobachevski space in the form of the gravitational diagram of the distribution of the quantum density of the medium (ρ_1, ρ_2) and gravitational potentials (φ_1, φ_2) of the nucleon; ρ_2 is the region of compression of the medium, ρ_1 is the region of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

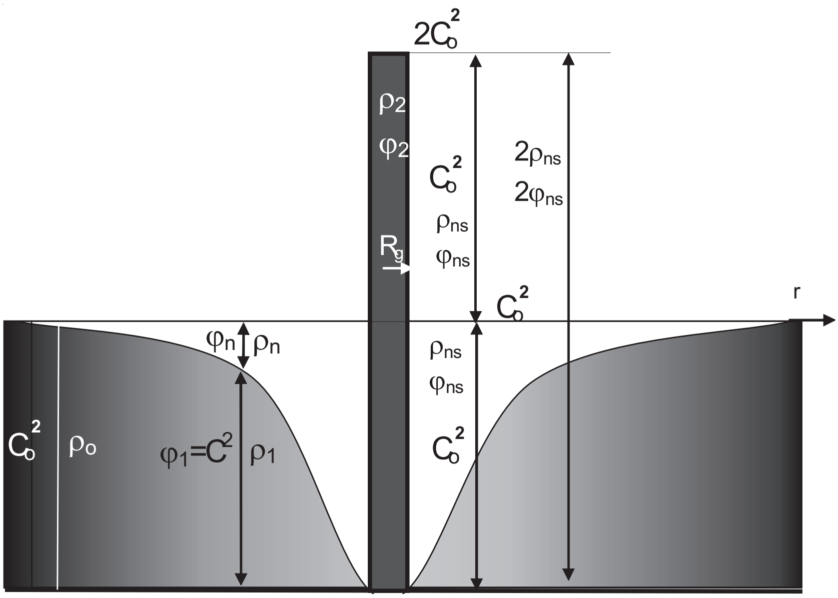

Fig. 3.12. Gravitational diagram of the black hole (microhole) in compression of the gravitational radius R_S (Fig. 3.11) to the gravitational radius R_g.

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)

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

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)

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

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:

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

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

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]:

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

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

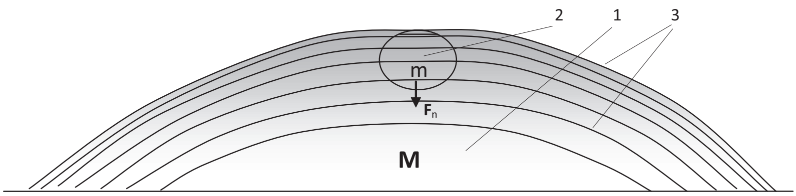

Fig. 3.13. Manifestation of the gravitational force F_m acting on the mass 2 (m) in the gradient vacuum field 3, perturbed by the mass 1 (M).

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,

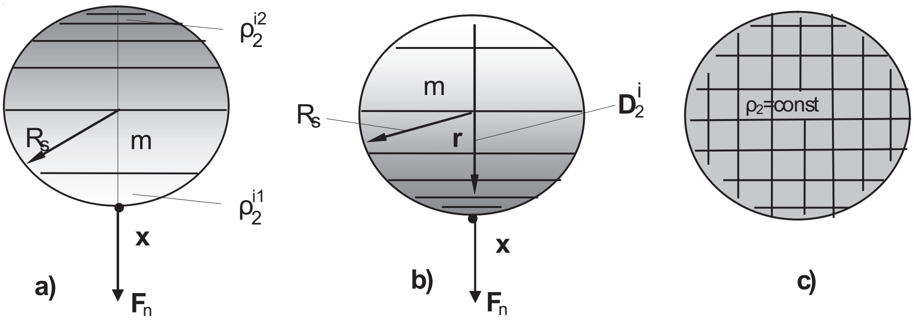

Fig. 3.14. Redistribution of the quantum density of the medium inside the solid as a result of the effect of accelerating force $\mathbf{F}_n$ (a), the formation of the quantised medium in acceleration of the solid (b), and the uniform grid of the quantum density of the medium in the absence of acceleration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

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

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)

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

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.

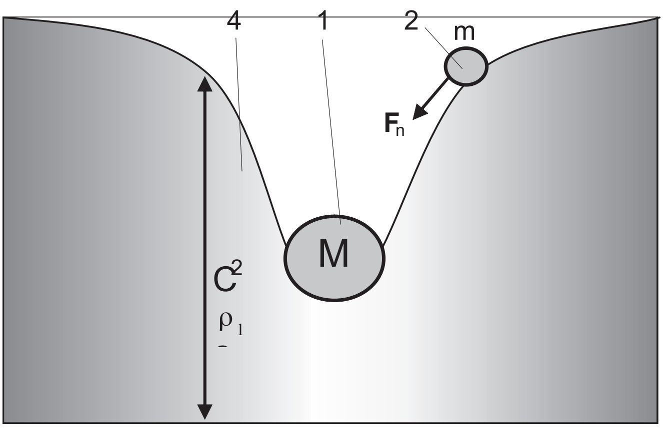

Fig. 3.15. Presence of a gravitational well in the vacuum field around the perturbing mass 1 (M) explains the effect of gravitational force $\mathbf{F}_m$ on the test mass 2 (m).

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

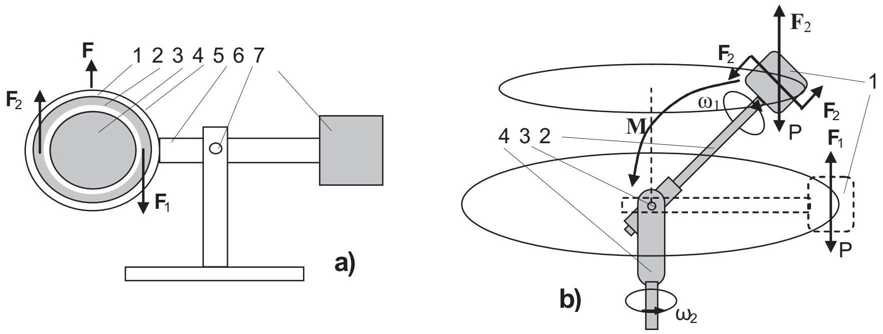

Fig. 3.16. Simple quantum mechanics defects. Reduction or increase of the weight of the flywheel (a); reversed gyroscopic effect (b).

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]

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

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 $v << C_0$, 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)

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

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:

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

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

$$\Delta W = W_a - W_{ka} = mv_0\Delta v \qquad (3.108)$$

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):

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

(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

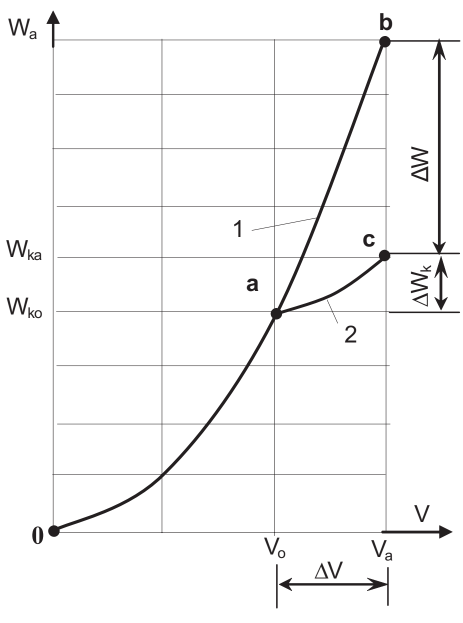

Fig. 3.17. Quadratic dependences of absolute 1 and relative 2 energies of the solid (particle) in relation to speed *v* of motion in the absolute space-time. The bifurcation point - (a).

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:

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

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

$$v^2 = \Delta v^2 + v_0^2 \tag{3.122}$$

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

$$v = \sqrt{\Delta v^2 + v_0^2} \tag{3.123}$$

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

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

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:

$$\varphi_v = \arccos\frac{\Delta v}{v_a} = \arccos\frac{\Delta v}{\sqrt{v_0^2 + \Delta v^2}} = \arccos\frac{\Delta v / v_0}{\sqrt{1 + \dfrac{\Delta v^2}{v_0^2}}} \tag{3.125}$$

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)

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

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 **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

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

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

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

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

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

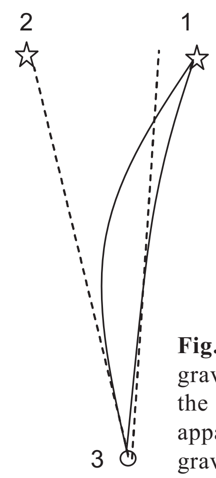

Fig. 3.18. Kozyrev effect of splitting the stellar light source and the gravitational wave as a result of different distortion of the light beam in the beam of the gravitational wave. 1) actual position of the stars; 2) apparent position of the star as a result of distortion of the beam of the gravitational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

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

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

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:

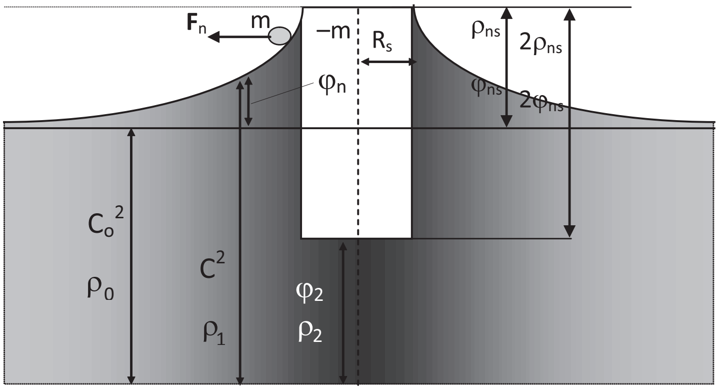

Fig. 3.19. Gravitational diagram of the minus mass and the effect of antigravitation repulsion (rolling from a hillock).

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

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

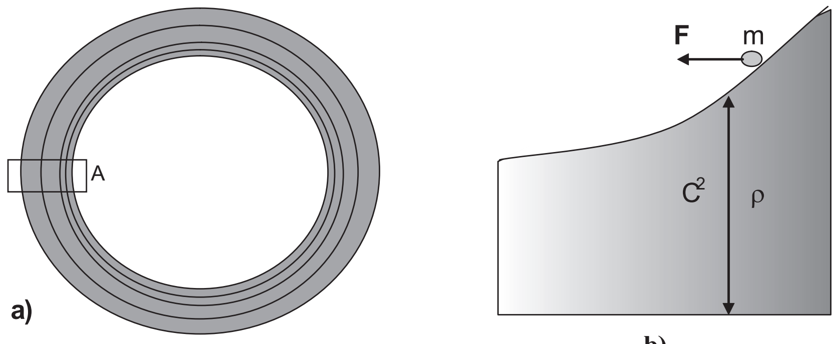

Fig. 3.20. The shell model of the closed universe (a) with the gradient of the quantum density of the medium and antigravitational repulsion of galactics (b).

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

$$V_n = \frac{4}{3}\pi R_s^3 \qquad (3.162)$$

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

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

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)

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

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:

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

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

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

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

$$W_{max} = \frac{C_0^4}{G} R_S \qquad (3.167)$$

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

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

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

where

$$n_0 = \frac{4}{3}\pi R_s^3 \rho_0 \tag{3.170}$$

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 $L_{q0} = 2_{e0} = 2r_{g0}$

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

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)

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

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

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

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

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

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}

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

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

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

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

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

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

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

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

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

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

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

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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4
The quantised structure of the electron and the positron
The neutrino

The quantised structure of the electron and the positron has been investigated in the development of the Superintegration theory. These particles are open quantum mechanical systems and are the compound part of the quantised space-time. The electron (positron) as an elementary particle forms as a result of attraction of the quantons to the central electrical charge placed in the quantised medium. As a result of the spherical deformation of the medium, the electrical charge acquires the mass and transforms into the electron (positron). It has been established that the main factor which ensures spherical deformation of the medium by the electron is its spherical magnetic field, an analogue of the spin. In annihilation of the electron and the positron the spherical magnetic field is disrupted and the energy of the spherical deformation of the medium, i.e., the energy of the mass defect, is released and transforms into radiation gamma quanta. The released massless charges merge into an electrical dipole, forming the electron neutrino, an information bit indicating that the pair of the particles electron and positron did exist. It has also been found that the movement of the electron (positron) in the superelastic and superhard quantised medium is determined by the wave transfer of mass and tunnelling of the point electrical charge in the channels between the quantons of the medium.

4 .1. Introduction

This study is a continuation of [1,2] concerned with the theory of Superintegration with special reference to investigations of the structure of the electron and the positron. Regardless of the fact that these particles have been studied extensively experimentally [3], the structure has been described for the first time by the theory of Superintegration of fundamental interactions.

The electron was discovered by G.G. Thomson in 1897. The properties of the electron: charge $x = -1.6 \cdot 10^{-19}$ C, rest mass $m_e = 0.91 \cdot 10^{-30}$ kg (0.511 MeV) or magnetic moment $\mu_e = 1.0011\ \mu_B$ (μ_B is the Bohr magneton), the radius (classic) $r_e = 2.82 \cdot 10^{-15}$ m, spin $\frac{1}{2}\hbar$ ($\hbar$ is the Planck constant), stable, lifetime $\tau > 2 \cdot 10^{22}$ years [4]. The positron is an anti-particle in relation to the electron and is characterised by the presence of an electrical charge with positive polarity $e = +1.6 \cdot 10^{-19}$ C. The positron was predicted by Dirac in 1931 and discovered a year later by Anderson [5].

Regardless of the fact that the electron and the positron belong to the main elementary particles, their structure remained unclear until the discovery of the quanton and the SEI. Firstly, the quantised structure of the electron (positron) was described in [6] and subsequently in [7, 8, 9]. Later in cases in which there are no principal differences between the particles we shall use the term electron, indicating that we mean the positron. It has been found that the electron is an open quantum mechanical system, representing the compound part of the quantised space-time. The electron is the carrier of the electrical monopole (massless) elementary charge and mass.

It has been found that the mass of the electron is a secondary formation as a result of spherical deformation of the quantised space-time around the central monopole charge and determines its quantised structure. Secondly, the movement of the electron in the superelastic and superhard quantised medium is investigated as a wave process of mass and corpuscular transfer of the monopole electrical charge, governed by the principle of corpuscular-wave dualism. In the quantised space-time, the electron is a wave energy bunch consisting of quantons around a central charge in the form of a particle-wave whose wave and corpuscular properties have been investigated by experiments [6–9].

The transfer of mass of any elementary particle, including the electron, should be regarded as the wave transfer of the energy of spherical deformation of the quantised space-time. It has been found that the mass of the elementary particle is equivalent to the energy of a single constrained gravitational wave of the soliton type whose speed is determined by the speed of the electron under the effect of inertia, and varies in a wide range from 0 to the speed of light C_0. In contrast to the transverse electromagnetic wave, the gravitational wave moves in the longitudinal direction and is associated with the displacement in the quantised space-time of its compression and rarefaction zones. It can be assumed that the free gravitational wave of the longitudinal type, not connected with the mass of the particle, has the speed determined by the speed of light [2].

It has been found that the electron does not have any distinctive gravitational boundary in the quantised medium, like the proton and the neutron [10]. The conventional gravitational boundary of the electron can be denoted by its classic radius $r_e = 2.82 \cdot 10^{-15}$ m. In addition, the quantised structure of the electron contains characteristic zones: the rarefaction zone (this is the zone of gravitational attraction), the conventional gravitational boundary, the compression zone of the medium (the zone of gravitational repulsion). In this book, the zone of gravitational repulsion of the electron is analysed for the first time.

As a result of the quantised structure of the electron, its mass may disintegrate as a result of the mass defect when the orbital electron is capable of emitting a photon. The structure of the photon has been studied in detail in [3], but the problem of investigation of the orbital electron is not discussed in this book because it is not connected with the electron and instead it is connected with the atom nucleus forming an electron–nucleus quantum system, with the unique properties.

Naturally, analysis of the structure of the electron and the positron is directed to the development of quantum considerations of the nature of matter in which the elementary particles are of the quantised form not representing matter 'in itself'', isolated from the quantised space-time. The idea that the elementary particle is an integral part of the quantised space-time is not a new one. In this context, the name of the English theoretical physicist and mathematician Joseph Larmor (1857–1942), a member of The London Royal Society and its vice president, has been unjustifiably forgotten. I managed to get acquainted with his monograph 'Aether and matter' [11], published in 1900 (and only with the Russian translation of a part of this book [12]).

Larmor regarded elementary particles as a unique singularity point in the ether forming the stress (tension) nucleus of the ether. This local tension nucleus is capable of moving in the elastic ether irrespective of whether the ether itself moves or is in the rest state. The Larmor particle is an integral compound part of the ether. However, not knowing the structure of ether, Larmor could not derive accurate equations to describe the tension nucleus which he predicted. In this book, we examine the problems of tensioning of the quantum space-time by the electron.

Modern physics of elementary particles does not know the structure of any of the known elementary particles, regardless of the large amount of data accumulated from studies of the properties. The reasons for this low efficiency in this elite area of science which is the physics of elementary particles and the atomic nucleus is that all the theoretical investigations of the structure of vacuum, i.e., quantised space-time [1], were 'frozen' throughout the second half of the 20th century.

It should be mentioned that the investigations of the structure of vacuum represent the priority area of theoretical physics. The experimental data collected in the first half of the 20th century were sufficient to discover the quanton and the superstrong electromagnetic interaction (SEI). This could have been carried out by Larmor, Einstein, and others.

For the reason unknown, this did not take place, although everything was ready: the Maxwell equations were accepted, Einstein formulated the concept of the distorted space-time, the Larmor singularity was established, Dirac magnetic monopoles were described. However, some mystic fate governed the physics of the 20th century, moving it away from the discovery of superstrong electromagnetic interaction.

Experimental investigations carried out in accelerators have made it possible to discover a huge number of elementary particles whose main mass is unstable. Classification carried out on the basis of indirect features of the particles is highly difficult and imperfect. Regardless of the enormous expenditure associated with the development of more powerful accelerators the results were not very successful because they did not make it possible for physics to come close to describing the structure of stable and main particles, such as: electron, positron, proton, neutron, neutrino, photon, regardless of extensive studies of their properties [13].

Saturation took place in which the discovery of all new particles in the accelerators does not move the physics closer to identifying their structure. Experimental physics accumulated a sufficiently large volume of information on the properties of the particles and now it was the turn of theoretical physicists to systematise correctly and analyse this information. In this respect, the theory of EQM and TEEM (theory of the united electromagnetic field) as quantum theories provide the most powerful analytical apparatus for investigating the structure of elementary particles.

The theory of EQM adds the quanton to the elementary particles as the most stable and most widely encountered particle in the universe and determining the fundamental role of the quanton and electrical monopoles charges in the structure of elementary particles. Being the compound part of the quantised medium, all the elementary particles are quantised in their principle.

The electron is the key particle in the physics of elementary particles. Understanding its structure in the quantised medium opens a path to investigating the structure of the electronic neutrino, nuclons, and also many other elementary particles. Undoubtably, the electron is one of the main particles which take active part in energy exchange processes, namely:

- photon emission of the orbital electron in the atom provides a wide spectrum of radiation, including the visible range;
- conduction electrons represent the basis of electrical engineering and power engineering, including superconducting power engineering of future;
- conduction electrons result in disruption of the magnetic equilibrium of the quantised medium in electromagnetic processes;
- accelerated and retarded electrons generate x-ray radiation;
- annihilation of the electrons results in the formation of gamma quanta;
- the orbital electrons are included in the composition of the atoms;
- valence electrons determine the molecular bonds;
- it may be possible to analyse electron–positron cycles as new sources of ecologically clean energy [9, 14].

This multifaceted nature of the electron is directly linked with its unique structure inside the quantised medium. The theory of Superintegration discovers the structure of the electron indicating the presence of several energy bands in the electron responsible for both the formation of its gravitational field and the hidden energy and mass. However, only the gravitational field of the electron, together with its electrical field, is responsible for the entire emission spectrum of the electron. The gravitational field also determines the gravity field of the electron.

However, in addition to the gravity field, the region of gravitational repulsion has been discovered in the electron, i.e., a very narrow band of the effect of antigravitation. In particular, the presence of this zone does not enable the electron to fall on the atom nucleus and is repulsed from it over a short distance of the order of 10^{-15} m and determines the stability of the electronic orbit. The spherical magnetic field was determined for the first time in the electron. This field is the physical analogue of the spin responsible not only for the formation of the electron mass but also for its unique properties. Most importantly, the electron on the whole has a unique structure because of which energy exchange processes take place between the electron and the quantised medium.

Prior to the discovery of the Superintegration theory, the electron was regarded as a free particle separated from the space-time which was not its compound part. This erroneous conclusion was based on the concept of the clearly defined material world in Newton mechanics. The material world was regarded as synonymous only with matter, i.e., with the mass, as an independent category not linked with anything. It was assumed that the mass itself is something firm representing the primary material.

Charges were introduced into physics with the development of electrodynamics. The concept of the absolute material world of the Newton mechanics was shaken. The following dilemma arose: 'what was the first, charges or mass?' A compromise variant, treating the charge and the electron mass as a single formation, was introduced. The theory of relativity was used to determine the dependence of mass on speed but could not explain this phenomenon.

Later, Dirac introduced the concept of the magnetic monopole (charge). By analogy with the electron, the magnetic monopole was attributed its intrinsic mass. However, the search for the magnetic monopole and its mass did not yield any results. The EQM theory shows that the magnetic monopole cannot exist in the form of a free particle and, correspondingly, have mass. The magnetic charge is tied in the structure of the quanton which can be separated into individual charges [1].

In addition to two magnetic monopoles, the quanton includes two electrical monopoles. The quantum combines electricity and magnetism into electromagnetism. The concept of the monopole has been widened, and in the EQM theory the monopole is represented by the mass-free charge, not only magnetic but also electrical. In particular, the structure of the monopole includes a point charge (electrical and magnetic) whose theory has also been developed further [1].

Undoubtebly, the role of the quantised space-time, as initial primary matter, is fundamental in explaining the structure of elementary particles, including the electron. If a massless electrical elementary charge with negative polarity is injected into the quantised space-time, then under the effect of the radial electrical field of the charge the quantons in the medium start to be pulled to the charge, spherically deforming the quantised space-time. The massless electrical charge acquires mass and transforms into the elementary particle, i.e., the electron, the carrier of electrical charge and mass.

The problem of formation of the quantised structure of the electron is the subject of this work.

4 .2. Classic electron radius

All the experimental investigation showed that electron appears not to have a distinctive gravitational boundary in the quantised space-time unlike, for example, proton or neutron. The electron is regarded as a particle similar to a point formation. However, for the particles with a small radius, the decrease of the radius of the point particle to zero increases its energy to infinity. This created the problem of the infinite energy of the point charge which was temporarily solved by classic radius r_e, restricting the rest energy of the electron to 511 MeV which corresponds to the experimental measurements.

The classic radius of the electron r_e is the calculation parameter obtained by equating rest energy W_0 of the electron $m_e C_0^2$ to its electrical energy W_e as the energy of the field of the point source at the distance r_e [1, 2]

$$W_o = \int_0^{C_o^2} m_e d\varphi = m_e C_o^2 \tag{4.1}$$

$$W_e = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r_e} = m_e C_0^2 = 0.82 \cdot 10^{-13}\,\text{J} = 0.511\ \text{MeV} \tag{4.2}$$

where

$$r_e = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{m_e C_0^2} = 2.82 \cdot 10^{-15}\,\text{m} \tag{4.3}$$

A sphere with radius r_e carries the electrical potential φ_{ere}

$$\varphi_{ere} = \frac{1}{4\pi\varepsilon_0} \frac{e}{r_e} = \frac{m_e C_0^2}{e} = 0.511\ \text{MeV} \tag{4.4}$$

The value of the potential (4.4) for a nonrelativistic electron determines the potential barrier inside the quantised medium. All the external energy exchange processes of the electron take place in the zone outside the limits of the potential barrier, and there is a ban on penetration inside the barrier.

The well-known solutions of (4.2), (4.3) and (4.4) have contradictions. In particular, the introduction of radius r_e suggests the presence of an equipotential sphere with a potential of 0.511 MeV (4.4) which contains the point electrical charge of the electron which accumulates around itself a colossal hidden energy, greatly exceeding 0.511 MeV. In particular, this hidden energy is found outside the limits of the potential barrier, with the approach of the nonrelativistic electron to this energy forbidden.

However, it is important to indicate the reasons for the formation of the hidden energy of the electron and the ban for the release of the energy in the rest state. Taking into account the fact that the internal sphere of the electron with a radius r_e is filled with quantons, the Superintegration theory allows to penetrate into its forbidden internal region beyond the potential barrier of 0.511 MeV. We can approach hypothetically the very point charge of the electron, penetrating into the region of superstrong interactions between the point charge of the electron and the quantised medium. However, the presence in the electron of the point charge carrying colossal energy should not contradict the observed facts according to which the energy which the nonrelativistic electron exchanges with the external world outside the limits of the classic radius r_e, should not exceed 0.511 MeV.

4.3. Gravitational boundary of the electron

Regardless of the assumption that the electron does not appear to have a distinctive gravitational boundary in the quantised medium, the classical radius r_e (4.3) will be regarded as the gravitational boundary. This has a clear physical meaning. The electron, being the carrier of not only the electrical charge but also of the mass, has a gravitational field. In a general case, the gravitational field of the nonrelativistic electron should be represented by the well-known function of distribution of gravitational potentials φ_1 and φ_2 as a result of solving the Poisson equation [2]

$$\begin{cases} \varphi_1 = C^2 = C_0^2\left(1 - \dfrac{R_g}{r}\right), & r > r_e \\ \varphi_2 = C_0^2\left(1 + \dfrac{R_g}{r}\right), & r < r_e \end{cases} \tag{4.5}$$

The gravitational field of the electron can also be represented by the distribution function of the quantum density of the medium ρ_1 and ρ_2 in the form $f(1/r)$, i.e., in inverse proportion to the distance from the central charge. However, since the quantum density of the medium is the equivalent of the gravitational potential, from function (4.5) of the gravitational potentials one can always transfer to the function of the quantum density of the medium [2].

Because of the absence of the distinctive gravitational boundary in the solution (4.5) we can regard the classic radius r_e (4.3) of the electron as the conventional spherical boundary of the electron within which the quantum density of the medium ρ_2 and gravitational potential φ_2 increase on approach to the central electrical charge of the electron. In fact, if we introduce into the quantised medium a monopole electrical charge which has no mass and is a carrier of the radial electrical field, then under the effect of ponderomotive forces acting on the electrical dipoles of the quantons the quantons start to be pulled to the central charge increasing the quantum concentration and the gravitational potential φ_2 (4.5) around the charge.

Since the quantised medium is an elastic medium, constriction of the quantons in the central charge of the electron is possible only in the local region restricted by the conventional gravitational boundary with radius r_e. The increase of the quantum density of the medium ρ_2 inside the conventional gravitational boundary of the electron can take place only as a result of reducing the quantum density of the medium to the value φ_1 outside the limits of this boundary. The function of the potential φ_1 (4.5) describes the distribution of the gravitational potential of action *C* (4.4) on the external side of the gravitational radius of the electron r_e.

The distinguishing feature of the gravitational field of the electron is that the potential function φ_2 (5) should transfer smoothly to the potential function φ_1 (4.5), without any distinctive 'jumps' of the conventional gravitational boundary with radius r_e. Consequently, ignoring the small gravitational perturbation of the quantised medium around the point charge of the electron we can write the distribution of the electrical potential φ_e of the electron in the form of a continuous function with the universally proportional dependence on distance $f(1/r)$

$$\varphi_e = \frac{1}{4\pi\varepsilon_0}\frac{e}{r} = f(1/r) \tag{4.6}$$

The continuity of the function φ_e (4.6) of the electrical potential of the electron, together with the functions φ_1 and φ_2 (4.5) of the distribution of the gravitational potentials, are the fundamental dependences for analysis of the fields and structure of the electron. Another important parameter of the electron is its rest mass m_e included in the dependence (4.5) through the value of the gravitational radius R_g of the electron [2]

$$R_g = \frac{Gm_e}{C_0^2} = 6.74 \cdot 10^{-58}\,\text{m} \tag{4.7}$$

As indicated by (4.7), the gravitational radius R_g of the electron is only a calculation parameter because the electron is not a collapsing gravitation object. It should be mentioned that gravitational radius R_g, being the parameter of the collapsing object, characterises the maximum compression of the quantised space-time which in the case of the quanton should not exceed the value 0.8 L_{q0}, where $L_{q0} = 0.74 \cdot 10^{-25}$ m is the quanton diameter.

Taking into account that the quanton diameter L_{q0} is approximately 10^{-25} m, the gravitational radius R_g of the electron is of the order of 10^{-58} *m* and cannot characterise the maximum compression of the quantised medium. The gravitational radius R_g for the electron has a completely different physical meaning.

The system (4.5) can be described by the united function $f(\pm 1/r)$ in the form of the function of the curvature of space-time $f(\pm R_g/r)$ [2]

$$\varphi_{1-2} = C_0^2\left(1 \pm \frac{R_e}{r}\right) = f(\pm 1/r) \tag{4.8}$$

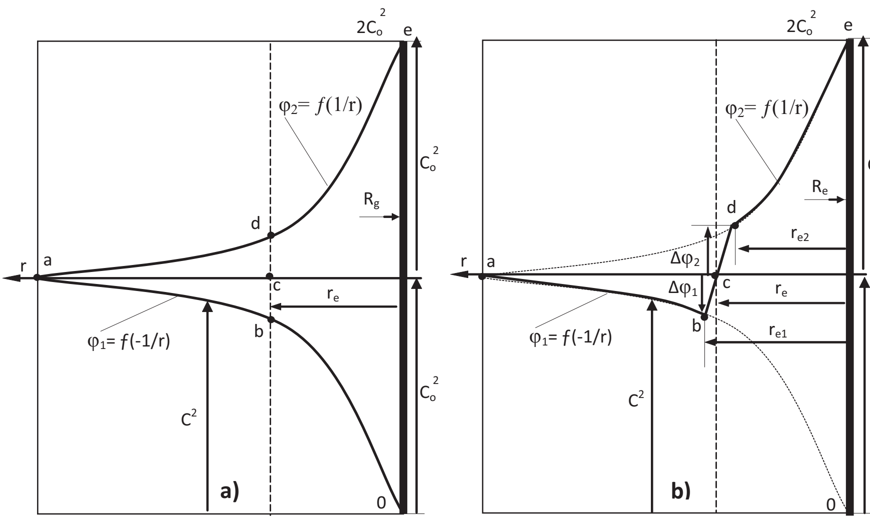

Fig. 4.1. Distribution of the gravitational potential of the electron in the form of the function $f(\pm 1/r)$ (8) (a) and combination of the functions on the gravitational diagram (b).

Figure 4.1 shows graphically the function $f(\pm 1/r)$ (4.8) and (4.5) of the distribution of the gravitational potential of the electron by two curves: $\varphi_1 = f(-1/r)$ and $\varphi_2 = f(+1/r)$ which are symmetric in relation to the level of the gravitational potential C_0^2 of the unperturbed space-time. The vertical axis of the diagram gives the gravitational potential and the horizontal axis the distance r from the centre of the electron.

The radius of the point electrical charge, situated in the centre of the electron, can be described by gravitational radius R_g. In accordance with (4.8) at $r = R_g$ we determine the range of gravitational potentials for the electron: $0...2\,C_0^2$. It should be mentioned that this range of the gravitational potentials fully characterises the energy state of the electron. The curve $\varphi_1 = f(-1/r)$ is in the range $0...C_0^2$, and the curve $\varphi_2 = f(+1/r)$ is in the range $C_0^2...2\,C_0^2$.

The curves (Fig. 4.1a) show the characteristic points. The general point (a) is situated at a large distance from the centre of the electron up to infinity and characterises the level of the gravitational potentials C_0^2 of the non-perturbed quantised medium. The points (b) and (d) are situated on the sphere defined by the classic radius r_e (3) of the electron. In the direction of the path (a-b-o) the curve $\varphi_1 = f(-1/r)$ decreases to the zero level 0 at $r = R_g$. If we travel along the path (a-d-e), the curve $\varphi_2 = f(+1/r)$) rises to the level $2\,C_0^2$ at $r = R_g$.

Levels of the gravitational potentials 0 and $2C_0^2$ are characteristic of the object in the condition of a black microhole [2]. However, the zero level of the potential 0, as already mentioned, relates only to collapsing objects to which the electron does not belong. The zero level of the gravitational potential of action C cannot be the parameter of the nonrelativistic electron.

Therefore, the level of the potential $2C_0^2$ is fully realistic for the electron, characterising the point charge. However, the level of the potential $2C_0^2$ also characterises the black microhole. In this respect, the electron appears to be partly in the condition of the black microhole. However, it would not be correct to refer to the electron as the half of the black microhole because a distinctive property of the black hole is the presence of a discontinuity in the quantised medium at the zero gravitational potential. The electron is an energy bunch of deformation of the quantised medium. This corresponds to the true condition of the electron, taking into account that the energy bunch is determined by the Larmor singularity, as the spherical deformation tension of the quantised medium.

To determine the unified function $f(\pm 1/r)$ of the distribution of the gravitational potential of the electron, it is necessary to determine the extent to which the classic radius of the electron r_e (4.3) can correspond to the artificially formed gravitational boundary in the medium. In fact, if we travel along the path (a–b–c–d–e) (Fig. 4.1a), the curve defined in the zone (b–c–d) shows a jump of the gravitational potential exactly at the boundary defined by the classic radius of the electron r_e.

It may be assumed that the curve (a–b–c–d–e) also represents the distribution of the gravitational potential of the electron in the quantised medium, but this curve is not continuous and is segmented, with the individual sections connected together by the classic radius r_e. It may be seen that the point charge of the electron, which initially does not have a distinctive boundary R_S capable of compressing the quantised medium in the formation of the particle mass, creates in the final analysis the gravitational boundary artificially at $R_S = r_e$.

It is now necessary to verify the extent to which the artificially gravitational boundary corresponds to reality. We assume in the first approximation that the deformation energy of the quantised space-time in the section (a–b) corresponds to the rest energy of the electron m_eC^2, where C^2 is the gravitational action potential, J/kg. To confirm this assumption, we use the function $\varphi_1 = f(-1/r)$ (4.5) in the section (a–b), expressing the gravitational radius R_g (4.7) through the Newton potential $\varphi_n = -C_0^2 R_g/r$ [2]:

$$\varphi_1 = C^2 = C_0^2\left(1 - \frac{R_g}{r}\right) = C_0^2 - \varphi_n \tag{4.9}$$

Equation (4.9) represents the balance of the gravitational potentials of the electron. We multiply (4.9) by the rest mass of the electron m_e and write the distribution function of the energy of the quantised space-time as a result of its perturbation by the electron mass:

$$m_e C^2 = m_e C_0^2 - m_e \varphi_n \tag{4.10}$$

Equation (4.6) is the balance of the energy of the nonrelativistic electron for the external region of the spherically deformed space-time. As indicated by (4.10), the electron energy $m_e C^2$ at the point (b) at the radius r_e is smaller than $m_e C_0^2$ (4.2) by the value $m_e \varphi_n$. This means that the well-known equation (4.2) is not suitable for describing the gravitational boundary of the electron by its classic radius r_e.

In order to correct the gravitational boundary of the electron, we introduce the additional classic radius r_{e1} at the point (b) when the energy (4.10) corresponds to the electrical energy W_e at the radius r_{e1}:

$$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{e1}} = m_0 C_0^2 - \frac{G m_0^2}{r_{e1}} \tag{4.11}$$

From (4.11) we determine the radius of the electron r_{e1}:

$$r_{e1} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{m_0 C_0^2} + \frac{G m_0}{C_0^2} \tag{4.12}$$

Equation (4.12) includes the classic radius r_e (4.3) and its gravitational radius R_g (4.7) [7]

$$r_{e1} = r_e + R_g \tag{4.13}$$

The same method is used to determine another additional radius r_{e2} of the electron at the point (*d*):

$$r_{e2} = r_e - R_g \tag{4.14}$$

Figure 4.1b shows the corrected gravitational boundary in the section (b-c-d) of the electron which is now characterised by three radii r_{e1}, r_e, r_{e2}. The radii r_{e1} and r_{e2} differ from the classic radius r_e by the value of the gravitational radius R_g (4.7) whose value is 10^{42} times lower than r_e

$$\frac{r_e}{R_g} = \frac{1}{4\pi\varepsilon_0 G}\left(\frac{e}{m_0}\right)^2 = 4.2\cdot 10^{42} \qquad (4.15)$$

It would appear that, taking into account the small dimensions of the gravitational radius R_g in comparison with the classic radius r_e (4.15) of the electron, the radius R_g in equation (4.13) and (4.14) can be ignored. However, this would not be correct in relation to the gravitational boundary (b-c-d) of the electron when the 'jump' of the gravitational potential $\Delta\varphi$ at the radius Δr characterises the gravitational boundary of the electron as the zone of gravitational repulsion with the strength **a** of the gravitational field of the electron

$$\Delta\varphi = \Delta\varphi_1 + \Delta\varphi_2 \approx 2\varphi_n = \frac{2Gm_0}{r_e} = 4.3\cdot 10^{-26}\,\mathrm{m}^2/\mathrm{s}^2 \qquad (4.16)$$

$$\Delta r = r_{e1} - r_{e2} = 2R_g = \frac{2Gm_0}{C_0^2} = 1.35\cdot 10^{-57}\,\mathrm{m} \qquad (4.17)$$

$$\mathbf{a} = -\frac{\Delta\varphi}{\Delta r}\mathbf{1}_r = -\frac{C_0^2}{r_e}\mathbf{1}_r = -3.19\cdot 10^{31}\,\mathrm{m/s^2}\cdot\mathbf{1}_r \qquad (4.18)$$

Unit vector $\mathbf{1}_r$ in (4.18) indicates that the vector of strength **a** (free repulsion acceleration of the zone of the gravitational boundary) is directed along the radius r, and the sign (–) indicates that the vector **a** of the strength of the field characterises the forces of gravitational repulsion from the electron. The region (d-e) also characterises the repulsion zone. The discovery of the zones of repulsion of the electron explains reasons for its stability in the atom when the repulsion forces prevent the orbital electron from falling onto the atom nucleus. An exception is electronic capture in which the atom nucleus is capable of trapping an electron as a result of the specific features of the alternating shells of the nuclons [10].

Thus, the gravitational boundary of the electron is characterised by four radii r_{e1}, r_e, r_{e2} and R_g and determines the zone of gravitational repulsion with very high strength (4.18) of the anti-gravitational field. Some processes of the action and reasons for antigravitation in the quantised medium have already been investigated in [7, 15].

4 .4. Electrical radius of the electron

As already mentioned, the gravitational radius R_g of the electron (4.7) is a calculation parameter. On the other hand, the appearance of R_g in (4.13) and (4.14) is not accidental. We replace the gravitational radius R_g by the concept of the electrical radius of the electron R_e, $R_e = R_g$:

$$R_e = R_g = \frac{Gm_e}{C_0^2} = 6.74 \cdot 10^{-58}\,\text{m} \tag{4.19}$$

This replacement is it makes it possible to characterise the electron charge as the point source of the electrical current. Consequently, the electrical radius of the electron R_e is not connected with the collapse of matter and refers to some very small sphere with a very high electrical potential φ_e

$$\varphi_e = \frac{1}{4\pi\varepsilon_0}\frac{e}{R_e} = 2.14 \cdot 10^{42}\ \text{MeV} \tag{4.20}$$

In [1], the equations of the electromagnetic field in the vacuum were derived for the case of displacement of the points charges inside a quanton. In this case, even in the region of strong electrical fields, the displacement of the charges is very small and equals approximately 10^{-62} m. It appears that the displacement of the charges inside the quanton by the value of the order of 10^{-62} m is closer to the electrical radius R_e (4.19) of the electron of the order of 10^{-58} m in comparison with its classic radius of the order of 10^{-15} m.

In the region of the ultra microworld, the distances of the order of 10^{-58}...10^{-62} m are working distances. The quanton diameter is approximately 10^{-25} m [1]. This is also incomparably larger in comparison with the electrical radius of the electron R_e (4.19). Naturally, the size of the point charge of the electron is one of the important parameters in the electron theory. The EQM theory already examines the point charge included in the composition of the monopole. Previously, it was its established that the nucleus of the electrical monopole in the composition of the quanton is estimated by the radius of $r_k \sim 10^{-27}$m (2.95) [1]. However, even this radius evidently does not solve the problems of the dimensions of the point source of the electron charge which is included in the sphere with radius r_k. At the moment, the size of the point charge of the electron is estimated by its electrical radius R_e of the order of 10^{-58} m.

Undoubtedly, the development of electron theory should be accompanied by the development of monopole theory, both electrical and magnetic, for example, investigating the zones of mutual attraction and repulsion. The fact that the monopoles in the composition of the quanton cannot collapse into a point was explained by the elastic properties of the monopoles. Now we can explain the elastic properties of the monopoles by the presence of repulsion zones between them. If the monopoles are introduced monotonically into the composition of the quantum, combining electricity and magnetism into a single substance [1], then the point electrical charge in the composition of the electron behaves as if it were independent of the monopole and represents a point formation that is free in the quantised space-time.

Finally, it would be ideal to show that the electrical monopole with the diameter of half the quanton diameter of 0.5 L_{q0} of the order of 10^{-25} m and also including the point charge [1] is also completely included in the structure of the electron representing its central charge. However, this contradicts the capacity of the electron to move freely in the quantised space-time. The close-packed quantons in the structure of the space-time represent a superhard elastic medium. The electrical monopole with the diameter of half the quanton diameter would be evidently compressed by the quantised medium preventing it from moving.

However, treating the electron charge as a point formation with very small dimensions with a radius R_e (4.19) of the order of 10^{-58} m, the problem of movement of the electron in the quantised medium can be solved by the tunnelling of the point charge between the quantons. The quantons, being spherical particles, form gaps between each other in the formation of the superhard quantised medium and these gaps are regarded as channels through which the point charge is transferred in the quantised medium [1].

In this respect, the properties of the monopole tied inside the quanton, should differ from the properties of the free point electrical charge with a radius R_e which forms the structure of the electron in the quantised medium. As shown by the analysis of electromagnetic processes in vacuum, the parameters of the quantised medium inside the quanton and between the quantons are characterised by the well-known constants, electrical ε_0 and magnetic μ_0.

This means that the gap between the quantons is an analogue of a hole in a solid when the point charge of the electron during its movement tunnels from one hole to another. The electrical and gravitational fields of the electron are transferred in the quantised medium in this case. The transfer of the gravitational field of the electron is accompanied by the wave transfer of mass as spherical deformation of the quantised medium around the point electrical charge.

The problems of tunnelling in space-time are not new in theoretical physics. Stephen Hawking, the well-known astrophysicist, has suggested the possibilities of tunnelling through space-time of even large cosmological objects of the type of black hole, assuming the presence of unique tunnels (wormholes) in space-time [16]. In this case, the very appearance of this concept is very important.

However, in any form, tunnelling is possible only in the presence in the quantised medium of channels formed by gaps between the quantons. Another essential condition of tunnelling is the quantised structure of any objects, including elementary particles, capable of displacement in the superhard quantised medium as a result of the wave mass transfer and tunnelling of point charges through the quantised medium.

In this respect, the electrical radius R_e (4.19) of the electron as a point formation satisfies all conditions of tunnelling in movement of the electron in the quantised medium. On the other hand, the small dimensions of the electrical radius determine the colossal concentration of energy around the point charge of the electron.

4.5. Hidden energy and electron mass

The small dimensions of the electrical radius R_e (4.19) of the electron concentrate the colossal electrical potential and energy around the point charge. The limiting value of the electrical potential $\varphi_{e\max}$ (4.20) of the electron on the sphere with a radius R_e (4.19) can be reduced to the form including the classic radius of the electron r_e (4 .3):

$$\varphi_{e\max} = \frac{1}{4\pi\varepsilon_0}\frac{e}{R_e} = \frac{C_0^4}{eG} r_e = 2.14 \cdot 10^{42}\ \text{MeV} \tag{4.21}$$

Evidently, being the carrier of such a high electrical potential (4.20), (4.21), the point charge of the electron polarises the quantised medium surrounding the electron. Electrical energy W_{ev} of the polarisation of the volume V of the quantised medium by the point charge of the electron can be determined on the basis of the previously derived expression [1] for the volume density of the energy of the vacuum polarised by the external electrical field

$$W_{ev} = \iiint\limits_V \frac{1}{2}\varepsilon_0 E^2 dV = \int_\infty^r \frac{1}{2}\varepsilon_0 E^2 (4\pi r^2) dr \tag{4.22}$$

Because of the spherical symmetry of the field of the point charge, the volume integral (4.22) has been transformed into the integral in the direction r. Into (4.22) we substitute the function of the strength of electrical field of the point charge in vacuum and determine energy W_{ev} of electrical polarisation of the quantised medium by the point charge of the electron:

$$W_{ev} = \frac{1}{2}\int_\infty^r \varepsilon_0 E^2 (4\pi r^2) dr = \frac{1}{2}\int_\infty^r \varepsilon_0 \left(\frac{1}{4\pi\varepsilon_0}\frac{e}{r^2}\right)^2 (4\pi r^2) dr = -\frac{1}{8\pi\varepsilon_0}\frac{e^2}{r} \tag{4.23}$$

The (–) sign in (4.23) is connected with mathematical transformations and can be disregarded when evaluating the value of energy. It is important for evaluating the direction of the interaction force, as a derivative of (4.23). The signs (+) and (–) are also important in the energy balance (4.20). On the other hand, it is well known that the total electrical energy W_e of the electron is determined by the expression (4.2) and is twice the energy W_{ev} (4.23) of electrical polarisation of the medium by the electron

$$W_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r} \tag{4.24}$$

It would appear that the total energy of the electron (4.24) should be fully used in the electric polarisation of the quantised medium, equating (4.23) and (4.24). However, this does not take place. It is not surprising because, as shown later, the other half of the electron energy is represented by the energy of magnetic polarisation of the quantised medium, determining the spherical magnetic field of the electron, the analogue of the spin [7, 8, 9].

For this reason, the physical nature of the equation (4 .24) has not as yet been completely determined. In accordance with (4.24), on approach to the point charge the energy of the latter increases. There is also some indeterminacy in this. It appears that if the charge is surrounded by a sphere, then as the size of the sphere decreases, the energy concentrated inside the sphere increases and determines the colossal energy concentration. However, equation (4.24) is not linked directly with the volume energy and determines the energy of the point charge as a formation independently isolated from the medium. However, the Superintegration theory shows that the electron is not an independent formation and should be regarded as part of the quantised medium.

In order to solve the resultant contradictions, it is necessary to clarify the principle of the equation (4.24), taking into account the effect of the quantised medium on the energy processes associated with the behaviour of the point charge of the electron in the medium. As a result of the interaction of the electrical field of the point charge of the electron with the quantised medium, the energy processes are characterised by polarisation of the quantised medium.

If any sphere surrounding a point charge is defined in the quantised medium, then in accordance with the Gauss theory the surface charge is induced on the surface of the sphere and the total surface charge is equal to the charge of its electron. Naturally, this is an artificial approach which, however, makes it possible in analysis of the energy of interaction of the point charge with the quantised medium to carry out calculations using the method of the probe charge and the method of imaging the probe charge on the spherical surface.

Consequently, the total energy of polarisation of the quantised medium by the point charge can be determined by the work of transfer of the probe charge e from infinity with the zero potential to the sphere with the electrical potential φ_e

$$W_e = \int_0^{\varphi_e} e d\varphi = e\varphi_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r} \tag{4.25}$$

It may be seen that the expression for the total energy (4.25) of polarisation of the quantised medium by the point charge is equivalent to the total energy of the electron (4.24). This means that the expressions (4.24) and (4.25) do not determine the energy of the electron inside some sphere with radius r and they determine the polarisation energy of the quantised medium by the electron charge outside the sphere with radius r in the range from ∞ to r. Therefore, on approaching the point charge, in accordance with (4.25), the energy of polarisation of the quantised medium increases and, consequently, the electron energy also increases.

Using equation (4.25), we determine the concentration of energy in the unit volume of the quantised medium for the electron

$$\frac{dW_e}{dV} = \frac{d\left(-\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}\right)}{d\left(\frac{4}{3}\pi r^3\right)} = \varepsilon_0\left(\frac{1}{4\pi\varepsilon_0}\frac{e}{r^2}\right)^2 = \varepsilon_0 E^2 \tag{4.26}$$

The complex derivative (4.26) with respect to volume is taken by replacing the variable $r^3 = x$

$$\frac{d(1/r)}{dr^3} = \frac{d(1/x^{\frac{1}{3}})}{dx} = -\frac{1}{3x^{\frac{4}{3}}} = -\frac{1}{3r^4} \tag{4.27}$$

Returning to the initial variable r (4.27), from (4.26) we obtain that the concentration (volume density) of the energy around the point charge of the electron is twice the volume density of the energy of electrical polarisation of the quantised medium. This again confirms that in addition to electrical polarisation of the quantised medium, the electrical field of the electron carries out additional energy effects with the quantised medium causing, as shown later, magnetic polarisation of the medium which is hidden because of a number of reasons.

Thus, equation (4.25) makes it possible to calculate the total energy of polarisation of the quantised medium performed by the point charge of the electron. In the limiting case, the total energy W_{max} [2] of polarisation of the quantised medium by the point charge of the electron is determined from (4.27) by the region of the space from infinity to $r = R_e$ (4.19)

$$W_{\max} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{R_e} = \frac{C_0^4}{G} r_e = 3.4 \cdot 10^{29}\,\mathrm{J} \tag{4.28}$$

A distinguishing feature of equation (4.28) is that it determines the balance of the maximum energy of the electron $C_0^2 r_e / G$ [2] and its limiting electrical energy at the radius R_e. The identical equation for the limiting energy of the electron can be obtained from (4.21), taking (4.25) into account. As indicated by (4.28), the electron is a carrier of the colossal hidden energy and, correspondingly, of the hidden mass $m_{\max}$:

$$m_{\max} = \frac{W_{\max}}{C_0^2} = \frac{C_0^2}{G} r_e = 3.8 \cdot 10^{12}\ \mathrm{kg} = 4.2 \cdot 10^{42} m_e \tag{4.29}$$

In acceleration of the electron, the hidden energy and electron mass transform to actual forms. In the limiting case when the electron reaches the speed of light, the energy and mass of the electron cannot exceed the values given by the equations (4.28) and (4.29). In this respect, the possibilities of the Superintegration theory are unique and enable us to solve in a relatively simple manner the most complicated, apparently unsolvable problems of theoretical physics of the limiting parameters of relativistic particles.

4 .6. Many relationships of electron parameters

Equation (4.29) shows that the ratio $m_{\max}/m_e$ for the electron is characterised by a very high value of $4.2 \cdot 10^{42}$. However, this value is also characteristic of other ratios of the electron parameters, including the ratio of force F_e of electrical interaction of two electrons to the force F_G of their gravitational attraction

$$\frac{m_{\max}}{m_e} = \frac{W_{\max}}{W_0} = \frac{F_e}{F_g} = \frac{r_e}{R_g} = \frac{r_e}{R_e} = \frac{C_0^2}{\varphi_{nre}} = \frac{\varphi_{e\max}}{\varphi_{ere}} = 4.2 \cdot 10^{42} \tag{4.30}$$

Equation (4.30) also includes the rest energy of the electron $W_0 = m_e C_0^2$, the Newton potential φ_{nre} at the distance of the classic radius r_e of the electron, the limiting electrical potential φ_{emax} (4.21) at the distance of the electrical radius R_e and the electrical potential φ_{ere} (4.4) at the distance of the classic radius r_e. The expression (4.30) links the energy, electrical, gravitational and dimensional parameters of the electron.

Attention should be given to the ratio F_e/F_g which indicates that the electrical force F_e of the interaction of two electrons is $4.2\cdot10^{42}$ times greater than the force F_g of their gravitational attraction:

$$F_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2} \tag{4.31}$$

$$F_g = \frac{Gm_e^2}{r^2} \tag{4.32}$$

$$\frac{F_e}{F_g} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{Gm_e^2} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{m_eC_0^2}\frac{1}{\frac{Gm_e}{C_0^2}} = \frac{r_e}{R_e} = \frac{W_e}{W_g} = 4.2\cdot10^{42} \tag{4.33}$$

For a long time, equation (4.33) caused confusion to physicists who assumed that the gravitational interactions of the electrons are so weak in comparison with electrical interactions that they can be ignored. This also relates to the ratios of the electrical energy W_e of interaction of two electrons to their gravitational energy W_g. No account was made of the gravitational interaction of the electron with the quantised medium, and attention was given only to the gravitational field of two electrodes in the case in which the extent of participation of gravitation in gravity is insignificant.

It should be mentioned that the gravity field is determined only by the Newton potential φ_n which in the case of the electron is incommensurably small in comparison with the gravitational potential C_0^2 of the quantised medium [2]. However, it is C_0^2 that initially determines the energy (4.1) of deformation of space-time in the formation of the electron mass and of the gravitational field of the electron which differs from the gravity field.

If the entire hidden mass $m_{\max}$ (4.29) of only one of the electrons would take part in gravity, the gravity force F_g would be equivalent to the electrical force F_e of interaction of two electrons: one with the mass $m_{\max}$ and the other one with the rest mass m_0

$$F_g = G\frac{m_em_{\max}}{r^2} = m_eC_0^2\frac{r_e}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2} \tag{4.34}$$

Equation (4.34) shows clearly that if the classic radius r_e of the electron did not screen the hidden mass of the electron from participation in gravitational interactions, the physical pattern of the world would be completely different. It appears that initially the electrical energy of the electron which takes part in the exchange processes is restricted by the classic radius r_e and by the value of 0.511 MeV (4.2). Only this fraction of energy in 0.511 MeV determines the rest mass m_e and takes part in gravity.

In accordance with (4.34) in the absence of gravitational screening in one of the two electrons, the electrical interactions of such a pair of electrons would be completely identical with their gravity. There would be no difference between the Coulomb and Newton laws for such interacting electrons. The force of Newton attraction would be completely compensated by the electrical force of repulsion of the electrons. Externally, these electrons would be perceived as particles completely neutral in relation to each other and not taking part in any interactions between them.

However, there is a ban on the interaction with the hidden energy and mass of the nonrelativistic electron. In this respect, the role of the classic radius r_e (4.3) of the electron is fully defined. Radius r_e has the function of the gravitational screen for the hidden mass m_{max} of the electron (4.29). For the electrical field of the electron, the classic radius r_e is not a screen. For this reason, there is a difference between the force F_e of electrical interaction and the force F_g of gravitational attraction of the two electrons.

A small fraction of the energy of the nonrelativistic electron, restricted by the value 0.511 MeV, is transferred outside the limits of the classic radius r_e (4.3) of the electron. Only this energy can take part in the exchange energy processes: fully transfer to the radiation in annihilation of the electron or can disintegrate into small portions in the emission of the orbital electron in the composition of the atom.

4 .7. Gravitational diagram and electron zones

Figure 4.2 shows the gravitational diagram of the electron in the form of the distribution of the gravitational potential. The gravitational diagram of the electron is constructed on the basis of the distribution of the gravitational potential of the electron (Fig. 4.1a) as a result of analysis of the relationships (4.5).

The structure of the elementary particle is indicated by its gravitational diagram which reflects on the plane the volume structure of the electron in the quantised medium. The central point charge of the electron (*e*) pulls quantons to itself, forming a compression region in the quantised medium. The compression region is restricted by the classic radius r_e of the electron (4.3) and can form only as a result of stretching of the elastic quantised medium outside the limits of the classic electron radius r_e.

However, from the viewpoint of gravitational interaction it is more logical to investigate different electron zones, not as the zones of compression and stretching of the quantised medium but as the zones of gravitational attraction

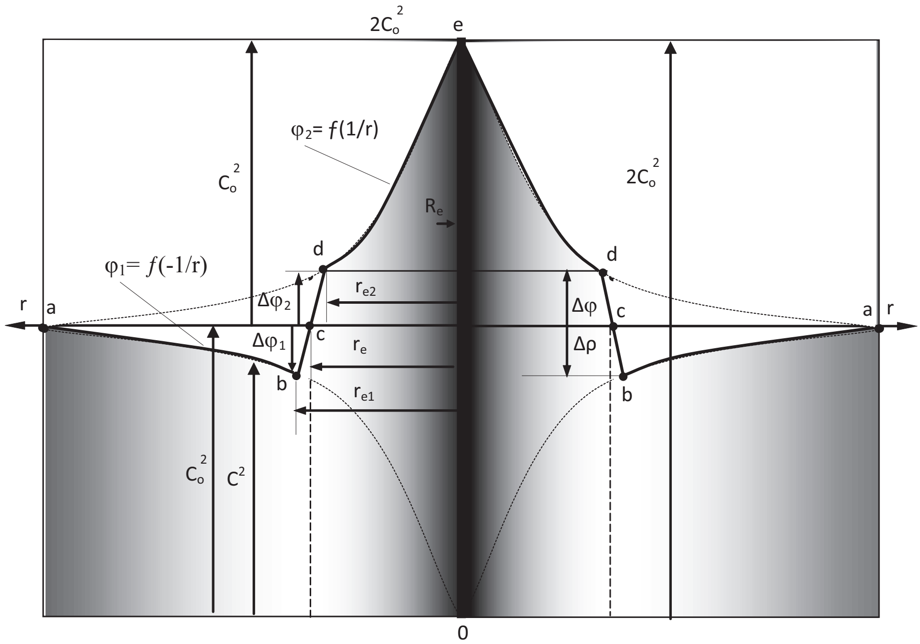

Fig. 4.2. Gravitational diagram of the electron in the form of the distribution of the gravitational potential in the compression zone (d–e) and in the stretching zone (a–b) of the spherically deformed quantised space-time.

and repulsion which will be referred to as the zones of the effect of gravitation and antigravitation.

Nowadays, the physicists are still discussing the possibilities of existence of antigravitation as an independent physical phenomenon. The theory of Superintegration shows quite clearly that antigravitation is encountered as widely in the nature as gravitation. The global manifestation of antigravitation is found both in the region of the microworld and in cosmology [2].

The effect of antigravitation starts to operate in the region of the microworld of elementary particles at the distances shorter than the classic electron radius r_e (10^{-15} m). This is the region of not only the repulsion of the orbital electron from the nucleus of the atom but also the region of the effect of nuclear forces which are reduced to the forces of electrical attraction of alternating shells of the nuclons, balanced by the forces of antigravitational repulsion [10]. In cosmology, the effect of antigravitation the effect of antigravitation explains the accelerated recession of the galaxies in the universe [2].

The manifestation of antigravitation is always associated with the sign of the gradient of the quantum density of the medium, i.e., with the direction of the effect of vector **D** (3.43) of the deformation of the quantised space-time. In fact, the deformation vector **D** is an analogue of the vector **a** of the strength of the gravitational field and is only expressed in different measurement units. In particular, the direction of the deformation vector **D** determines the direction of the vector **a** of the strength of the gravitational field [2]

$$\mathbf{D} = \text{grad } \rho_1 \tag{4.35}$$

$$\mathbf{a} = \text{grad } C^2 = \text{grad } (C_0^2 - \varphi_n) = \text{grad } (-\varphi_n) \tag{4.36}$$

Taking into account the fact that the gravitational potential of action C^2 is the equivalent of the quantum density of the medium ρ_1, the value of the gravitational potential C^2 can always be used to determine the quantum density ρ_1 in the perturbed quantised medium, and vice versa [2]:

$$\rho_1 = \rho_0 \frac{C^2}{C_0^2} \quad , \qquad C^2 = C_0^2 \frac{\rho_1}{\rho_0} \tag{4.37}$$

The gravitational diagram (Fig. 4.2) of the electron shows the distribution of the gravitational potentials whose value determines the direction of vector **a** when substituted into (4.35). However, the gravitational diagram of the electron can be presented in the form of the equivalent distribution of the quantum density of the medium [2].

The centre of the electron contains the point charge e represented on the gravitation diagram by a narrow band with the radius R_e. The gravitational potential on the surface of the charge at point e reaches the value $2C_0^2$. Actually, the point charge of the electron in the three-dimensional measurement has the form of a sphere with the radius R_e, in the two-dimensional measurement it has the form of a band.

In imaging on the plane of the curve of distribution of the gravitational potentials, it is convenient to represent the point charge of the electron by a narrow band with the characteristic radii of the electron: r_{e1} (4.30), r_e (4.3), r_{e2} (4.14), R_e (4.19), plotted from the centre of the band along the horizontal axis. The vertical axis gives the values of the gravitational potential in the range $0...2C_0^2$. The level of the potential C_0^2 determines the potential depth of the quantised medium for the non-perturbed vacuum. The potential C_0^2 can be referred to as the equilibrium vacuum potential.

In particular, the gravitational diagram of the electron clearly demonstrates perturbation of vacuum in relation to the equilibrium potential C_0^2, when a point electrical charge is introduced into the quantised medium. This is not similar to vacuum fluctuations because the disruption of the equilibrium state of the quantised medium by the electron is a relatively extensive and in the limiting case the gravitational potential on the surface of the point charge increases in relation to the equilibrium level C_0^2 to the value $2C_0^2$, it is doubled, with the electron also represented in the form of a unique energy bunch in the quantised medium.

Undoubtedly, the quantum density of the medium is a highly noticeable parameter in comparison with the gravitational potential which is in fact a purely calculation mathematical parameter. Like the concentration of the quantons, the quantum density of the medium can be described physically. The gravitational potential can only be estimated by its value. Therefore, when analysing the structure of the electron, it is hypothetically more efficient to study the change of the quantum density in perturbation of the quantised medium.

The introduction of a point electrical charge into the non-perturbed medium results in the rearrangement of the quantised medium. In the immediate vicinity of the charge, the quantons are pulled to the charge and are also compressed, increasing the quantum density of the medium and the value of the gravitational potential to $2C_0^2$. On the gravitational diagram this central region of the electron is dark.

When moving away from the point charge, the gravitational potential $\varphi_2 = f(1/r)$ decreases along the path (e-d) and the quantum density of the medium also decreases. The artificial interface (b-c-d) is characterised by a small jump $\Delta\varphi$ (4.16) of the gravitational potential and the quantum density of the medium. For better understanding, the gravitational diagram of the electron is constructed without observing the scale, otherwise because of the small value the jump $\Delta\varphi$ (16) of the gravitational potential could not be seen.

Zone (b-c-d-e) is the region of the effect of gravitation because the gradient of the gravitational potential of the function $\varphi_2 = f(1/r)$ and of the function (4.18) is negative and directed away from the central point charge of the electron. This energy zone of the electron is slightly larger than the zone of compression of the quantised medium (c-d-e).

The compression zone (c-d-e) of the quantised medium of the electron differs from the stretching zone (a-b-c) by the level of the quantum density of the medium and the gravitational potential. If the quantum density of the medium is higher than equilibrium density ρ_0, this characterises the compression zone of compression of the medium and, vice versa, if the quantum density of the medium is lower than the equilibrium density ρ_0, this is the stretching zone. This also applies to the level of the gravitational potential. If the gravitational potential is higher than the equilibrium potential C_0^2, then this characterises the compression zone of compression and, vice versa, if the gravitational potential is smaller than the equilibrium potential C_0^2, it is the stretching zone.

The compression zone (c-d-e) of the quantised medium of the electron is the region of hidden energy and mass of the electron which is screened for the exchange energy processes with the quantised medium by the artificial gravitational boundary (d-c-b). Taking into account that the electrical radius R_e of the electron is incommensurably small in comparison with its classic radius r_e, the role of the energy screen for the nonrelativistic electron is played by the classic radius r_e.

At point *c*, the compression of the medium is replaced by stretching of the medium which forms, along the path (c-b-a), a gravitational potential well with depth $\Delta\varphi_1$ (4.16) equal to the level of the Newton potential at point *b*. The classic radius r_e of the electron at point *c* characterises the neutral sphere subjected to the simultaneous effect of the forces of compression and stretching of the quantised medium, equalising each other.

The stretching zone (a–b–c) of the quantised medium is described by the curve (b-a) and section (b-c) as the function $\varphi_1 = f(-1/r)$ and the potential jump $\Delta\varphi_1$ (4.16). At point *a* the quantum density of the medium ρ_0 and the gravitational potential C_0^2 are restored to the level of the non-perturbed vacuum.

Zone (b–a) is the region of the effect of gravitation. Zone (b-a) is transferred outside the limits of the classic radius r_e of the electron and is responsible for the exchange energy processes of the electron and the effect of the forces of gravitational attraction in the quantised medium.

Figure 4.3 shows the graphical computer simulation of the electron in the quantised space-time with the scale not taken into account to enable better understanding. The dark point in the centre of the electron is its point electrical charge. The dark region around the point charge is the

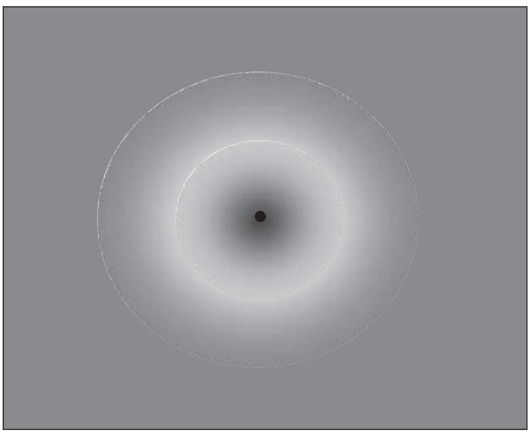

Fig. 4.3. Computer simulation of the structure of the electron in the quantised space-time as a result of its spherical deformation by the radial electrical field of the central charge.

compression zone of the quantised medium which is replaced by the stretching zone (lighter region). With the increase of the distance from the electron of the quantum density of the medium is restored to the equilibrium state. In fact, the electron, being the compound part of the quantised medium, appears to be stretched over the space-time.

We examine in greater detail the following energy zones of the electron:

- zone (a–b) of the gravitational attraction of the electrons;
- the gravitational well (a–b–c) of the electron;
- zone (b–c-d–e) of the antigravitational repulsion of the electron;
- zone (c–d–e) of the hidden mass and energy of the electron

4.8. The gravitational attraction zone

On the gravitational diagram in Fig. 4.2, the zone of gravitational attraction of the electron is represented by the curve (a–b) and the function $\varphi_1 = f(-1/r)$ (4.5) with the gravitational radius R_g replaced by the electrical radius R_e to improve accuracy. In fact, the zone (a-b) extends from the infinite point (*a*) to the point (*b*) over the distance $r_{e1} = r_e + R_g$ (4.13) from the centre of the electron. Since $R_g \ll r_e$, in the calculations it can be assumed that $r_{e1} \approx r_e$.

The energy zone (a-b) is transferred outside the classic radius r_e of the electron and is not screened from external interactions, including the gravitational attraction of other elementary particles with a mass. Gravity starts with the interaction of the masses of the elementary particles, and to understand the reasons for gravitational attraction, it is necessary to consider accurately the nature of formation of the mass and the effect of tensions in the quantised medium.

Over a number of centuries, physicists thought erroneously that the mass is something stable, firm and represents an independent category irrespective of space. The Superintegration theory shows that the mass does not physically exist in the interpretation used at the present time. There is a distinctive energy zone (a–b–c) of the electron responsible for the formation of the rest mass of the electron and its energy is equivalent to half the electron mass. This is the stretching region of the spherically deformed quantised medium which is shown on the gravitational diagram in Fig. 4.2 by a potential well in the form of the zone (a–b–c) with depth $\Delta\varphi_1$ (4.16).

The second part of the deformation energy of the medium with the potential $\Delta\varphi_2$ (4.16) enters the region of the conventional gravitational boundary of the electron with radius r_e. The deformation energy, used for the formation of the potential well (a–b–c) and of the potential jump $\Delta\varphi_1$ (4.16) determines the rest energy of the electron. For this purpose, it would be necessary to section the gravitational diagram in Fig. 2 along the b-b line whose gravitational potential φ_2 would not exceed the jump $\Delta\varphi_2$ (4.16). In this case, the cut-off gravitational diagram of the electron could be investigated without the hidden zone represented by the region (d-e-d). This cut-off gravitational diagram is responsible for the electron mass as the equivalent of the energy of spherical deformation using different measurement units.

In these terms, the properties of the electron greatly differ from the properties of the nuclons which contain a distinctive gravitational boundary with radius R_S. As reported in [2], for the particles with the distinctive gravitational boundary the mass is determined by the total energy of the spherical deformation of the quantised medium, both inside the gravitational interface and outside it. In this case, we do not consider the structure of the gravitational boundary of the nuclon in the form of the alternating shell and investigate some simplified analogy of the interface in the form of an abstract sphere with radius R_S.

Here, it should be mentioned that the gravity itself is not linked directly with the electron mass but it is linked directly with the section (a-b) of distortion of the quantised space-time which determines the function of the gravitational potential $\varphi_1 = f(-1/r)$ (2.57) and quantum density $\rho_1 = f(-1/r)$ (3.42)

$$\varphi_1 = C^2 = C_0^2\left(1 - \frac{R_e}{r}\right) = f(-1/r) \tag{4.38}$$

$$\rho_1 = \rho_0\left(1 - \frac{R_e}{r}\right) = f(-1/r) \tag{4.39}$$

In accordance with (4.36) and (4.35), from (4.38) and (4.39) we determine the value (and direction) of the vector **a** of the strength of the gravitational field and the vector **D** of the formation for the electron in the section (a–b) [2]

$$\mathbf{a} = \text{grad}\, C^2 = C_0^2 \frac{R_e}{r^2}\mathbf{1}_r = \frac{Gm_e}{r^2}\mathbf{1}_r \tag{4. 40}$$

$$\mathbf{D} = \text{grad}\, \rho_1 = \rho_0 \frac{R_e}{r^2}\mathbf{1}_r = \frac{\rho_0}{C_0^2}\frac{Gm_e}{r^2}\mathbf{1}_r = \frac{\rho_0}{C_0^2}\mathbf{a} \tag{4.41}$$

If the test mass m_0 of another particle is introduced into the zone (a-b), then formally the attraction force of the masses $\mathbf{F}_g$ is determined by the vectors **a** (4.40) and **D** (4.41)

$$\mathbf{F}_g = m_0\mathbf{a} = m_0\mathbf{D}\frac{C_0^2}{\rho_0} = \frac{Gm_e m_0}{r^2}\mathbf{1}_r \tag{4.42}$$

A new feature in (4.42) is that the reasons for the formation of the gravity force $\mathbf{F}_g$ (4.42), like the strength **a** the gravitational field, are determined by the deformation **D** of the quantised medium, although in the final analysis the gravity force $\mathbf{F}_g$ is determined by the Newton gravity law. In this respect, the Superintegration theory does not reconsider well-known laws and only supplements them by the causality of phenomena. Regardless of gravity being determined by the formation of the quantised space-time, the gravity equation (4.42) formally includes masses. However, the nature of gravity is far more complicated and it will be shown that force $\mathbf{F}_g$ (4.42) of gravitational attraction of masses is associated with the disruption of the spherical symmetry of the tensioning forces in the quantised medium.

4.9. Equivalence of gravitational and electromagnetic energies

In physics, it has been erroneously believed that the energy of the gravitational field of the electron is incommensurably small in comparison with its electrical (electromagnetic) energy. As already mentioned, the equation (4.35) of electrical energy of the electron includes equally the energy of electrical (4.23) and magnetic (shown later) polarisation of the quantised medium. In this respect, the free electron is a carrier of not only the electrical but also specific electromagnetic field which can transform to electromagnetic radiation. In particular, the electromagnetic field of the electron determines the energy of spherical deformation of the quantised medium part of which, defined by the classic radius r_e, is used in the formation of the electron rest mass. In particular, the mass, as the integral parameter (4.1), determines the gravitational field of the electron.

Previously, the energy W_g of the gravitational field was determined from the gravity equation (4.2) for, for example, two electrons, when $m_0 = m_e$

$$W_g = \frac{dF_g}{dr} = \frac{Gm_e m_e}{r} = m_e C_0^2 \frac{R_g}{r} \tag{4.43}$$

As indicated by (4.30), energy W_g (4.43) of the gravitational interaction of the two electrons is incommensurably small in comparison with their electrical interaction energy W_e. In particular, the total electrical polarisation energy W_e (4.25) of the quantised medium by the free electron is equivalent to the interaction energy of the two electrons. This is determined by the imaging method when the total energy of polarisation (4.25) can be placed by the interaction of two electrons, where the charge of one of these electrons is distributed uniformly over the sphere within which there is a secondary electron. The total ionisation energy W_e (4.24) of the quantised medium determines the energy W_D of its spherical deformation, as the energy of the gravitational field of the electron:

$$W_D = W_e = \int_0^{\varphi_e} e d\varphi = e\varphi_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r} \quad (4.44)$$

The numerator and denominator in (4.44) is multiplied by $m_e C_0^2$ and taking into account r_e (4.3), we obtain the dependence of the gravitational energy W_D of the electron for the removal of the energy of spherical deformation of the quantised medium from the electron

$$W_D = m_e C_0^2 \frac{r_e}{r} = W_0 \frac{r_e}{r} \quad (4.45)$$

The expressions (4.44) and (4.45) are fully equivalent to each other and establish the equivalence of the gravitational electrical (electromagnetic) energy of the electron. This is in complete agreement with the nature of the united electromagnetic field where the gravitation is regarded as the representation of the superstrong electromagnetic interaction (SEI) in the quantised medium. It can easily be shown that at $r = r_e$ the electrical (4.44) and gravitational (4.45) energies of the free electron fully correspond to its rest energy $m_e C_0^2$ (4.1).

It should be mentioned that energy W_e (4.44) of polarisation of the quantised medium is the primary manifestation of superstrong electromagnetic interaction in perturbation of the quantised medium by the electrical charge of the electron. Deformation energy W_D (4.45) is manifested as the secondary formation of the same energy, only in a different form. For this reason, the summation of the energies W_e (4.44) and W_D (4.45) is not permissible.

4.10. Stretching of the medium by the electron

Knowing the distribution of deformation energy W_D around the electron, it is quite easy to determine the force $\mathbf{F}_D$ of tensile deformation acting on the entire spherical surface of the deformed medium in the direction to the centre of the electron

$$\mathbf{F}_D = \frac{dW_D}{dr} = -m_e C_0^2 \frac{r_e}{r^2}\mathbf{1}_r \quad (4.46)$$

The minus sign in (4.46) indicates that the deformation force $\mathbf{F}_D$ is directed to stretch the medium from the the electron centre to the external region of space. The maximum value of force $F_{D\max}$ (4.46) is obtained on the surface of the sphere with radius r_e

$$F_{D\max} = \frac{m_e C_0^2}{r_e} = 29\text{N} \tag{4.47}$$

It can be seen that the maximum value of the deformation force of the quantised medium immediately beyond the limits of the classic radius r_e of the electron has the appreciably higher value of 29 N. The deformation force $\mathbf{F}_D$ (4.46) of the quantised medium by the electron can be compared with the force $\mathbf{F}_g$ (4.42) of Newton attraction of two electrons

$$\frac{F_D}{F_g} = \frac{C_0^2 r_e}{G m_e} = 4.2 \cdot 10^{42} \tag{4.48}$$

It is pleasing to see that this relationship F_D/F_g corresponds to the previously determined ratio F_e/F_g (4.30) of the force F_e of electrical interaction of two electrons to the force F_g of their Newton attraction. This means that the magnitudes of the forces F_e and F_D are identical. This can be easily verified by substituting into (4.46) the value r_e (4.3)

$$F_D = m_e C_0^2 \frac{1}{r^2} \cdot \frac{1}{4\pi\varepsilon_0} \frac{e^2}{m_e C_0^2} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r^2} \tag{4.49}$$

Equation (4.49) again confirms that spherical deformation of the quantised medium takes place as a result of the polarisation of the quantised medium by the point charge of the electron. Polarisation energy W_e (4.25) of the medium can be determined by the work required for the transfer of the test charge e from infinity with zero potential to a sphere with the electrical potential φ_e.

Therefore, when examining the gravitational interaction of the electron with the quantised medium and of two electrons in the quantised medium, it should be mentioned that the deformation force F_D of the medium by the electron is incommensurably high (4.48) in comparison with the force F_g of Newton attraction of two electrons. Force $\mathbf{F}_D$ (4.46) can be described through $\mathbf{F}_{D\max}$ (4.47)

$$\mathbf{F}_D = -m_e C_0^2 \frac{r_e}{r^2} \mathbf{1}_r = \mathbf{F}_{D\max} \frac{r_e^2}{r^2} \tag{4.50}$$

Dividing the force $\mathbf{F}_D$ (4.50) by the area $S = 4\pi r^2$ of the spherical surface surrounding the electron, we determine the variation of tension $\Delta\mathbf{T}_1$ of the quantised medium in stretching of the medium as a result of the deformation of the medium by the electron [1]:

$$\Delta \mathbf{T}_1 = \frac{\mathbf{F}_D}{4\pi r^2} = -\frac{1}{4\pi} m_e C_0^2 \frac{r_e}{r^4} \mathbf{1}_r = \frac{1}{4\pi} \mathbf{F}_{D\max} \frac{r_e^2}{r^4} \tag{4.51}$$

The maximum value of $\Delta \mathbf{T}_1$ (4.51) for the electron is obtained at the artificial interface in the form of a jump of normal tension $\Delta \mathbf{T}_{n1}$ at $r = r_e$

$$\Delta \mathbf{T}_{n1} = \frac{1}{4\pi} m_e C_0^2 \frac{1}{r_e^3} \mathbf{1}_r = \frac{1}{4\pi} F_{D\max} \frac{1}{r_e^2} \mathbf{1}_r = 0.29 \cdot 10^{30} \frac{\text{N}}{\text{m}^2} \tag{4.52}$$

Knowing the value of the maximum tension ΔT_{n1} (4.52) of the quantised medium on the electron surface (the sphere with radius r_e) we can calculate two identical forces $\mathbf{F}_{1x}$ and $\mathbf{F}_{2x}$, directed to opposite sides along the axis **X** with which the medium tries to break up the electron. For this purpose, we use the method of the section of the shell (sphere with a radius r_e) of the electron, assuming that the maximum tension ΔT_{n1} acting on the electron is identical with the pressure acting on the section πr^2 of the electron

$$\mathbf{F}_{1x} = -\mathbf{F}_{2x} = \Delta T_{n1} \cdot \pi r_e^2 \cdot \mathbf{1}_x = \frac{1}{4} F_{D\max} \mathbf{1}_x = 7.25 \text{ N} \tag{4.53}$$

Figure 4.4 shows the diagram of gravitational attraction of two identical masses m_0 and m_e in different stages in relation to the distance between the masses. Mass m_0 belongs to the testing particle with no electrical charge. In this case, the electrical interaction forces of the charges of the electron and the test mass are not taken into account. At a large distance (the stage shown in Fig. 4.4a), the level of the gravitational potential C_0^2 and of the quantum density ρ_0 of the medium between the masses corresponds to the equilibrium state of the non-perturbed vacuum. In this case, there is no gravitational interaction between the masses but there is a gravitational interaction between the mass and the quantised medium as a result of spherical deformation of the medium. The particles are situated at the bottom of the gravitational well and are subjected to the symmetric tension by the quantised medium which in any diagonal cross-section generates forces of

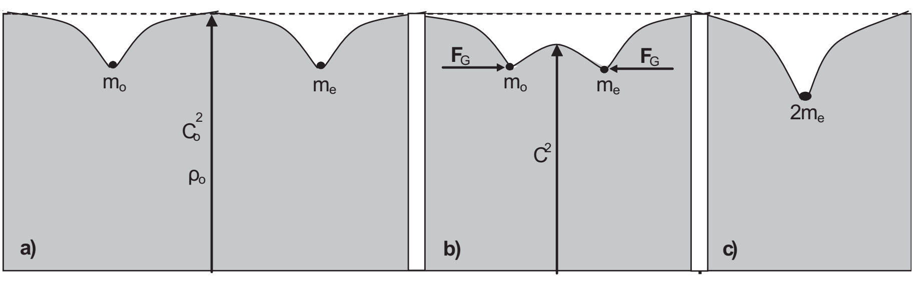

Fig. 4.4. Diagram of gravitational attraction of two masses m_0 under the effect of force $\mathbf{F}_G$.

the tension of the medium $\mathbf{F}_{1x}$ and $\mathbf{F}_{2x}$, (4.53).

If the distance between the particles is minimum (stage in Fig. 4.4b), attention should be given to the disruption of the spherical symmetry of the general gravitational well formed in the quantised medium by the interacting masses. It may be seen that in the middle between the masses, the gravitational potential decreases to the value C^2 in relation to the potential C_0^2 of the non-perturbed vacuum. Naturally, the disruption of the spherical symmetry of the quantised space-time in gravitational interaction of two identical masses results in disruption of the spherical symmetry of tensions $\Delta\mathbf{T}_1$ (4.51) of the quantised medium around the masses. In particular, the disruption of the spherical symmetry of tensions of the medium in interaction of the masses determines the effect of the law of universal gravity (4.42).

It is shown in Fig. 4.4b that the forces of gravity of two identical masses start to be evident at distances when the masses mutually enter into interaction in the zones (a–b) (Fig. 4.2). Externally, the disruption of the spherical symmetry appears as the effect of forces $\mathbf{F}_g$ (Fig. 4.42) on the masses m_0 in the direction of the region with the lower gravitational potential C^2 and, correspondingly, in the direction to the region with the lower quantum density of the medium. It appears that the gravity in this case of interaction of two identical masses is determined by the pressure of the quantised medium from the region with the high quantum density of the medium in the direction of the lower quantum density.

In 1673 in a letter to Boyle, Newton presented his viewpoint on the problem of the aether and gravitation in interaction of two solids and wrote: 'However, when they come together so closely that the excess of pressure of the external aether, surrounding the solid, in relation to the pressure of the rarefied aethyer, situated between them, becomes so large that these solids cannot resist coming closer together, then this pressure excess stops them from moving towards each other...' [17]. Now when the concept of the obsolete aether in the EQM theory has been replaced by the elastic quantised medium, and its existence is confirmed by all experimental investigations, this greatly simplified Newton's explanation, although it is more than three hundred years old, is surprising, even after three centuries.

To determine the pressure of the medium on the gravitating masses, it is necessary to know the function of distribution of tensions in the form of a jump of tension on the surface of the electron $\Delta\mathbf{T}_{n1}$ (4.52) which in the case of disruption of spherical symmetry is determined by the additional effect of the second mass of the first one.

However, initially it is necessary to describe the distribution function of the Newton potential for two masses situated at the distance r from each other. This can be carried out in different coordinate systems. In any case, the function of distribution of the gravitational potential of two point masses is not suitable for analysis in any coordinate system because of the disruption of the spherical symmetry of the system.

For two gravitating masses, disruption of the spherical symmetry is replaced by the axial symmetry in relation to the axis linking the masses along the radius r. In this case, the volume of gravitational potential φ_n (x, y, z) at any point of space in accordance with the principle of superposition of the fields is determined by the sum of gravitational potentials of each mass. We extend the radii r_1 and r_2 from the centre of the masses m_e and m_0 to an arbitrary point φ_n (x, y, z) and write the gravitational potential at this point of space in the vicinity of the gravitating masses, taking into account the equality of the masses:

$$\varphi_n = \frac{Gm_e}{r_1} + \frac{Gm_0}{r_2} = Gm_e \frac{r_1 + r_2}{r_1 r_2} \tag{4.54}$$

Consequently, the distribution of the potential C^2 of action in the quantised medium for the two masses, corresponding to the simplified gravitational diagram in Fig. 4.4b, is described, taking into account (4.54), by the function C^2

$$C^2 = C_0^2 - \varphi_n = C_0^2 - Gm_e \frac{r_1 + r_2}{r_1 r_2} \tag{4.54}$$

The projections of the radii r_1 and r_2 on the axial distance r between the masses can be expressed by the appropriate angles α_r and β_r of inclination of the radii r_1 and r_2 in relation to the axis r

$$r = r_1 \cos\alpha_r + r_2 \cos\beta_r \tag{4.56}$$

Consequently, the function (4.54) can be described by the distance r and one of the radii, for example, radius r_1 and its angle of inclination α_r in relation to the axis r:

$$\varphi_n = \frac{Gm_0}{r_1} + \frac{Gm_0}{r - r_1 \cos\alpha_r} = Gm_0 \frac{r_1 + r_2}{r_1(r - r_1 \cos\alpha_r)} \tag{4.57}$$

In the rectangular coordinate system, if the axis x is represented by the direction with respect to r, and the origin of the coordinates by one of the masses m_0, the function of distribution of the Newton potential φ_n (x, y, z) for two masses is also determined by the method of superposition of the fields, adding up the gravitational potential φ_{1n} and φ_{2n} of two masses

$$\varphi_n = \varphi_{1n} + \varphi_{2n} = \frac{Gm_e}{\sqrt{x^2 + y^2 + z^2}} + \frac{Gm_0}{\sqrt{(r-x)^2 + y^2 + z^2}} \tag{4.58}$$

Naturally, the expressions (4.55) with (4.57) and (4. 58) taken into account are designed for computer processing for the case in which the field of the gravitational potentials of two masses can be efficiently represented in the form of equipotential surfaces and the force lines of the vectors of the strength **a** (4.40) along the unit vectors **i**, **j** and **k**

$$\mathbf{a} = -\left(\frac{\partial \varphi_n}{\partial x}\mathrm{i} + \frac{\partial \varphi_n}{\partial y}\mathbf{j} + \frac{\partial \varphi_n}{\partial z}\mathbf{k}\right) \tag{4.59}$$

On the surface of the electron represented by a sphere with the classic radius r_e, the direction of the vector of strength **a** (4.59) determines the direction of the vector $\Delta\mathbf{T}_{n1}$ (4.52). For the unit mass, the vector $\Delta\mathbf{T}_{n1}$ is normal and directed along the radius r. For two gravitating electron masses, because of the disruption of spherical symmetry, the direction and magnitude of the vector on the surface of the electron change. This is already the new vector of surface tension $\Delta\mathbf{T}_{1S}$. In particular, the new vector $\Delta\mathbf{T}_{1S}$ determines force $\mathbf{F}_g$ (4. 42) of Newton gravity of two masses as the difference of the forces $\mathbf{F}_{1x}$ and $\mathbf{F}_{2x}$, stretching the electron in the direction of the force $\mathbf{F}_g$

$$\mathbf{F}_g = \mathbf{F}_{2x} - \mathbf{F}_{1x} \tag{4.60}$$

Figure 4.5 shows the forces $\mathbf{F}_{1x}$ and $\mathbf{F}_{2x}$ acting in the opposite directions on half (positions 1 and 2) of the surface of the electron in the section A–A. Force $\mathbf{F}_{2x}$ is directed in the direction of the second mass m_0 along the radius r. Force $\mathbf{F}_{2x}$, acting on half (position 2) of the electron surface, is the resultant of the tensions $\Delta\mathbf{T}_{1S}$ on this surface. Force $\mathbf{F}_{1x}$ is the resultant force from the effect of tensions $\Delta\mathbf{T}_{1S}$ on the first (external) half (position 1) of the electron surface. The forces $\mathbf{F}_{1x}$ and $\mathbf{F}_{2x}$ are surface forces.

Naturally, the solution of the problem of gravity force $\mathbf{F}_G$ (4.60) is reduced to the determination of the surface forces $\mathbf{F}_{1x}$ and $\mathbf{F}_{2x}$. For this purpose, it is necessary to divide the electron surface into elementary areas dS and determine the elementary forces $d\mathbf{F}_{1x}$ and $d\mathbf{F}_{2x}$ acting on the areas dS. Further, all the elementary forces $\mathbf{F}_{1x}$ and $\mathbf{F}_{2x}$ should be projected

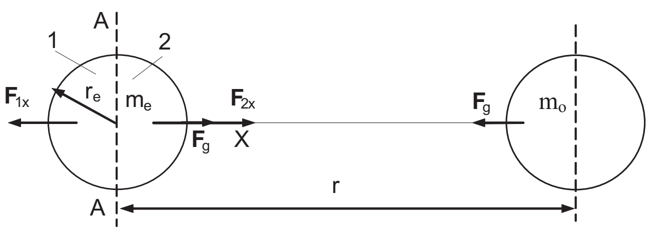

Fig. 4.5. Calculation of gravity force $\mathbf{F}_g$ of two identical masses m_e and m_0

onto the X axis and we should find a sum of all projections expressing $\mathbf{F}_{1x}$ and $\mathbf{F}_{2x}$. The solutions of these problems are complicated by the fact that it is necessary to know the function of distribution of the tensions $\Delta\mathbf{T}_{1S}$ on the electron surface for the two gravitating masses.

For a free electron, normal tension $\Delta\mathbf{T}_{n1}$ (4.52) is uniformly distributed on the electron surface establishing the spherical symmetry of the system. In this case, the determination of the forces $\mathbf{F}_{1x} = -\mathbf{F}_{2x}$ can be carried out more efficiently in the spherical coordinate system, combining this system with the orthogonal one.

Figure 4.6 shows the calculation diagram of the forces of surface tension acting on the electron. For the systems with the axial and spherical symmetry, it is sufficient to analyse the first quadrant of the rectangular coordinate system, examining $\frac{1}{8}$ of the electron surface. The electron centre is combined with the origin of the coordinates, and the electron surface is denoted by radius r_e. The electron surface is divided into the elementary areas dS.

This division can be carried out more efficiently in the spherical system of coordinates combined with the rectangular system. For this purpose, using two vertical sections passing through the axis Y, we separate the elementary spherical triangle of the electron surface with the angle $d\beta$ from the axis Y. Angle $d\beta$ is the angle between the two previously mentioned vertical sections.

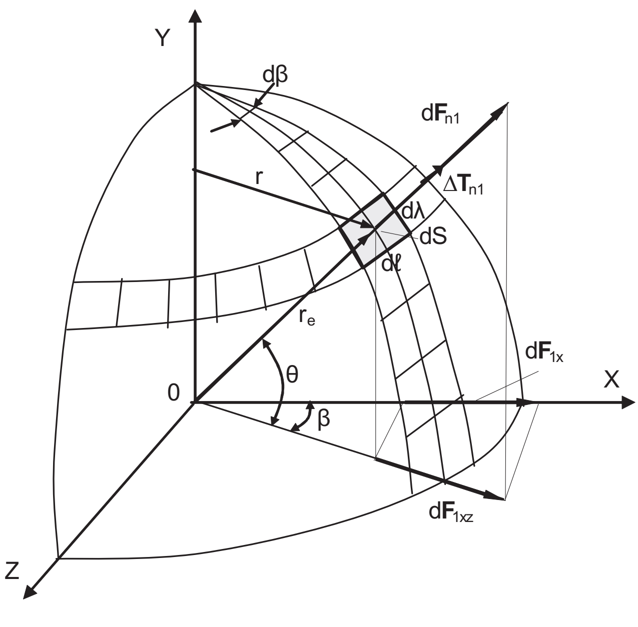

Fig. 4.6. Calculation of the surface tension forces acting on the electron.

The elementary spherical triangle is divided into elementary sections by horizontal sections and we define an arbitrary area *dS* for analysis. The coordinates of the area *dS* in the spherical system are represented by the electron radius r_e and two angles θ and β. The sides of the area *dS* are denoted by $d\ell$ and $d\lambda$.

Attention should be given to the fact that in dividing the elementary areas on the electron surface, the side $d\lambda$ represents the same interval on the sphere, and the side dℓ depends on the angle θ. The maximum value of the side $d\ell_{\max}$ is recorded at the angle θ = 0. Consequently, taking into account that the sinus of the small angles is equal to the value of the angle in radians, we determine $d\ell_{\max}$

$$d\ell_{\max} = r_e \sin(d\beta) = r_e d\beta \tag{4.61}$$

The actual value of $d\ell$ is determined by the radius *r* situated in the horizontal section of the electron

$$d\ell = r d\beta = d\ell_{\max} \cos\theta = r_e \cos\theta d\beta \tag{4.62}$$

The side $d\lambda$ is determined more efficiently by means of the radius r_e and the increment of the angle $d\theta$

$$d\lambda = r_e \sin(d\theta) = r_e d\theta \tag{4.63}$$

Taking into account (4.62) and (4.63), we determine the parameters of the elementary area *dS* of the electron surface

$$dS = d\ell d\lambda = r_e^2 \cos\theta d\theta d\beta \tag{4.64}$$

To verify (4.62), we determine the area of ⅛ of the electron surface (Fig. 4.6)

$$S = \int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}} r_e^2 \cos\theta d\theta d\beta = r_e^2 \sin\theta\Big|_0^{\frac{\pi}{2}} \cdot \int_0^{\frac{\pi}{2}} d\beta = r_e^2 \beta\Big|_0^{\frac{\pi}{2}} = \frac{\pi}{2} r_e^2 \tag{4.65}$$

The result (4.65) corresponds the actual situation. An equation is available for the element of the area of the spherical surface in the spherical coordinates which is far more complicated than *dS* (4.64) [18]. Using (4.64), we can determine more efficiently the resultant force $\mathbf{F}_{1x}$ of tensioning of the medium acting on the axis *X* on half the surface of the free electron for the spherically symmetric system when the tensions $\Delta\mathbf{T}_{n1}$ (4.52) are uniformly distributed on the electron surface. Taking into account that tension $\Delta\mathbf{T}_{n1}$ is normal to the electron surface, the element of the normal force $d\mathbf{F}_{n1}$ is determined by the elementary area *dS* (4.64)

$$d\mathbf{F}_{n1} = \Delta\mathbf{T}_{n1} dS = \Delta\mathbf{T}_{n1} r_e^2 \cos\theta d\theta d\beta \tag{4.66}$$

The element of the normal force $d\mathbf{F}_{n1}$ (4.66) is connected with the element of the force $d\mathbf{F}_{1x}$ in the direction of the X axis by appropriate projections (Fig. 4.6)

$$d\mathbf{F}_{1x} = d\mathbf{F}_{1xz}\cos\beta = d\mathbf{F}_{n1}\cos\theta\cdot\cos\beta \tag{4.67}$$

Substituting (4.66) into (4.67) we determine the element of the force $d\mathbf{F}_{1x}$ in the direction of the X axis

$$d\mathbf{F}_{1x} = \Delta\mathbf{T}_{n1}r_e^2\cos^2\theta d\theta\cdot\cos\beta d\beta\cdot\mathbf{1}_x \tag{4.68}$$

Equation (4.60) is integrated into range from 0 to π/2 and we obtain the resultant force $\mathbf{F}_{1x}$ acting on half the electron surface from the side of the medium:

$$\mathbf{F}_{1x} = 4\int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}}\Delta T_{n1}r_e^2\cos^2\theta d\theta\cdot\cos\beta d\beta\cdot\mathbf{1}_x =$$
$$= 4\Delta T_{n1}r_e^2\left(\frac{\theta}{2}+\frac{\sin\theta\cos\theta}{2}\right)\Bigg|_0^{\frac{\pi}{2}}\cdot\sin\beta\Big|_0^{\frac{\pi}{2}}\cdot\mathbf{1}_x = \Delta T_{n1}\pi r_e^2\mathbf{1}_x \tag{4.69}$$

As indicated by (4.69), the force $\mathbf{F}_{1x}$ which tries to break up the electron by the tension $\Delta\mathbf{T}_{n1}$ of the medium is determined by the cross-section of the electron πr_e^2. Previously, but without proof, the result (4.69) was already presented in (4.53).

For the system with two or more masses, into (4.16 (necessary to introduce the functional dependence of the tension $\Delta\mathbf{T}_{n1}$ on the surface S of the electron in the coordinates (x, y, z) or (r_e, θ, β). In a general case, it is the surface tension function $\Delta\mathbf{T}_{1S}f(r_e, \theta, \beta)$, and the vector $\Delta\mathbf{T}_{1S}$ is not normal to the surface S. Consequently, the resultant force $\mathbf{F}_{1x}$ can be expressed by the double integral (4.69) from the normal component of the function $\Delta\mathbf{T}_{1S}f(r_e, \theta, \beta)$ for the function $\Delta\mathbf{T}_{1S}f(r_e, \theta, \beta)$:

$$\mathrm{F}_{1x} = 4\int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}}\Delta T_{n1}f(r_e,\theta,\beta)r_e^2\cos^2\theta d\theta\cdot\cos\beta d\beta\cdot 1_x \tag{4.70}$$

In (4.70) we can immediately introduce $\Delta\mathbf{T}_{1S}f(r_e, \theta, \beta)$ but in this case it is necessary to change the functional dependence of the element of the force $d\mathbf{F}_{1x}$ as projection on the X axis.

In a general case, for the system of two masses (Fig. 4.5), the force of Newton gravity $\mathbf{F}_g$ (4.60) is determined by the disruption of spherical symmetry of the system leading to the formation of mutual additional tensions of the medium between the interacting masses which determine their mutual gravitational attraction

$$F_g = F_{2x} - F_{1x} = 4\int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}} \Delta T_{n2} f(r_e,\theta,\beta) r_e^2 \cos^2\theta d\theta \cdot \cos\beta d\beta \cdot 1_x - \\ -4\int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}} \Delta T_{n1} f(r_e,\theta,\beta) r_e^2 \cos^2\theta d\theta \cdot \cos\beta d\beta \cdot 1_x \quad (4.71)$$

The force $\mathbf{F}_g$ (4.71) acts in the same manner on the first and second masses. The masses themselves, in contrast to $\mathbf{F}_g$ (4.42), are not included in equation (4.71). Instead of the masses, equation (4.71) contains the tensions of the quantised medium along the X axis. The result of the effect of these tensions on half the electron surface from two opposite sides are the forces $\mathbf{F}_{1x}$ and $\mathbf{F}_{2x}$ (Fig. 4.5).

The specific features of the surface tension of the electron $\Delta\mathbf{T}_1$ (4.51) do not enable the principle of the superposition of the fields to be used for the given parameter, because the field of tensions $\Delta\mathbf{T}_1$ is the inverse function of the fourth power of the distance to the electron. Tension $\Delta\mathbf{T}_1$ is a local vector acting on the element of the electron surface from the side of the medium. Therefore, the transfer of tension $\Delta\mathbf{T}_1$ from one electron to another is not correct.

Naturally, in every specific case it is necessary to find the partial solution of (4.71). Now it is important to use the completely new mathematical interpretation of the law of worldwide gravity through the tension (pressure) of the quantised medium, although the very concept of gravity was determined by means of the tension of the medium already by Newton [17]. We can propose the following elements of the method of calculating force $\mathbf{F}_g$ (4.71) for computed processing:

1. We determine the function of the field of gravitational potentials $C_2(x, y, z)$ and $\varphi_n(x, y, z)$ on the surface of one of the electrons as a result of the combined field of two electrons using equation (4.54)... (4.58).
2. The field of gravitational potentials is transformed into the field of the quantum density of the medium $\rho_1(x, y, z)$ (4.37), because it is its analog. The field of the quantum density of the medium can be determined immediately, bypassing calculations with gravitational potentials.
3. Knowing the distribution function of the quantum density $\rho_1(x, y, z)$ of the medium, we can determine the displacement of the electrical and magnetic charges Δx and Δy inside the quantons on the electron surface in relation to the non-perturbed vacuum with the quantum

density ρ_0. The displacement of the charges is used to determine the variation of the modulus of tensions $\Delta T_{1S} f(r_e, \theta, \beta)$ of the quantised medium on the electron surface.

4. The direction of the tension vector $\Delta \mathbf{T}_{1S}$ is determined from the function of the deformation vector **D** (4.35) as the gradient of the quantum density of the medium, or from the function of the vector of strength **a** (4.59) of the gravitational field of two electrons.
5. Knowing the modulus and the direction of the tension vector $\Delta \mathbf{T}_{1S}$, we determine the functions of its normal components $\Delta T_{n2} f(r_e, \theta, \beta)$ and $\Delta T_{n2} f(r_e, \theta, \beta)$ on the surface of the electron from two sides and, correspondingly, we determine the Newton gravity force $\mathbf{F}_g$ (4.71).

We can directly integrate function $\Delta \mathbf{T}_{1S}$ over the surface of the electron and determine the force $\mathbf{F}_g$. For the system of two solids having the axial symmetry, the direction of interaction of masses can be examined more conveniently along the Y axis, rather than along the X axis (Fig. 4.6). However, in this case it is necessary to determine more accurately the element of the electron surface dS (4.64). In any case, partial solutions of the problems of gravitation of two or more solids (particle) in the total volume taking into account the tension of the medium are connected with cumbersome calculations and require computing methods. It should be mentioned that when two identical masses come together, the total deformation energy of the medium in all stages of approach (Fig. 4.4) remains constant and equal to $2 m_e C_o^2$, including the moment when they merge (stage 4c). Finally, the merger of two electrons is not possible in reality because of their strong electrical repulsion.

4 .11. Gravitational well of the electron

The presence of the gravitational well of the electron was not previously examined in quantum theory, like the gravitational diagram as a whole. The fact that the energy balance of the electron was not known and this complicated understanding of the physics of the electron and of its quantised structure. The energy zone (a-b-c) of the electron has already been partially investigated as the region (a-b) of gravitational attraction. The gravitational well is the potential well of the electron produced as a result of adding the region (b-c) of gravitational repulsion to the region (a-b) of gravitational attraction .

In Fig. 4.2, the gravitational well is actually represented by the well (a-b-c) on the gravitational diagram. The gravitational well forms as a result of stretching the quantised medium in the external region of space beyond the classic radius r_e of the electron during its compression inside the classic radius, forming a jump of the quantum density of the medium $\Delta\rho$ and gravitational potentials $\Delta\varphi$ at the gravitational boundary of the electron. Thus, the mass (4.1) of the electron forms as an energy bunch of the spherically deformed medium.

Figure 4.7 shows the truncated gravitational diagram of the electron responsible for the formation of the electron mass. In particular, the energy of spherical deformation of the quantised medium on the truncated gravitational diagram of the electron is equivalent to its mass. The truncated diagram does not show the zone of hidden energy and electron mass.

The energy W_{a-d} of deformation of the quantised medium in the section (a–b–c–d) determines the rest energy W_0 (4.1) of the electron and is divided into halves between the energy W_{a-c} of deformation of the medium inside the gravitational well and energy W_{c-d} of the formation inside the gravitational boundary. Taking into account the stable state of the electron, determined by the equilibrium of the energies $W_{a-c} = W_{c-d}$ inside the gravitational well and the gravitational boundary, we can write the deformation the other quantised medium inside the gravitation well as half the rest energy of the electron

$$W_{a-c} = W_{c-d} = \frac{1}{2} W_o = \frac{1}{2} m_e C_0^2 \tag{4.72}$$

Attention should be given to the fact that the deformation energy of the quantised medium is determined by the redistribution of the quantum density of the medium as a result of its compression inside the gravitational boundary due to stretching from the external side. In this case, it may be that the

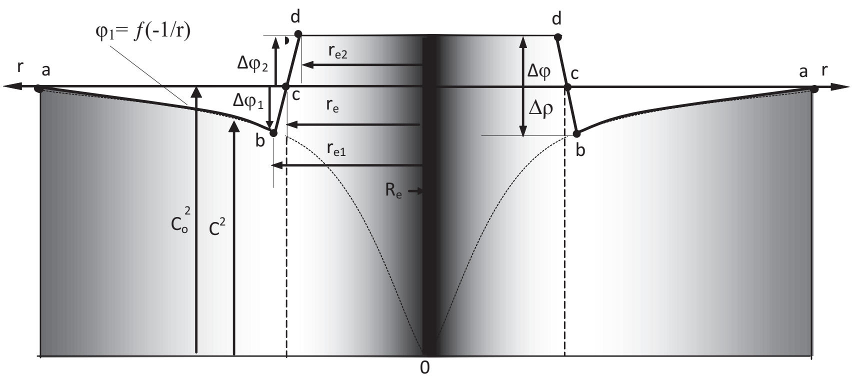

Fig. 4.7. Truncated gravitational diagram of the electron, responsible for the formation of its mass.

gravitation well of the electron forms as a result of the quantons being transferred from the gravitational well into the internal part of the gravitational boundary thus ensuring some balance of the quantum density of the medium. In fact, this balance is not reached. To confirm this assumption, we calculated the number by which the number of quantons ΔN_{q2} inside the conventional gravitational boundary with radius r_e is higher, replacing the exchange integrals by the integral with respect to the direction r ($dV = Sdr = 4\pi r^2 dr$) and taking into account $R_g = R_e$ (4.19)

$$\Delta N_{q2} = \int_0^{r_e} \Delta\rho_2 dV = \int_0^{r_e} \Delta\rho_2 S dr = 4\pi \int_0^{r_e} \rho_o \frac{R_e}{r_e} r^2 dr = \frac{4}{3}\pi R_e r_e^2 \quad (4.73)$$

The number of quantons ΔN_{q1} which could fill the gravitational well is determined within the integration limits from r_e to $r \to \infty$:

$$\Delta N_{q1} = \int_{r_e}^{r} \Delta\rho_1 dV = 4\pi \int_{r_e}^{r} \rho_0 \frac{R_e}{r} r^2 dr = 2\pi\rho_0 R_e r^2 \Big|_{r_e}^{r} =$$
$$= 2\pi\rho_0 R_e r^2 - 2\pi\rho_0 R_e r_e^2 \quad (4.74)$$

Comparing (4.73) and (4.74), we determine that the expected balance of the quantum density does not form. Regardless of the fact that externally the integrals (4.73) and (4.74) are similar, their integration limits differ. Integral (4.74) is diverging because the parameter r is not restricted on the outside. This means that in spherical compression of some region of quantised space-time the stretching of its external region is theoretically extended to infinity. For this reason, the direct determination of the continuous function of distribution of the quantum density of the medium and gravitational potentials of the electron leads to diverging integrals by infinities on the outside. It is possible that there is a continuous solution of the distribution function of the electron differing from the piecewise function (4.5) in Fig. 4.2, but this must be proved.

It should be mentioned that the zone of the gravitational well includes part of the region of gravitational repulsion, i.e., the zone of antigravitation, represented by the section (b–c).

4.12. The zone of anti-gravitational repulsion

The open zones (b–c–d–e) of antigravitational repulsion at the electron (Fig. 4.2) are of global importance for the development of the physics of elementary particles and the atomic nucleus. In particular, the zone of gravitational repulsion explains many reasons for the behaviour of elementary particles, both the electron itself and of other particles, interacting with the electron or formed as a result of such an interaction. Primarily, this relates to: stability of the orbital electron in the composition of the atom nucleus, electrical nature of the nuclear forces, and also the structure of the positron, electronic neutrino, proton and neutron, and other particles.

Thus, an orbital electron, falling on the atom nucleus, may travel quite close to the nucleus itself but is not capable of falling on the nucleus. Falling on the nucleus is prevented by the zone of antigravitational repulsion restricted by the classic radius of $2.8\cdot10^{-15}$ m of the electron. The zone is comparable with the radius of the effect of nuclear forces. An exception is electronic capture of the particle by the proton when the atomic nucleus captures spontaneously the electron from the internal shell of the atom with emission of an electronic neutrino. Electronic capture is a probability process which is made possible by the specific features of the shell model of the proton with the excess electrical charges of positive polarity implanted into the alternating shell [10].

We can estimate the value of the force $\mathbf{F}_g$ of antigravitational repulsion of the electron from the proton nucleus of the atom with mass m_p, knowing the value of negative acceleration $\mathbf{a}$ (4.18) of repulsion (the strength of the gravitational field) at the gravitational boundary (b-c-d) of the electron:

$$\mathbf{a} = -\frac{\Delta\varphi}{\Delta r}\mathbf{1}_r = -\frac{C_0^2}{r_e}\mathbf{1}_r = -3.19\cdot10^{31}\,\mathrm{m}/s^2\cdot\mathbf{1}_r \qquad (4.75)$$

$$\mathbf{F}_g = m_p\mathbf{a} = 1.67\cdot10^{-27}\cdot(-3.19\cdot10^{31}) = -5.3\cdot10^4\,\mathrm{N}\cdot\mathbf{1}_r \qquad (4.76)$$

For comparison, we determine the force $\mathbf{F}_e$ of electrical attraction between the charges of the electron and the proton at the distance of the classic radius r_e, as in the case of (4.76)

$$\mathbf{F}_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_e^2}\mathbf{1}_r = 29\,\mathrm{N}\cdot\mathbf{1}_r \qquad (4.77)$$

As indicated by (4.76) and (4.77), the force of antigravitational repulsion $\mathbf{F}_g$ of the electron from the proton is considerably greater than the force of electrical attraction of the charges of the gravitational interface, i.e. $\mathbf{F}_g \gg \mathbf{F}_e$. Taking into account that at the distances of the effect of nuclear forces the proton also has its own local zones of gravitational repulsion in the zones of distribution of the charges in the alternating shell of the proton, the incidence of the electron on the proton is possible with low probability only in an exceptional case of electronic capture [10].

It should be shown that the classic approach to the determination of the force $\mathbf{F}_g$ (4.76) is approximate at short distances of interaction of the elementary particles. A more accurate value of force $\mathbf{F}_g$ may yield the expression (4.71) or some other expression, taking into account the tension of the quantised medium.

For the force $\mathbf{F}_g$ (4.76) the value of the negative acceleration **a** (4.75) is calculated in a very small interval equal to $\Delta r = 2R_g$ (4.17) on the condition $R_g = R_e$ (4.19), but extends to the entire radius r_e, determining the acceleration **a** as a constant (4.75). Therefore, integrating (4.75) over the distance r, we determine the linear dependence of the gravitational potential φ_2 on the distance r inside the classic radius r_e of the electron

$$\varphi_2 = C_0^2\left(2 - \frac{r}{r_e}\right) \tag{4.78}$$

Figure 4.8 shows the section of the gravitational diagram of the electron with the linear function (c–d–e) of the gravitational potential $\varphi_2 = f(r)$ (4.78) inside the classic radius r_e.

On the other hand, the function of distribution of the gravitational potential $\varphi_1 = f(-1/r)$ (4.5) inside the classic radius of the electron was previously determined (more accurately r_e–R_e). This function is inversely proportional to the distance r for $R_g = R_e$ (Fig. 4.2):

$$\varphi_2 = C_0^2\left(1 + \frac{R_e}{r}\right) \tag{4.79}$$

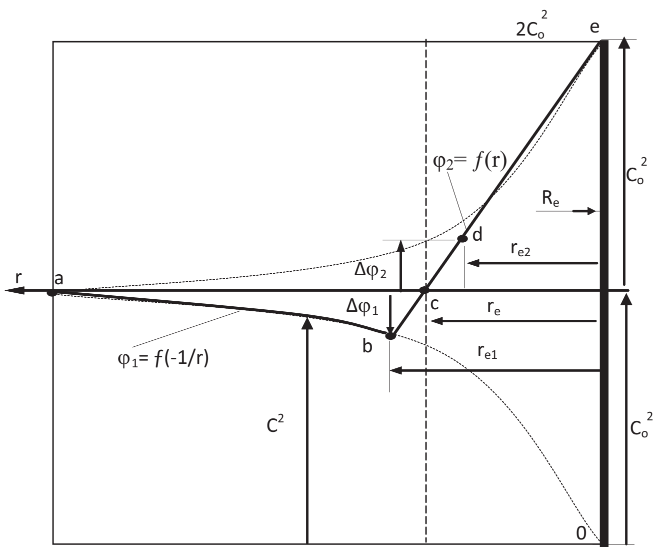

Fig. 4.8. Section of the gravitational diagram of the electron with the linear function (c-d-e) of the gravitational potential inside the classic radius r_e.

The two functions (4.78) and (4.79) satisfy, although only approximately, the boundary conditions: 1) at $r = r_e$, $\varphi_2 \approx C_0^2$, 2) at $r = R_e$, $\varphi_2 \approx 2C_0^2$.

However, the function φ_2 (4.79) at the point (d) at $r = (r_e - R_e)$ on the gravitational diagram in Fig. 4.2 has a relatively low value of negative acceleration $\mathbf{a}'$ (strength of the field) which is incommensurably small in comparison with (4.75):

$$\mathbf{a}' = \text{grad}\ \varphi_2 = -C_0^2 \frac{R_e}{r_e^2} \mathbf{1}_r = -7.6 \cdot 10^{-12} \text{m/s}^2 \cdot \mathbf{1}_r \tag{4.80}$$

$$\frac{a}{a'} = \frac{r_e}{R_e} = 4.2 \cdot 10^{42} \tag{4.81}$$

Inside the radius $r_e - R_e$ the function (4.79) does not ensure that the forces of repulsion of the masses are higher than the forces of electrical attraction of the charges of the electron and the proton. It appears that the anti–gravitational repulsion should be the result of a very narrow zone (b–c–d) of the gravitational boundary of the electron equal to $2R_e$, which can be regarded as a gravitational screen with the colossal strength $\mathbf{a}$ of the field (4.75).

We have already discussed the energy screening of the internal region of the electron. It should be assumed that the screening of the hidden mass and energy of the electron is realised by the previously mentioned gravitational screen. Only the exchange energy processes of the electron with the external medium beyond the classic radius r_e have been resolved. On the other hand, the gravitational screen remains transparent to the electrical field of the point charge of the electron.

Thus, there are two functions of the distribution of gravitational potentials inside the classic radius of the electron: linear (4.78) and non-linear (4.79). The linear function determines the zone of gravitational repulsion with the colossal strength of the field (4.75) inside the classic radius of the electron throughout the entire volume. The non-linear function does not ensure that the repulsion forces of the masses prevail over the forces of electrical attraction of the electron and the proton. In this case, the function of anti-gravitational repulsion should be played by the gravitational boundary of the electron (b–c–d).

On the other hand, the gravitational boundary (b–c–d) of the electron is the purely calculation parameter equal to $2R_e$ (4.17) of the order of 10^{-57} m. This means that the boundary (b–c–d) does not have any physical analogue because at least one layer of the quantons, representing the physical gravitational boundary, has the thickness equal to the quanton diameter ($L_{q0} = 0.74 \cdot 10^{-25}$ m), and this thickness is considerably greater than $2R_e$ (4.17). In this case, the gravitational boundary should be wider. Taking into account the linear dependence of the gravitational potential (4.78) at the gravitational boundary, the point (*d*) on the gravitational diagram should move upwards, determining the new potential φ_{2d} and resulting in a considerably larger jump $\Delta\varphi$ of the gravitational potential:

$$\varphi_{2d} = C^2 = C_0^2\left(2 - \frac{r_e - L_{q0}}{r_e}\right) = C_0^2\left(1 + \frac{L_{q0}}{r_e}\right) \tag{4.82}$$

$$\Delta\varphi = C_0^2\frac{L_{q0}}{r_e} \tag{4.83}$$

Thus, it is possible that the true value of the function of the gravitational potential in the section (b–c–d–e) of the gravitational diagram of the electron is determined by the third function which takes into account the special features of the relationships (4.78) and (4.76), shown in Fig. 4.2 and 4.8. For this purpose, the point (*d*) on the gravitation diagram in Fig. 4 .2 should be transferred in a linear fashion to the region of the potential (4.82). Possibly, the gravitational boundary of the electron is in reality even wider (4.83), but further investigations are required to confirm this.

In early studies of the EQM theory, the zone of antigravitational repulsion of the electron was not yet taken into account, although the gravitational diagram for the minus mass had already been investigated. Naturally, analysis of the shell model of the nuclons and of the nuclear forces would be incomplete without taking into account the zone of antigravitational repulsion [10], together with analysis of the orbital electron and other masses and this will generate a number of questions which can be fully answered after discovering the zone of antigravitational repulsion of the electron.

4.13. The zone of the minus mass of the electron

In addition to the plus mass m_0, the electron contains the hidden mass m_{max} (4.29) and energy W_{max} (4.28) which characterises the zone (c–d–e) of action of antigravitation and minus mass.

If the gravitational well is removed from the electron, i.e., if the energy zone (a–b–c) on the gravitational diagram is removed (Fig. 4 .2), we obtain a completely new, purely hypothetical particle without additional mass (plus mass), but having the energy band (c–d–e) of anti-gravitational repulsion which in fact represent nothing else but the minus mass.

This hypothetical particle with the minus mass cannot exist in the free condition, but it is interesting from the theoretical viewpoint because it enables us to analyse the effect of antigravitation on both the plus mass and the minus mass. This hypothetical particle will be referred to as, for example, 'electrino' (the negative charge with the minus mass).

The plus mass is characterised by the presence of a gravitational well in the form of the zone (a-b-c) and by a decrease of the gravitational potential of action $\varphi_1 = C^2$ and the quantum density of the medium ρ_1 on approach to the electron centre, governed by the condition:

$$C^2 << C_0^2; \quad \rho_1 << \rho_0 \tag{4.84}$$

In contrast to the plus mass, the minus mass gives a negative value of strength **a** (4.75) of the gravitational field. The minus mass is characterised by the presence of a gravitational hillock in the form of the zone (c-d-e) and by an increase of the gravitational potential $\varphi_2 = C^2$ quantum density of the medium ρ_2 on approach to the centre of the electron, governed by the condition:

$$C^2 >> C_0^2; \quad \rho_2 >> \rho_0 \tag{4.85}$$

The interaction between the plus mass and the minus mass has been studied insufficiently [2]. At the moment, it is clear that the presence of the minus mass at the electron prevents the electron from falling on the nucleus of the atom and this is manifested also in a number of cases which are of fundamental importance in the physics of elementary particles and atomic nucleus.

Formally, the gravitational attraction and antigravitational repulsion of both the plus mass and the minus mass can be explained by rolling into a gravitational well (Fig. 3.15) or by sliding from a gravitational hillock shown in the diagram in Fig. 3.19. On the external side of the gravitational well the test mass rolls sidewise to the centre of the electron, determining the forces of gravitational attraction. On the internal side of the electron, the test mass also rolls down from the gravitational hillock but in the opposite side from the centre of the electron, determining the forces of antigravitational repulsion [2].

However, in reality, the interaction of the plus mass and the minus mass is determined by the sum of all tensions of the quantised medium for the given system and by the variation of the force interaction in the system which depends on the distance between the masses and on the magnitude of the mass.

Can the minus mass be regarded as antimatter? Nowadays, in physics there is a sharp boundary between matter and antimatter which is often substituted by the concept of the particle and the anti particle. For example, the positron in relation to the electron is an antiparticle although, like the electron, it has a plus mass and is characterised only by the positive polarity of the electrical charge.

If we disregard the concept of the polarity of the charge of the particle and accept the formulation of matter and antimatter as the plus mass and the minus mass, respectively, we face contradictions regarding the electron and the positron. Clearly, the concepts of the matter and antimatter are not equivalent to the concept of the particle and the antiparticle, and require more detailed examination.

It is accepted that antimatter and matter should react completely, transforming to radiation energy. If the minus mass of the electron is characterised as the antimatter, a paradoxic situation forms in the case of the electron in which the matter and the antimatter are situated in the same particle without interacting together. In the electron, the plus mass and the minus mass are separated by the gravitational boundary (b-c-d), having the role of the gravitational screen. However, regardless of this, the plus mass and the minus mass of the elementary particles cannot in principle react together because of their antigravitational repulsion.

When the electron is accelerated to the relativistic velocities, its hidden mass, like the minus mass, transforms to the plus mass, increasing the depth of the gravitational well (a-b-c) and, correspondingly, the energy of the spherical deformation of the quantised medium in the external region beyond the classic radius of the electron. Experimentally, this fact is manifested as the increase of the mass of the relativistic electron.

4 .14. Annihilation of the electron and the positron

The theory of the electron is based on the well-known experimental facts which enable us not only to clarify the parameters of the electron but also examine the very physical processes, for example, processes such as the annihilation of the electron and the positron. Therefore, albeit briefly, it is necessary to discuss this question, taking into account the fact that annihilation of the electron and the positron may be accompanied by breaking of the gravitational boundaries of the electron.

Formally, the gravitational diagram of the positron does not differ from that of the electron (Fig. 4.2). The positron, like the electron, includes the plus mass and the hidden minus mass. The main difference of these particles is in the opposite polarity of their electrical charges.

The term 'annihilation', denoting the disappearance, destruction of the particles, is not suitable in this case because the annihilation of the electron and the positron is characterised by the processes of transformation of the particles with full adherence to the laws of conservation: energy, mass, pulse, charges and information. The process of annihilation of the electron and the positron is interesting because it makes it possible to analyse the mutual penetration of the particles when their gravitational boundaries break open $\Delta\varphi$ (4.16) and (4.82).

Experimentally, it has been found that in annihilation of the nonrelativistic electron and the positron, the energy released in the form of radiation equals 1.022 MeV and is equivalent to the plus mass of the particles, having 0.511 MeV each. This means that the electron and the positron have lost the region (a-b-c-d) on the gravitational diagram, Fig. 4.2, which was responsible for the presence of the plus mass in the electron and the positron (Fig. 4.7).

Taking these considerations into account, we can write the reaction of annihilation of the electron and the positron for the two-photon gamma radiation 2γ, denoting the electron and the positron as e_m^- and e_m^+ (index $_m$ denotes the presence of mass in the particle, index $^\pm$ the presence of the electrical charge) [9–14]

$$\begin{gathered} e_m^- + e_m^+ \rightarrow 2\gamma + e^- e^+ \rightarrow 2\gamma + \nu_e \\ \text{where} \quad e^- e^+ \rightarrow \nu_e \end{gathered} \tag{4.86}$$

The annihilation of reaction (4.86) shows that only the plus mass of the particle transfers to the emission of two gamma quanta 2γ, and the charges form an electrical dipole $e^- e^+$ which represents the electronic neutrino ν_e. In particular, the electrical dipole $e^- e^+$ is the elementary bit of information in vacuum showing that a pair of particles has formed: the electron and the positron, fulfilling the law of conservation of information. On the whole, the electron neutrino carries the total hidden energy of the electron and the positron, fulfilling the conservation laws.

It is important to understand the processes taking place in the gravitational and electrical fields of the electron and the positron after annihilation. As shown earlier, only the radial electrical field is capable of ensuring the total spherical deformation of the quantised medium generating the plus and minus mass of the electron and the positron.

After annihilation, the radial electrical fields of the particles breakdown and change to the field of the electrical dipole. The spherical symmetry of the fields is disrupted in this case. The electrical field of the dipole is not capable of sustaining the total spherical deformation of the quantised medium. This is accompanied only by the breaking up of the external gravitational field determined by the gravitational well and the plus mass of the particle. The released energy of deformation of the quantised medium changes to the wave electromagnetic radiation of gamma quanta.

What does take place in the internal field of the particles and in the minus mass? Since the energy of the particles is not manifested in the form of radiation and remains unchanged, the energy equilibrium of the system is ensured on the whole and is determined by the equality:

$$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{a\max}} - 2m_0C_0^2 = 0 \tag{4.87}$$

The first term in (4.87) determines the energy of interaction of the electrical charges of the dipole (electronic neutrino) of the maximum distance r_{amax} of annihilation between the charges. The second term shows that the energy of the system on the whole decreased by the radiation energy 2γ to which the two plus masses of the particles were transformed. In order to split the electronic neutrino into the electron and the positron, it is necessary to break up the electrical dipole and separate the electrical charges. For this purpose, the energy not lower than 2 $m_0C_0^2$ should be supplied to the dipole.

From equation (4.86) we determine the maximum distance r_{amax} of annihilation which is half the classic radius of the electron r_a (3)

$$r_{a\max} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{2m_0C_0^2} = 1.41\cdot10^{-15}\,\text{m} \tag{4.88}$$

Equation (4.88) shows that after the loss of the plus mass by the electron and the positron in annihilation, the convergence of the electrical charges can be prevented by the force of antigravitational repulsion of the minus masses.

This shows that after the loss of the plus mass as a result of annihilation, the electron and the positron are transferred to the state of charges with the minus mass, forming the electronic neutrino.

Figure 4.9 shows conventionally (without the scale) the electrical field of the electron neutrino as the field of the electrical dipole and its gravitational diagram with the double minus mass. If we analyse this electrical field along the equal potential lines (equipotentials), then we can see that in the case of the dipole the spherical symmetry is clearly disrupted.

For the radial electrical field of the free electron (positron), the equipotentials represent concentric circles with the central electrical charge, having spherical symmetry. In the dipole, the spherical symmetry of the field is disrupted. The equipotentials and charges are displaced.

The disruption of the spherical symmetry of the field results in a weakening of the sustaining force by the charges of the minus mass which should decrease with annihilation of the particles. This should be accompanied by the generation of additional energy to radiation. It is possible

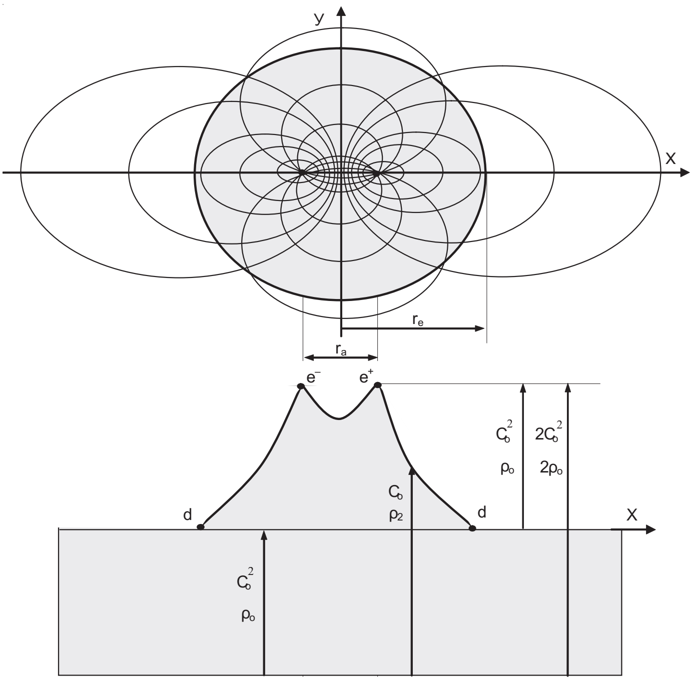

Fig. 4.9. Electrical field of the electronic neutrino as the field of the electrical dipole and its gravitational diagram with the double minus mass.

that this is also detected in some experiments which were regarded as artefacts because of the disruption of the law of energy conservation.

However, the classic laws of conservation hold for two-photon radiation. In this case, the loss of the minus mass should be compensated by the increase of the interaction energy of the charges in the dipole as a result of the charges coming together to the annihilation distance r_a which is always smaller than the maximum annihilation distance r_{amax}

$$r_a < r_{a\max} \tag{4.89}$$

The fulfilment of the condition (4.89) is connected with breaking of the gravitational boundary of the charges with the minus mass. This break may be expressed in the mutual penetration of particles into each other behind the gravitational boundary (d-d), or in the displacement of the gravitational boundary in relation to electrical charges during their coming together. In this case, the gravitational boundary can be represented by one of the equipotentials (or by a group of equipotentials) on the gravitational boundary of the neutrino (Fig. 4.9) when the equipotentials have been displaced and deformed.

It should be mentioned that the antigravitational field of the neutrino and the electrical field of the dipole are anisotropic. Consequently, the radius of interaction and the scattering cross-section of the neutrino depend on the orientation of the neutrino in relation to the object of interaction. The radius of interaction of this field is very small and comparable with the classic radius of the electron for the maximum annihilation distance r_{amax} and the radius of the effect of the nuclear forces. Taking into account the condition (4.89), the radius of interaction and the scattering cross-section of the neutrino can be very small.

In a general case, the annihilation distance, satisfying the condition (4.89) can be determined from the electrical dipole moment of the neutrino or scattering cross-section of the neutrino on the particles.

According to the data in [19], the dipole electrical moment p_e of the neutrino is approximately equal to 10^{-20} e·cm

$$p_e = r_a e = 10^{-22} e \cdot \text{m}, \quad \text{from which} \quad r_a = 10^{-22}\,\text{m} \tag{4.90}$$

At the distance $r_a = 10^{-22}$ m between the dipole charges, the electrical energy W_{ev} of the electronic neutrino is:

$$W_{ev} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_a} = 2.3 \cdot 10^{-6}\,\text{J} = 1.4 \cdot 10^{25}\ \text{eV} \tag{4.91}$$

Equation (4.91) shows that when the neutrino charges come together, the electrical energy of the interaction of the charges of the dipole increases, ensuring an energy balance. The former hidden energy of the particle with the minus mass should decrease by the value (4.91).

Evidently, the quantity (91) establishes the limiting electrical energy of the charges of the electronic neutrino which is considerably smaller than its hidden energy $2W_{max}$ (4.28) which, in turn, is determined by the electrical radius R_e = 6.74·10^{-58} m (4.19) of the electron. However, the linear parameters of the quantised medium are determined by the quanton diameter L_{q0} = 0.74·10^{-25} m [1] and greatly exceed the radius of the point charge R_e.

This means that the interaction of the point electrical charge of the electron with the quantised medium does not start at the distance R_e = 6.74·10^{-58} m and, instead, it starts at a distance equal to the size of the quantons of the order of 10^{-25} m. In particular, the range of the distances 10^{-25}...10^{-58} m around the point charge of the electron accumulates the main part of the hidden energy of the electron ΔW_{emax}:

$$\Delta W_{e\max} = \frac{e^2}{4\pi\varepsilon_0}\left(\frac{1}{L_{q0}} - \frac{1}{R_e}\right) \tag{4.92}$$

The energy ΔW_{emax} of the electron (4.92) differs only slightly from its limiting energy W_{max} (4.28), since $R_e \ll L_{q0}$. However, energy ΔW_{emax} is not connected with the polarisation of the quantised medium. Therefore, in order to investigate the main part of hidden energy ΔW_{emax} of the electron it is necessary to analyse the polarisation of quantons and their behaviour in the immediate vicinity of the point charge of the electron, and also polarisation of the quantised medium inside the classic radius of the electron.

4 .15. The effect of electrical force on the quanton in the electron

Until now, the structure of the electron in the quantised medium has been studied on the basis of analysis of the distribution of the quantum density of the medium and gravitational potentials, both inside the gravitational boundary of the electron and outside it. No attention was given to the behaviour of an individual quanton in the field of the point charge of the electron, and calculations were carried out on the basis of their group behaviour.

However, knowing the structure of the quantum, we can look inside the quantised medium and investigate the processes of behaviour of an individual quanton in the field of the point charge of the electron. For this, there is sufficient experience and information obtained in the theory of electromagnetism for solving the problems of the effect of forces on the quanton. In [1], attention was given to the structure of the quanton consisting of two dipoles: electrical and magnetic, whose axes are orthogonal.

Figure 4.10 shows the effect of the ponderomotive electrical force $\mathbf{F}_{eq}$ on quantons from the side of the point charge of the electron vector e^-. The quanton is indicated as an electrical dipole with electrical moment $\mathbf{p}_e$. The direction of the vector of the moment in a general case does not coincide with the vector of the strength of the electrical field of the charge $\mathbf{E}$ in the direction of the force $\mathbf{F}_{qe}$, and forms some angle α_{pe}, including with radius $\mathbf{r}$.

It is well known that in the electrical field the electrical dipole tries to unfold by its axis in the direction of the force lines of the strength of the electrical field. In addition, in a nonuniform electrical field (the radial field of the point charge is such a field), the dipole in vacuum is subjected to the effect of the ponderomotive (driving) electrical force $\mathbf{F}_{qe}$ directed towards the charge [20]

$$\mathbf{F}_{qe} = (p_e \cdot \operatorname{grad} E)\mathbf{1}_r \cdot \cos\alpha_{pe} \tag{4.93}$$

where p_e is the modulus of the electrical moment of the quanton, C·m; α_{pe} is the angle between the vectors $\mathbf{p}_e$ and $\mathbf{E}$; grad E is the gradient of the modulus of the strength of the electrical field of the charge.

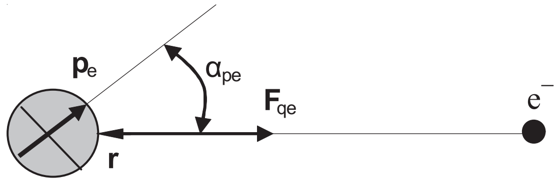

Fig. 4.10. Effect of electrical force $\mathbf{F}_{qe}$ on the quanton from the side of the point charge of the electron e^-.

The electrical moment $\mathbf{p}_e$ of the quanton is determined, knowing the distance between the charges e inside the quanton which is equal to half the quanton diameter 0.5 L_{q0}

$$\mathbf{p}_e = \frac{1}{2} e L_{q0} \mathbf{1}_p \tag{4.94}$$

here $\mathbf{1}_p$ is the unit vector which determines the direction of the dipole mo ment $\mathbf{p}_e$.

The nonuniform electrical field of the point charge of the electron, acting on the quantum with the moment $\mathbf{p}_e$, is a radial field with strength **E**

$$\mathbf{E} = \frac{1}{4\pi\varepsilon_0} \frac{e}{r^2} \mathbf{1}_r \tag{4.95}$$

Substituting modulus p_e (4.94) into (4.93), and determining the gradient of the modulus of the strength of the field **E** from (4.95), we obtain the value of ponderomotive forces $\mathbf{F}_{qe}$, assuming that vector $\mathbf{1}_p$ is taken into account by cos α_{pe}

$$\mathbf{F}_{qe} = p_e \cos\alpha_{pe} \cdot \operatorname{grad} E \cdot \mathbf{1}_r = \frac{1}{4\pi\varepsilon_0} \frac{e^2 L_{q0}}{r^3} \cos\alpha_{pe} \cdot \mathbf{1}_r \tag{4.96}$$

$$\operatorname{grad} \mathbf{E} = \frac{d}{dr}\left(-\frac{1}{4\pi\varepsilon_0} \frac{e}{r^2} \right) = \frac{1}{2\pi\varepsilon_0} \frac{e}{r^3} \mathbf{1}_r \tag{4.97}$$

The expression for the force $\mathbf{F}_{qe}$ (4.96) is not final because we do not know the function of the dependence of angle α_{pe} of rotation of the electrical axis of the quanton in relation to the radius **r** on the distance r. Angle α_{pe} determines the direction of orientation of the quanton in space. It is not possible to determine directly from (4.94) the function of angle α_{pe} when moving away from the point charge of the electron. For this purpose, it is necessary to derive another equation for the dipole moment of the quanton.

This can be done by means of the theory of electromagnetism. Taking into account that the volume of the quanton V_q is characterised by dielectric permittivity ε_0 as the electrical parameter of the vacuum penetrated by the electrical field **E** (4.95) of the point charge of the electron, the volume integral gives the value of the dipole moment of the volume. However, the given volume of the quanton also includes two electrical charges whose effect can be taken into account by coefficient k_p. The new moment is referred to as the reduced dipole moment $\mathbf{p}'_e$ of the quanton in the field of the electron charge:

$$\mathbf{p}'_e = k_p \varepsilon_0 \int_V \mathbf{E}\, dV = k_p \varepsilon_0 \mathbf{E} \cdot \frac{1}{6} \pi L_{q0}^3 = \frac{k_p}{24} e \frac{L_q^3}{r^2} \mathbf{1}_r \qquad (4.19)$$

It can be seen that the reduced moment $\mathbf{p}'_e$ (4.98) of the quanton differs from the dipole moment $\mathbf{p}_e$ (4.94) and takes into account the effect of the strength **E** (4.95) of the field of the point charge of the electron on the magnitude of the moment. A distinguishing feature of the reduced moment $\mathbf{p}'_e$ of the quanton (4.98) is that it takes into account the behaviour of the quanton in the immediate vicinity of the point charge of the electron in the first layer and determines the boundary conditions for the determination of coefficient k_p.

Figure 4.11 shows schematically the first layer of the quantons around the point charge of the electron, represented by three quantons in the cross-section. This corresponds to dense packing of the quantons in vacuum. In the gap between the quantons in the centre of the electron there is a point charge which differs from the monopole charge of the quanton by the radius R_e. As already mentioned, this enables the point charge to tunnel in the gaps between the quantons during movement of the electron, ensuring wave transfer of the mass as spherical deformation of the quantised medium.

In fact, if the point electrical charge of negative polarity is injected into the quantised medium, the quantons in the medium start to move towards the point charge. The following effects should be observed in this case:

1. The quantons will try to rotate by their electrical axis along the radius **r** in the direction to the point charge of the electron.
2. The electrical charges inside the quanton should be displaced in relation to the equilibrium position. The charge of the positive polarity of the quanton should be displaced to the point charge of the electron, and vice versa, the charge of negative polarity of the quanton should be moved away from the point charge.
3. The quanton should be compressed by the pressure resulting from all quantons directed towards the point charge of the electron, increasing the quantum density of the medium inside the gravitational boundary of the electron.

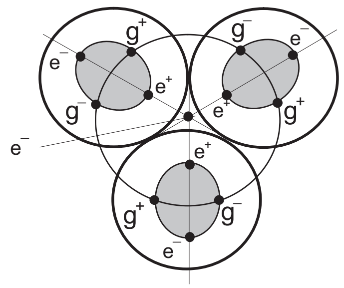

Fig. 4.11. The first layer of the quantons around the point charge of the electron.

Initially, we examine compression of the quanton in the first layer (Fig. 4.11) and subsequently the displacement of its charges and orientation of the quanton in space. It is quite complicated to estimate the compression of the quanton in the field of the electron charge for a single quanton because compression is determined by the set of the pressures of the quantised medium as a result of the effect of the electrical field on all quantons around the point charge. Compression of the quanton is determined by the quantum density of the medium or by the value of the gravitational potential.

We examine the region of the first layer of the quantons around the point charge of the electron assuming approximately that the thickness of this layer is equal to the quanton diameter L_{q0}. The value of the gravitational potential at the distance L_{q0} from the point charge can be estimated using two equations (4.78) and (4.79):

$$\varphi_2 = C_0^2\left(2 - \frac{L_{q0}}{r_e}\right) \approx 2C_0^2 \tag{4.99}$$

$$\varphi_2 = C_0^2\left(1 + \frac{R_e}{L_{q0}}\right) \approx C_0^2 \tag{4.100}$$

It can be seen that the equations (4.99) and (4.100) gave completely different results which at present can be used to propose two variants because of the absence of essential experimental data:

1. In accordance with (4.99), the quanton is located in the field of the limiting gravitational potential $2\,C_0^2$, and this means that it is compressed to the limiting state $0.8L_{q0} = L_{q0}/\sqrt[3]{2}$. Naturally, equation (4.99) treats the compression of the quanton in the vicinity of the point charge of the electron as limiting compression. However, if this is proven by experiments in the investigations of the limiting parameters of the electron, then the assumptions determined by the equation (4.19) can be developed further for the renormalisation of the hidden energy (4.28) of the electron from the range of the distances $r_e...R_e$ to the new range $r_e...L_{q0}$ in which

the quantons are actually present.

2. In accordance with (4.100), the quanton is situated in the field of the gravitational potential $\sim C_0^2$ similar to the equilibrium state of the quantised medium, and compression of the quanton can be ignored. In this case, we can also estimate the hidden energy of the electron $W_{\max}^1$ in the first stage using (4.100) and the method of transfer of the hidden mass (4.29) on the level of the gravitational potential (4.100), accepting that the distance r_0 from the point charge to the centre of the quanton in Fig. 4.11 is the calculation distance r_0=0.58L_{q0}

$$r_0 = \frac{0.5L_{q0}}{\cos 30^0} = 0.58L_{q0} \tag{4.101}$$

$$W_{\max}^1 = m_{\max}\varphi_2 = \frac{C_0^2}{G} r_e \cdot C_0^2 \frac{R_e}{0.58L_{q0}} = \frac{C_0^4}{G}\frac{r_e}{0.58L_{q0}} R_e =$$
$$= m_0 C_0^2 \frac{r_e}{0.58L_{q0}} = 6.57\cdot 10^{10} m_0 C_0^2 = 3.36\cdot 10^{16}\,\text{eV} \tag{4.102}$$

The estimated value of the first stage of hidden energy $W_{\max}^1$ (4.102) is considerably smaller than the limiting energy of the electron (4.28). In any case, the estimated value of the hidden energy (4.102) exceeds by 3...4 orders of magnitude the possibilities of the most expensive and powerful elementary particle accelerators. If it were possible to carry out experiments with the acceleration of the electron to the first stage of hidden energies (4.102) and the results would show that the relativistic mass of the electron stopped to grow, then the equation (4.102) would correspond to the limiting mass and energy of the electron.

Theoretical investigations of the behaviour of quantons in the first layer (Fig. 4.11) can be carried out both in the conditions of maximum compression to 0.8 L_{q0} and in the absence of this compression. Since there are no confirming experimental facts, in further calculations we consider the simpler condition in which the compression of the quantons can be neglected.

Since the distance between the charges affects the magnitude of the dipole moments of the quanton (4.94), we estimate the displacement Δx=Δr [1] of electrical charges inside the quanton from the equilibrium state in the field **E** (4.95) of the point charge of the electron:

$$\Delta r = \frac{\varepsilon_0}{2e}\frac{L_{q0}^3}{k_3} E = \frac{1}{8\pi k_3}\frac{L_{q0}^2}{r} \tag{4.103}$$

We determine distances r_{e1} and r_{e2} (Fig. 4.11) to the first and second electrical charges of the quantum from the point charge of the electron taking into account r_0 (4.101):

$$r_{e1} = r_0 - 0.25L_{q0} = 0.33L_{q0} \tag{4.104}$$

$$r_{e2} = r_0 + 0.25L_{q0} = 0.83L_{q0} \tag{4.105}$$

We determine the displacements Δr_{e1} and Δr_{e2} of the first and second electrical charges from their equilibrium state in the first layer of the quantons in the field of the point charge of the electron ($k_3 = 1.44$)

$$\Delta r_{e1} = \frac{1}{8\pi k_3}\frac{L_{q0}^2}{r_{e1}} = 0.08L_{q0} \tag{4.106}$$

$$\Delta r_{e2} = \frac{1}{8\pi k_3}\frac{L_{q0}^2}{r_{e2}} = 0.03L_{q0} \tag{4.107}$$

Taking into account the displacements (4.106) and (4.107), we determine more accurately the distances (4.104) and (4.105) from the electrical charges of the quanton to the point charge of the electron, denoting them by r_1 and r_2:

$$r_1 = r_{e1} - \Delta r_{e1} = 0.33L_{q0} - 0.08L_{q0} = 0.25L_{q0} \tag{4.108}$$

$$r_2 = r_{e2} + \Delta r_{e2} = 0.83L_{q0} + 0.03L_{q0} = 0.86L_{q0} \tag{4.109}$$

Knowing the distances r_1 (4.108) and r_2(4.109), we determine the force $\mathbf{F}_{qe1}$ of the electron on the quanton in the first layer from the side of the field $\mathbf{E}$ (4.95) of the point charge of the electron as the difference of the forces acting on the electrical charges e^+ and e^- inside the quanton:

$$\mathbf{F}_{qe1} = (e^+ - e^-)\mathbf{E} = \frac{e^2\mathbf{1}_r}{4\pi\varepsilon_0}\left(\frac{1}{r_1^2} - \frac{1}{r_2^2}\right) = \frac{e^2\mathbf{1}_r}{4\pi\varepsilon_0 L_{q0}^2}\left(\frac{1}{0.25^2} - \frac{1}{0.86^2}\right) \approx \frac{12}{4\pi\varepsilon_0}\frac{e^2}{L_{q0}^2}\mathbf{1}_r \tag{4.110}$$

An equivalent electrical dipole with the moment $\mathbf{p}'_e$ (4.19) is now placed in the centre of the quanton (Fig. 4.11) at the distance $r_0 = 0.58L_{q0}$ (4.101) from the point charge of the electron. This dipole moment also determines force $\mathbf{F}_{qe1}$ at α_{pe}=0 in the first layer of the quantons

$$\mathbf{F}_{qe1} = \mathbf{p}'_e \cdot \text{grad } E \cdot \mathbf{1}_r = \mathbf{p}'_e \frac{1}{2\pi\varepsilon_0}\frac{e}{r^3}\mathbf{1}_r = \frac{k_p e^2}{48\pi\varepsilon_0}\frac{L_{q0}^3}{r^5}\mathbf{1}_r \tag{4.111}$$

We equate the equivalent forces $\mathbf{F}_{qe1}$ (4.110) and (4.111) at $r = r_0 = 0.58L_{q0}$ and determine the value of the coefficient $k_p = 12$.

We substitute $k_p = 12$ into (4.111) and determine the functional dependence of force $\mathbf{F}_{qe}$, acting on the quantons in the field of the point charge of the electron in relation to the distance r:

$$\mathbf{F}_{qe} = \frac{e^2}{4\pi\varepsilon_0}\frac{L_{q0}^3}{r^5}\mathbf{1}_r \qquad (4.112)$$

It may be seen that the ponderomotive force $\mathbf{F}_{qe}$ (4.112), acting on the quantum in the nonuniform electrical field of the point charge, decreases in inverse proportion to the fifth power of the distance to the electron charge.

Equating the force $\mathbf{F}_{qe}$ (4.112) to the equivalent force $\mathbf{F}_{qe}$ (4.96), we determine the function of angle α_{pe} of the orientation of the quanton in the field of the point charge of the electron when moving away from it:

$$\frac{e^2}{4\pi\varepsilon_0}\frac{L_{q0}^3}{r^5}\mathbf{1} = \frac{e^2}{4\pi\varepsilon_0}\frac{L_{q0}}{r^3}\mathbf{1}_r \cos\alpha_{pe} \qquad (4.113)$$

$$\cos\alpha_{pe} = \frac{L_{q0}^2}{r^2} \qquad (4.114)$$

$$\alpha_{pe} = \arccos\frac{L_{q0}^2}{r^2} \qquad (4.115)$$

We verify (4.115). Angle $\alpha_{pe} = 0$ corresponds to the total orientation of the quanton by the electrical axis along the radius at distance $r = L_{q0}$ from the point charge of the electron. Only the first layer of the quantons penetrates into this region. For subsequent layers of the quantons, the electrical axis does not coincide with the radius **r** as regards direction. As indicated by (4.115), angle α_{pe} of orientation of the quantons in relation to radius **r** increases with movement away from the electron charge. As already mentioned when examining electromagnetism of vacuum, the angle α_{pe} of orientation of the quantons is the mean statistical parameter as a result of polarisation of the quantised medium.

Taking into account (4.111) and (4.94), from equation (4.112) we determine the reduced dipole moment $\mathbf{p}'_e$ (4.98) of the quanton as the function of the distance r in the field of the point charge of the electron:

$$\mathbf{p}'_e = \frac{1}{2}eL_{q0}\frac{L_{q0}^2}{r^2}\mathbf{1}_r = p_e\frac{L_{q0}^2}{r^2}\mathbf{1}_r \qquad (4.116)$$

Thus, the resultant dependence of ponderomotive force $\mathbf{F}_{qe}$ (4.112), acting on the quanton in the nonuniform electrical field of the point charge, can be used to analyse the structure of the electron and its new parameters. However, equation (4.112) is not final because the electron theory is being developed. The result (4.112) is not so important, of greater importance is the new methodical principle of investigating the internal structure of the electron and analysis of its parameters on the basis of the quantum considerations of the discrete space-time.

The accuracy of the equation (4.104) can be improved and the equation can be developed further using the following approach. In the classic theory of electricity [20], the internal structure of the dielectric, consisting of a large number of small electrical dipoles of the neutral molecules in the unit volume dV characterises the given volume by the polarisation vector **P** of the medium. For the internal structure of the electron, the group of quantons with the dipole moment $\mathbf{p}'_e$ (4.116) in the unit volume dV of the medium can be characterised by the electrical vector of polarisation **P** for the dipole moment $\mathbf{p}_{ev}$ in the volume V:

$$\mathbf{P}dV = \sum_{dV} \mathbf{p}'_e = d\mathbf{p}_{ev} \tag{4.117}$$

The sum (4.117) can be presented in the integral form taking into account dielectric susceptibility χ for the linear dependence of the polarisation vector **P** on the strength of the field **E**:

$$\mathbf{p}_{ev} = \int_V \mathbf{P}dV = \varepsilon_0 \int_V \chi \mathbf{E} dV = \varepsilon_0 \int_V (\varepsilon_2 - 1)\mathbf{E}\, dV \tag{4.118}$$

where ε_2 is the relative dielectric permittivity of the quantised medium inside the gravitational boundary of the electron (dimensionless quantity).

Comparing (4.118) and (4.98) it may easily be seen that coefficient k_p is the equivalent of dielectric susceptibility χ:

$$k_p = \chi = \varepsilon_2 - 1, \quad \text{from which} \quad \varepsilon_2 = k_p + 1 = 13 \tag{4 .119}$$

From (4.119) we determine the relative electrical permittivity ε_2 of the quantised medium inside the gravitational boundary of the electron. The presence of ε_2 is determined by the compression of the quantised medium in the formation of the electron mass. For the non-perturbed vacuum $\varepsilon_2 = 1$ and $\varepsilon_1 = 1$. Relative dielectric permittivity ε_1 determines the parameters of the medium in the external region of the medium behind the gravitational boundary of the electron. In a general case, the structure of the electron is characterised by absolute dielectric permittivity ε_a, for both the internal region of the medium and the external region, establishing the jump $\varepsilon_2/\varepsilon_1$ at the gravitational boundary:

$$\varepsilon_a = \varepsilon_2 \varepsilon_0, \quad \varepsilon_a = \varepsilon_1 \varepsilon_0 \tag{4.120}$$

The results showing that the quantised medium for the electron, perturbed by the deformation of vacuum, is characterised by absolute dielectric permittivity ε_a (4.120) coand rrespond to the principles of the classic theory of electromagnetism in which the nucleation of the particles, as real matter, changes the electrical parameters of the quantised medium. Electrical constant ε_0 is a parameter of the vacuum non-perturbed by gravitation, and can be used to calculate the interactions inside the quanton and between the quantons.

In the classic electricity theory, the increase of the dielectric permittivity of the dielectric medium reduces the forces of interaction of the electrical charges in the given medium. In contrast to the classic theory, the increase of dielectric permittivity ε_2 (4.120) inside the electron increases the ponderomotive force $\mathbf{F}_{qe}$ acting on the quantons:

$$\mathbf{F}_{qe} = \frac{(\varepsilon_2 + 1)}{\varepsilon_0} \frac{e^2}{48\pi} \frac{L_{q0}^3}{r^5} \mathbf{1}_r \tag{4.121}$$

The increase of force (4.121) with the increase of ε_2 is explained by the compression of the quantons in the internal region of the electron resulting in a decrease of the distance between the charges of the quanton and, therefore, increases the intensity of fields and interacting forces. Naturally, if the accuracy of all the calculations in which the compression of the medium inside the quanton is improved, this increases the accuracy of analytical expressions.

As already mentioned, gravitational interaction is determined by the simultaneous displacement Δx and Δy [2] of the electrical and magnetic charges inside the quanton in compression or stretching of the quantised medium. This can be realised only by the combined effect of the electrical and magnetic fields on the quanton.

However, prior to transferring to analysis of the magnetic fields of the electron, it should be mentioned that the electrical parameters of the particle in compression of the medium in the internal region are connected with the variable nature of ε_2 as the function of distance to the point charge of the electron. In this case, the quantised medium inside the electron is a heterogeneous medium and is characterised by gradient ε_2 (grad ε_2) which must be taken into account in the calculations.

Attention should be given to the fact that ponderomotive force $\mathbf{F}_{qe}$ (4.112) is not a parameter of the polarisation energy of the quantons inside the electron does not solve the problem of hidden energy $W^1_{\max}$ of the electron (4.102). The classic continues electrical field with strength $\mathbf{E}$ (4.95) determines hidden energy $W^1_{\max}$ (4.102) of the electron without taking into account the deformation of the medium inside the electron at distances up to $r_0 = 0.58L_{q0}$ (4.101):

$$W_{\max}^{1} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{0.58L_{q0}} = \frac{1}{7.3}\frac{e^2}{\varepsilon_0 L_{q0}} \tag{4.122}$$

In transition to the discrete structure of the quanton, the expression (4.122) results in an appreciable error. The energy of interaction of the charges of the quanton with the point charge of the electron is higher than the energy $W_{\max}^{1}$ of the continuous layer (4.122) already in the first layer (Fig. 4.11).

In the cross-section, the first layer contains three quantons and in the volume four quantons. Taking into account that the total energy of interaction of the electrical charges is independent of their polarity, we calculate the total energy W_{q1} accumulated in the first layer of the quantons in the electron structure:

$$W_{q1} = 4\frac{e^2}{4\pi\varepsilon_0}\left(\frac{1}{r_1}+\frac{1}{r_2}\right) = \frac{e^2}{\pi\varepsilon_0 L_{q0}}\left(\frac{1}{0.25}+\frac{1}{0.86}\right) = \frac{5.16}{\pi\varepsilon_0}\frac{e^2}{L_{q0}} \tag{4.123}$$

Prior to interaction with the electron charge, the quanton energy is determined by the equilibrium distance of the medium at the distance of 0.5 L_{q0} between the charges in the quanton. Expression (4.123) does not take into account the energy of interaction between the quantons. Therefore, without taking into account the interaction between the quantons, we determine the internal energy W'_{q1} of four quantons in the electrical equilibrium state

$$W'_{q1} = 4\frac{1}{4\pi\varepsilon_0}\frac{e^2}{0.5L_{q0}} = \frac{2}{\pi\varepsilon_0}\frac{e^2}{L_{q0}} \tag{4.124}$$

The difference of the energies W_{q1} (4.123) and W'_{q1} (4.124) determines the energy Wp_1 of polarisation of the first layer of the quantons by the electron charge:

$$W_{p1} = W_{q1} - W'_{q1} = \frac{3.16}{\pi}\frac{e^2}{\varepsilon_0 L_{q0}} \approx \frac{e^2}{\varepsilon_0 L_{q0}} \tag{4.125}$$

Comparing (4.125) and (4.122) we may see that the discrete energy W_{p1} of polarisation of the electron of the first layer with four quantons is 7.3 times higher than the limiting energy $W_{\max}^{1}$ (4.122) of the continuous field which is determined by the classic electricity theory. We may now see that to describe the internal structure of the electron it is necessary to develop further the quantum theory of electricity based on the discrete representation of the quantised space-time inside the electron.

4.16. Effect of the spherical magnetic field of the quanton. Electron spin

As already mentioned, spherical compression of the quantons around the electron charge resulting in the electron acquiring the mass can be carried out only as a result of the combined effect of the electrical and magnetic fields whose axes are orthogonal or almost orthogonal.

The effect of the radial electrical field of the electron the quanton has already been investigated. It is now necessary to examine the effect of the magnetic field of the electron on the quanton. However, the electron is not a carrier of the magnetic charge and cannot have a magnetic field in the relative rest condition.

It may be assumed that the free electron rotates around its intrinsic axis. The concept of electron spin was developed on the basis of this assumption. For the orbital electron in the composition of the atom rotating around the nucleus, the concepts of the spin has been fully argumented. For the free electron representing part of the quantised medium, the rotation of the electron around its own axis has no physical sense. For this reason, the spin of the free electron is regarded as a mathematical model with no physical analogue. Only the analysis of the quantised structure of the electron makes it possible to describe the physical model of the spin in the form of a spherical magnetic field, described for the first time in [6, 7].

Figure 4.11 shows the first layer of the quantons of the electron in projection on a plane. All the quantons are oriented with the electrical axis along the direction of the strength vector **E** of the radial electrical field of the point charge of the electron. Since the magnetic axis of the quantum is orthogonal to its electrical axis, we can easily see the circulation of the magnetic axes around a circle with the centre denoted by the point charge of the electron.

The circulation of the magnetic axes of the quantons differs in its nature from the circulation of the magnetic field **H**, described previously [1]. The circulation of the magnetic field **H** is regarded as rotor disruption of the magnetic equilibrium of the quantised space-time. Vector **H** is closed on the circle and determines the rotor of the strength of the magnetic field. The circulation of the magnetic axes of the quantons does not lead to any disruption of the magnetic equilibrium of the quantised medium and only changes its topology, forming a spherical magnetic field.

Figure 4.12a shows the scheme of formation of a spherical magnetic field in the vicinity of the point charge of the electron (second and third layer of the quantons). The radial electrical field of the electron orients the electrical axes of the quantons along the field with respect to radius. The magnetic axes close spontaneously around the circumference, rotating the quantons in the required direction.

The magnetic charges g^- and g^+ inside the quanton generate strengths $\mathbf{H}_{q\tau}$ and $\mathbf{H}_\tau$ of the magnetic field both between themselves and with the adjacent quantons. It is interesting to consider the vector of the strength of the magnetic field $\mathbf{H}_\tau$ tangential in relation to the radius **r**. This vector forms the external field between the quantons. In particular, the external field $\mathbf{H}_\tau$ results in the magnetic coupling of the quantons forming a magnetic string closed on the sphere. The equilibrium condition of the fields $\mathbf{H}_{q\tau}$ and $\mathbf{H}_\tau$ and the magnetic string is the equation previously discussed in [1]

$$\Delta\varphi_{1-ny} = \sum_{1x}^{n}\left(\int_{r_k}^{a_y - r_k} \mathbf{H}_\tau dy - \int_{r_k}^{r_{gy}-r_k} \mathbf{H}_{q\tau} dy\right) = 0 \qquad (4.126)$$

In this case, the coordinate y (4.126) is curvilinear and circulates around the circumference and determines the magnetic equilibrium when the difference of the magnetic potentials along the closed circulating contour is equal to 0, i.e. $\Delta\varphi_{1-ny} = 0$ (the notations $\mathbf{H}_y \rightarrow \mathbf{H}_\tau$ and $\mathbf{H}_{qy} \rightarrow H_{q\tau}$ have been changed).

The fields in the presence of which there is no disruption of the magnetic or electrical equilibrium of the quantised space-time but their topology is disrupted have been studied in theoretical physics prior to the development of the EQM theory. In this case, the variation of topology is characterised by the circulation of the magnetic axis of the quantons on the sphere (in the plane of the figure around the circumference). This field should be referred to as spherical.

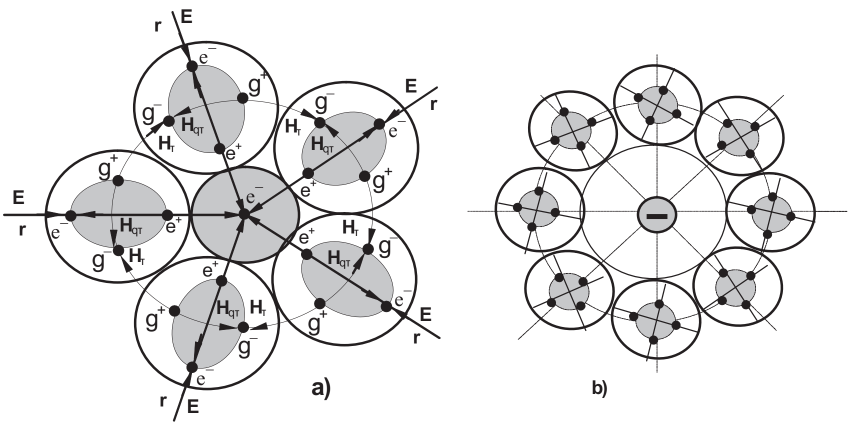

Fig. 4.12. Scheme of formation of the spherical magnetic field in the vicinity of the point charge of the electron (a) and when moving away from it (b).

The spherical magnetic field should be described by a conventional analogue physical model. For this purpose, it is necessary to use small ferromagnetic spheres magnetised as dipoles (magnetics). If the spheres–dipoles are distributed on the spherical surface at small distances between them, the opposite poles of the magnetic dipoles couple with each other and generate tension forces between the spheres on the sphere, forming a spherical magnetic field as a multitude of local magnetic fields. In every cross-section of the spherical magnetic field there are tension forces between the spheres-dipoles, regardless of some random distribution of interaction between the spheres.

Naturally, the spherical magnetic field consisting of quantons differs from the previously presented analogue model. The quantons are so small that their local magnetic fields which have been completely equalised do not manifest themselves in the macroworld. From the position of the macroworld, the spherical magnetic field, formed around a central electrical charge, can be regarded as the imaginary magnetic field of the electron.

The imaginary magnetic field of the electron is denoted by the vector of magnetic strength $i\mathbf{H}$. The imaginary unity i shows that the strength vector $i\mathbf{H}$ of the spherical magnetic field of the electron in the region of the macroworld is only a calculation parameter. The vector $i\mathbf{H}$ is orthogonal to the vector $\mathbf{E}$ (4.95) of the electrical field which is observed in reality. Another distinguishing special feature of the field $i\mathbf{H}$ is that it is the local (quantised field) and is concentrated around the magnetic charge of the quanton. Field $i\mathbf{H}$ can be efficiently characterised by the new vector ($\leftrightarrow$) having two directions in the opposite sides from the charge.

Regardless of the imaginary nature, the strength of the spherical magnetic field $i\mathbf{H}$ has a fully determined physical meaning. Strength $i\mathbf{H}$ determines the tangential force $\mathbf{F}_{g\tau}$ of tensioning of the magnetic charges g^+ and g^- on the sphere as a result of circulation of the magnetic axes of the quantons

$$\mathbf{F}_{g\tau} = \mu_0 g(i\mathbf{H}) \tag{4.127}$$

In the ideal case, the electrical axes of the quantons are oriented along the radius $\mathbf{r}$ like the vector $\mathbf{E}$, and the magnetic axes are situated in the plane in Fig. 4.12a and are closed on the sphere. In this case, the tangential strength of the magnetic field $i\mathbf{H}$ is determined by its components $\mathbf{H}_\tau$ and $\mathbf{H}_{q\tau}$ resulting in the equality of their moduli (modulus $i\mathbf{H}$ is denoted by $\mathbf{H}_i$) of the same distance from the magnetic charge

$$H_i = H_\tau = H_{q\tau} \tag{4.128}$$

In fact, with the increase of the distance from the neutral charge e^- of the electron the strength $\mathbf{E}$ of the electrical field (4.95) decreases. The electrical axes of the quantons no longer coincide with vector **E**, and the magnetic axes are not situated in the plane in Fig. 4.12a. In a general case, when moving away from the charge e^- the tangential strength of the magnetic field i**H** is no longer determined by its components $\mathbf{H}_\tau$ and $\mathbf{H}_{q\tau}$, and is determined only by their projections on the plane in Fig. 4.12b and by projections of the sphere. This weakens the magnetic spherical field whose strength i**H** is the equivalent of the strength of electrical field **E** (4.95) because of symmetry between electricity and magnetism in a vacuum

$$i\mathbf{H} = i(\varepsilon_0 C_0)\mathbf{E} = \frac{1}{4\pi}\frac{ig}{r^2}\mathbf{1}_{r\tau} \tag{4.129}$$

where ig is the imaginary magnetic charge located together with the central perturbing electrical charge e^- and describing the field i**H** (129); $g = C_0 e = 4.8\cdot10^{-11}$ Dirac (Dc) is the elementary magnetic charge; $\mathbf{1}_{r\tau}$ is the unit vector orthogonal to radius **r** and tangential to the spherical surface.

Formally, the moduli of the strength of the electrical E (4.95) and magnetic iH (4.129) fields of the electron can be expressed jointly by a single expression if we introduce the concept of the complex strength Q of the static electromagnetic field of the electron

$$Q = E + iH = \frac{1}{4\pi\varepsilon_0 r^2}e + \frac{1}{4\pi r^2}ig \tag{4.130}$$

The complex strength Q (4.130) can be reduced to a single measurement units, for example, the electrical unit

$$Q = E + \frac{iH}{\varepsilon_0 C_0} = \frac{1}{4\pi\varepsilon_0 r^2}e + \frac{1}{\varepsilon_0 C_0}\frac{1}{4\pi r^2}ig = \frac{1}{4\pi\varepsilon_0 r^2}\left(e + \frac{1}{C_0}ig\right) \tag{4.131}$$

Into (4.131) we introduce the complex charge of the electron q

$$q = e + \frac{1}{C_0}ig \tag{4.132}$$

The complex charge of the electron can be expressed in magnetic units of measuring the charge [1], or in electrical and magnetic units $q = e + ig$.

Thus, albeit formally, the complex charge q (4.132) of the electron as the source of the spherical magnetic field of the electron contains the imaginary elementary magnetic charge g; the position of the charge is combined with the point electrical elementary charge of the electron.

The introduction of the complex charge q (4.132) of the electron which includes the imaginary magnetic charge enables us to transfer to the problem of the electron spin as a physical reality not connected with the rotation of the electron around its own axis. The formation of the magnetic field of the electron (4.129) is caused by the quantum processes, associated with the electrical polarisation of the quantons by the radial electrical field of the point charge of the electron. Symmetry between electricity and magnetism results in the spontaneous formation of the spherical magnetic field of the electron (4.129).

Previously, the spherical fields were not investigated in the theory of electromagnetism. This requires adding additional functions rad **E** and spher (*i***H**) to the theory of vector analysis. Consequently, the operation of the formation of the spherical magnetic field through radial field of the electron can be described by new functions [7]

$$\mathrm{rad}\,\mathbf{E} = \mu_0 C_0\, \mathrm{spher}(i\mathbf{H}) \tag{4.133}$$

Electron spin S_e as the characteristic of the orbital electron is measured in the units of $\hbar$ (here $\hbar = 1.05\cdot10^{-34}$ J·s is the Planck constant)

$$S_e = \frac{1}{2}\hbar \tag{4.134}$$

It should be mentioned that the Planck constant is equivalent to the momentum of the amount of motion of the orbital electron in the first Bohr orbit with the radius r_0 [21]:

$$\hbar = m_e v \cdot r_0 \tag{4.135}$$

Bohr magneton μ_B determines the magnetic moment of the orbital electron as a quanton with the current in SI taking into account $\hbar$ (4.135)

$$\mu_B = \frac{1}{2} ev \cdot r_0 = \frac{1}{2}\hbar\frac{e}{m_e} = 9.27\cdot10^{-24}\frac{J}{T} = \mathrm{A}\cdot\mathrm{m}^2 = \mathrm{Dc}\cdot\mathrm{m} \tag{4.136}$$

The magnetic moment of the electron μ_B (4.136) is measured in the units of the magnetic charge [Dc · m].

$$\mu_B = \frac{1}{2}\hbar\frac{ig}{m_e C_0} \qquad [\mathrm{A}\cdot\mathrm{m}^2 = \mathrm{Dc}\cdot\mathrm{m}] \tag{4 .137}$$

Equation (4.137) determines the magnetic moment of the free electron as an imaginary value linked with its magnetic properties (spherical magnetic field) through the imaginary magnetic charge *ig*. The equivalence of the imaginary magnetic moment (4.137) of the free electron and of the magnetic moment (4.136) of the orbital electron indicates the unity of manifestation of the field quantised structure of the electron in different interactions.

Equation (4.136) includes the Compton wavelength of the electron λ_0

$$\lambda_0 = \frac{\hbar}{m_e C_0} = 3.86\cdot10^{-13}\,\mathrm{m} \tag{4.138}$$

Taking into account (4.138) we obtain the value of the magnetic moment μ_B (4.137) of the electron expressing this moment through the imaginary magnetic charge of the electron and the Compton wavelength λ_0

$$\mu_B = \frac{1}{2} ig \cdot \lambda_0 = 9.27 \cdot 10^{-24}\,\text{Dc} \cdot \text{m} \tag{4.139}$$

Formally, equation (4.139) shows that Compton wavelength λ_0 and the imaginary magnetic charge of the electron *ig* determine its magnetic moment.

It is interesting to consider the purely hypothetically minimum magnetic moment μ_{emin} of the electron, determined by the interaction of the imaginary magnetic charge with the identical charge at the distance of the classic radius of the electron r_e

$$\mu_{e\min} = ig \cdot r_e = 1.35 \cdot 10^{-25}\ \text{Dc·m} \tag{4.140}$$

Dividing (4.149) by (4.139), we obtain the value of the fine structure α [21]

$$\frac{\mu_{e\min}}{\mu_B} = 2\frac{r_e}{\lambda_0} = 2\frac{1}{137} = 2\alpha \tag{4.141}$$

$$\alpha = \frac{r_e}{\lambda_0} = \frac{1}{137} \tag{4.142}$$

As indicated by (4.142), α is determined by the ratio r_e/λ_0. This is understandable because the classic radius of the electron r_e determines its rest energy $m_0 C_0^2$. Compton wavelength λ_0 corresponds to the photon energy equal to the rest energy of the electron: $\hbar C_0 / \lambda_0 = m_0 C_0^2$. In fact, the constant of the fine structure α (4.142) describes the relationship between the corpuscular and wave properties of the electron.

As a corpuscule, the electron is enclosed in the gravitational interface with radius r_e. On the other hand, wave mass transfer takes place during movement of the electron. In this respect, the classic radius of the electron r_e determines, as shown previously, the rest energy of the electron, including the gravitational well (Fig. 4.7). Taking into account that the radius of the gravitational well is considerably greater than the classic radius of the electron and may be comparable with Compton wavelength $r = \lambda_0 = 137 r_e$, the rest energy of the electron may transfer to the energy of photon radiation, determining the wavelength equal to λ_0.

Thus, the investigations of the magnetic parameters of the electron, such as magnetic fields (4.129) and the imaginary elementary magnetic charge *ig* (4.132), make it possible to specify more accurately a number of the properties of the electron, such as spin and other properties, associated with its magnetic parameters.

On the other hand, the presence of the spherical magnetic field at the electron (4.129) enables us to calculate the magnetic force $\mathbf{F}_{qg}$ acting on the quanton in the spherical magnetic field of the electron. The determination of magnetic force $\mathbf{F}_{qg}$ is associated with the analysis of the tangential tension force $\mathbf{F}_{g\tau}$ (4.127) of the magnetic charges g^+ and g^- of the quantons in the spherical magnetic field of the electron.

Figure 4.13 shows the spherical layer of the quantons in the spherical magnetic field of the electron. This layer of the quantons represents an elastic spherical shell or stretching is determined by magnetic force $\mathbf{F}_{g\tau}$ (4.127). The tension force $\mathbf{F}_{g\tau}$, acting on the magnetic charge g inside the magnetic shell, is determined using the strength $i\mathbf{H}$ (4.129) of the spherical magnetic fields of the electron

$$\mathbf{F}_{g\tau} = \mu_0 g(i\mathbf{H}) = \frac{\mu_0}{4\pi}\frac{ig^2}{r^2}\mathbf{1}_{r\tau} \tag{4.143}$$

The tension force (4.143) of the magnetic shell can be expressed by means of the electrical charge $g = C_0 e$

$$\mathbf{F}_{g\tau} = \frac{\mu_0}{4\pi}\frac{i(C_0 e)^2}{r^2}\mathbf{1}_{r\tau} = \frac{1}{4\pi\varepsilon_0}\frac{ie^2}{r^2}\mathbf{1}_{r\tau} \tag{4.144}$$

In order to determine the compressive effect of the tension forces on the shell, it is necessary to determine force $\mathbf{F}_{qg} = \mathbf{N}$, acting on the quanton in the direction to the centre of the electron, where $\mathbf{N}$ is the normal force to the surface of the shell. In particular, this force balances the pressure $\mathbf{P}$ of the quantised medium inside the spherical shell during its compression for the cross-section of the quanton S_q

$$\mathbf{N} = -\mathbf{P}S_q = -\frac{\pi L_{q0}^2}{4}\mathbf{P} \tag{4.145}$$

To determine the pressure of the field inside the shell on the side of the medium during its compression, we used the method of the diametral section of the shell (4.69). In Fig. 4.13 this is represented by section S. The resistance of the shell to fracture is determined by two forces mutually compensating each other: pressure force $\mathbf{F}_p$, acting on every half of the shell from the inside, and the total magnetic tension force $\mathbf{F}_m$, acting in the section of the shell

$$\mathbf{F}_P = -\mathbf{F}_m \tag{4.146}$$

Pressure force $\mathbf{F}_p$ is determined as the force acting in the entire dimensional section of the shell

$$\mathbf{F}_P = \mathbf{P}\cdot\pi r^2 \tag{4.147}$$

The equation, identical with (4.147), has been validated in (4.69). The

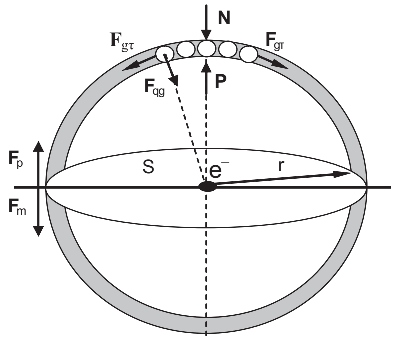

Fig. 4.13. Calculation of the magnetic force $\mathbf{F}_{qb}$ acting on the quanton in the spherical magnetic field of the electron.

magnetic tension force $\mathbf{F}_m$ is determined as the sum of the tension forces $\mathbf{F}_{g\tau}$ (4.127) acting on every magnetic charge inside the quanton in the diametral section of the shell

$$\mathbf{F}_m = \mathbf{F}_{g\tau} n_q = \mathbf{F}_{g\tau} \frac{2\pi r}{L_{q0}} \tag{4.148}$$

where n_q is the number of quantons in the diametral section of the shell.

In accordance with condition (4.146), equating (4.147) and (4.148), we determine the pressure vector **P** of the quantised medium inside the spherical shell of quantons

$$\mathbf{P} = -F_{g\tau} \frac{2}{L_{q0} r} \mathbf{1}_r \tag{4.149}$$

Substituting (4.149) into (4.145), we determine force **N** acting on the quanton as a result of compression of the spherical shell under the effect of tension forces of the spherical magnetic field of the electron

$$\mathbf{N} = -\frac{\pi L_{q0}^2}{4} \mathbf{P} = \frac{1}{2} \frac{\pi L_{q0}}{r} F_{g\tau} \mathbf{1}_r \tag{4.150}$$

Taking into account (4.143), we determine the required force $\mathbf{F}_{qg} = \mathbf{N}$ (4.150), acting on the quanton from the side of the spherical magnetic field of the electron in the direction to its centre

$$\mathbf{F}_{qg} = \mathbf{N} = \frac{\mu_0 g^2}{8} \frac{L_{q0}}{r^3} \mathbf{1}_r \tag{4.151}$$

$i^2 = -1$ was removed from (4.151). The sign (–) can be transferred into (4.151), determining the direction of the force. However, the direction of the force $\mathbf{F}_{qg}$ (4.151) to the centre of the electron is already taken into account by unit vector $\mathbf{1}_r$.

Force $\mathbf{F}_{qg}$ (4.151) can be expressed through the electrical parameters of the electron taking (4.144) into account

$$\mathbf{F}_{qg} = \mathbf{N} = \frac{e^2}{8\varepsilon_0}\frac{L_{q0}}{r^3}\mathbf{1}_r \tag{4.152}$$

Previously, we determine the electrical force $\mathbf{F}_{qe}$ (4.112), acting on the quanton from the side of the nonuniform electrical field of the electron charge

$$\mathbf{F}_{qe} = \frac{e^2}{4\pi\varepsilon_0}\frac{L_{q0}^3}{r^5}\mathbf{1}_r \tag{4.153}$$

Dividing magnetic force $\mathbf{F}_{qg}$ (4.152) by electrical force $\mathbf{F}_{qe}$ (4.153) acting on the quantum inside the electron at a distance equal to its classic radius $r = r_e = 2.8\cdot10^{-15}$ m, we obtain the required relationship:

$$\frac{F_{qg}}{F_{qe}} = \frac{\pi}{2}\left(\frac{r_e}{L_{q0}}\right)^2 = \frac{\pi}{2}\left(\frac{r_e}{L_{q0}}\right)^2 = 2.3\cdot10^{21} \tag{4.154}$$

The result (4.154) changes diametrically the ratio to the effect of the spherical magnetic field of the electron which appears fundamental in comparison with the electrical field in the formation of the electron mass. The magnetic effect on the quantons in compression of the spherical shell at the distance of the classic radius proved to be 10^{21} times greater than electrical compression.

Thus, the spherical magnetic field plays the controlling role in the deformation of the quantised space-time in generation of the electron mass. This is explained by the fact that in comparison with the radial electrical field of the electron, the spherical magnetic field is closed on the sphere ensuring greater tensioning of the quantised medium for the same conditions (equivalent strength of the field).

However, at distances close to the centre of the electron, the forces of magnetic F_{qg} and electrical F_{qe} effects on the quanton are equal

$$F_{qg} = F_{qe} \quad \text{at} \quad r = L_{q0}\sqrt{\frac{2}{\pi}} = 0.8L_{q0} \tag{4.155}$$

However, force $\mathbf{F}_{qg}$ (4.151), (4.152) is the force of spherical compression of only one layer of the quantons. The resultant force is determined by the sum of compression forces of all spherical layers. On the gravitational diagram in Fig. 4 .2, the compression zone (c–d–e) is restricted by the classic radius of the electron r_e. Using (4.151), we determine the sum of forces from the effect of the first layer F_{qg1} at $r_0 = 0.58L_{q0}$ (4.101), two layers $\sum_1^2 F_{qg2}$, n layers $\sum_1^n F_{qgn}$ of the quantons, resulting in spherical compression of the medium inside the electron

$$\mathbf{F}_{qg1} = \frac{\mu_0 g^2}{8} \frac{L_{q0}}{(0.58 L_{q0})^3} \mathbf{1}_r = \frac{0.64 \mu_0 g^2}{L_{q0}^2} = 3.4 \cdot 10^{23} \text{ N} \tag{4.156}$$

$$\sum_1^2 \mathbf{F}_{qg2} = \frac{\mu_0 g^2 L_{q0}}{8} \left[\frac{1}{(0.58 L_{q0})^3} + \frac{1}{(0.58 L_{q0} + L_{q0})^3} \right] \mathbf{1}_r = \frac{0.67 \mu_0 g^2}{L_{q0}^2} \tag{4.157}$$

$$\sum_1^n \mathbf{F}_{qgn} = \frac{\mu_0 g^2 L_{q0}}{8} \left\{ \frac{1}{(0.58 L_{q0})^3} + \ldots + \frac{1}{\left[0.58 L_{q0} + (n_r - 1) L_{q0}\right]^3} + \ldots + \frac{1}{r_e^3} \right\} \mathbf{1}_r \tag{4.158}$$

$$n = \frac{r_e}{L_{q0}} = 3.81 \cdot 10^{-10} \text{ layers} \tag{4.159}$$

$$n_r = \frac{r}{L_{q0}} \tag{4.160}$$

Equation (4.159) determines the number of layers n of compression inside the electron in the range from $r_0 = 0.50\ 8L_{q0}$ to r_e. The sum of the series (4.150) consists of: the first term – the first layer of the quantons, the intermediate term – for any layer n_r (4.160) at the distance r, and the last term – for the last layer of the quantons at distance r_e. Equation (4.158) determines the compression force from the total effect of n layers of quantons (4.159). The summation of the series (4.150) has been prepared for numerical computer processing, but can be processed by the analytical method. Identical summation is essential for electrical force $\mathbf{F}_{qe}$ (4.112), and they should be followed by layer by layer summation of the combined effect of the electrical and magnetic fields of the electron in compression of its internal region.

In any case, the symmetry of electricity and magnetism should ensure the energy of the electromagnetic polarisation of the quantised medium by the electron. Consequently, the rest energy $m_0 C_0^2$ of the electron is determined by the total energy of electrical W_{ev} (4.23) and magnetic polarisation W_{gv}, on the condition that $W_{ev} = W_{gv}$

$$m_0 C_0^2 = W_{ev} + W_{gv} = \frac{1}{8\pi\varepsilon_0} \frac{e^2}{r_e} + \frac{\mu_0}{8\pi} \frac{g^2}{r_e} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r_e} \tag{4.161}$$

The second term of the sum (4.161) is the energy W_{gv} of magnetic polarisation of the quantised medium by the spherical magnetic field of the electron. Regardless of the fact that the magnetic charge g of the electron is an imaginary value, the magnetic energy of polarisation of the quantised medium by the electron should be regardws as real energy. The sum of the electrical and magnetic energies of the electron can be reduced to a single parameter, for example electrical, as in (4.161). It is the total energy of the electron, reduced to the electrical parameter, that is used in calculations with no account of the magnetic components. It should be mentioned that the rest energy (4.161) is responsible for the deformation of the quantised medium of the electron in the external region outside the limits of the gravitational boundary $r > r_e$.

The exact distribution of the electric and magnetic energies inside the gravitational boundary ($r < r_e$) has not as yet been determined. However, since compression of the quantised medium is possible only in the case of the combined effect of the electrical and magnetic fields, it is fully admissible that the electrical and magnetic components inside the electron should also satisfy the symmetry conditions.

The compression of the quantised medium inside the gravitational boundary leads to its spherical tensioning outside the classic radius of the electron. Consequently, the electrical charge e^- acquires the charge m_e and transforms to an electron, i.e., the particle carrying the electrical charge with negative polarity and mass m_e [2]

$$m_e = k_m \oint_S \mathrm{D} dS \tag{4.162}$$

Thus, the spherical magnetic field, together with the radial electrical field of the electron, plays a significant role in the formation of the electron mass.

4 .17. Electron energy balance

The results discussed previously can be used for analysis of the behaviour of the electron in the quantised medium in the entire range of velocities from 0 to C_0. The presence of limiting energy (4.28) and mass (4.29) for the electron enables us to replace the relativistic factor γ by the normalised relativistic factor γ_n, restricting the energy and mass m of the relativistic electron when the electron reaches the speed of light C_0 [5]

$$m = m_e \gamma_n = \frac{m_e}{\sqrt{1 - k_n \dfrac{v^2}{C_0^2}}} \tag{4.163}$$

where k_n is the normalisation coefficient.

To determine the coefficient k_n, we use the condition that the electron acquires the limiting mass m_{max} when it reaches the speed of light $v = C_0$

$$m_{\max} = \frac{m_e}{\sqrt{1-k_n}} = \frac{C_0^2}{G} r_e \tag{4.164}$$

We determine coefficient k_n and the normalised relativistic factor γ_n, taking into account the electrical radius R_e (4.19) of the electron

$$k_n = 1 - \frac{R_e^2}{r_e^2} \tag{4.165}$$

$$\gamma_n = \frac{1}{\sqrt{1-\left(1-\frac{R_e^2}{r_e^2}\right)\frac{v^2}{C_0^2}}} \tag{4.166}$$

Taking into account the normalised relativistic factor γ_n, we determine the balances: of the gravitational potential and the energy of the relativistic electron, multiplying by m_{max}

$$C^2 = C_0^2 - \gamma_n \varphi_n \tag{4.167}$$

$$m_{\max} C^2 = m_{\max} C_0^2 - m_{\max} \gamma_n \varphi_n \tag{4.168}$$

The equations (4.167) and (4.168) are unique equations in which the gravitational potentials and electron energy are completely balanced in the entire speed range, including the speed of light C_0.

Analysis of (4.167) shows that in the vicinity of the relativistic electron the speed of light (of the photon) decreases

$$C = \sqrt{C_0^2 - \gamma_n \varphi_n} = C_0 \sqrt{1 - \frac{\gamma_n \varphi_n}{C_0^2}} \tag{4.169}$$

When the electron reaches the speed of light $v = C_0$, in accordance with (4.167) the gravitational potential C^0 on the surface of the gravitational interface with radius r_e on the external side decreases to the zero value ($C^2 = 0$) and the electron is transferred to the state of the black microhole. The gravitational diagram of the electron should be plotted in the state of the black microhole when there is a discontinuity in the quantised medium at the gravitational interface [2]. This means that in the condition of the black microhole the electron interrupts all electromagnetic exchange processes with the quantised medium, with the exception of the gravitational processes. This is confirmed by (4.169) where at $v = C_0$ the speed of light at the gravitational boundary decreases to 0.

Analysis of the balance of electron energy (4.168) shows that the electron energy W observed in the entire speed range is determined by the difference between the limiting energy W_{max} (4.28) and the hidden energy W_s of the electron. In fact, taking into account (4.164) and the values of the Newton potential $\varphi_n = Gm_e/r_e$ of the gravitational boundary of the electron with the radius r_e we determine the energy W of the component included in the energy balance (4.168)

$$W = m_{\max}\gamma_n\varphi_n = m_e C_0^2\gamma_n \tag{4.170}$$

The limiting value of the energy W_{max} of the electron as the second component of the balance (4.168) is taken from (4.28)

$$W_{\max} = m_{\max}C_0^2 = \frac{C_0^4}{G}r_e \tag{4.171}$$

The value of hidden energy $W_s = m_{\max}C^2$, included in the balance (4.168) is presented taking m_{max} into account (4.29)

$$W_s = m_{\max}C^2 = \frac{C_0^2C^2}{G}r_e \tag{4.172}$$

Substituting (4.171), (4.172) and (4.172) into (4.168), we obtain the energy balance of the electron in the form suitable for understanding the physical nature in the entire speed range from 0 to C_0

$$\begin{aligned} W &= W_{\max} - W_s = m_{\max}(C_0^2 - C^2) = m_{\max}\gamma_n\varphi_n = m_e C_0^2\gamma_n \\ W &= W_{\max} - W_s = m_e C_0^2\gamma_n \end{aligned} \tag{4.173}$$

The equation of the energy balance of the relativistic electron (4.173) confirms that the electron energy W is determined by the difference between the limiting energy of the electron W_{max} (4.28) and its hidden energy W_s (4.172). With the increase of the electron speed, the hidden energy of the electron changes to the observed structural form, determining the energy balance of the electron

$$W_{\max} = W + W_s = \text{const} \tag{4.174}$$

Figure 4.14 shows the family of the curves 1, 2, 3 of the distribution of the gravitational potentials of the electron with the increase of the electron speed (curve 3 corresponds to higher speed). The family of the curves 1, 2 and 3 shows that the increase of electron speed is accompanied by an increase of the gravitational potential at the gravitational boundary inside the electron with a simultaneous decrease of the potential on the external side of the electron boundary.

Since the electron energy and mass are proportional to its gravitational potentials, the increase of energy and mass with the increase of electron speed is determined by the release of its hidden energy and, correspondingly, mass. Attention should be given to the fact that the energy balance (4.173) is connected with the absolute quantised space. This does not change the fundamental principle of relativity because relativity is the fundamental property of the quantised medium which reacts only to movement with acceleration, establishing the relationship between the kinetic energy of the electron W_k, the amount of its motion **p** (pulse) and accelerating force **F**

$$W_k = W - W_0 = m_e C_0^2(\gamma_n - 1) \tag{4.175}$$

$$\mathbf{p} = \frac{dW}{dv} = \frac{d(m_e C_0^2 \gamma_n)}{dv} = m_e C_0^2 \frac{d(\gamma_n)}{dv} \tag{4.176}$$

$$\mathbf{F} = \frac{dW}{dx} = \frac{d(m_e C_0^2 \gamma_n)}{vdt} = m_e C_0^2 \frac{d(\gamma_n)}{vdt} \tag{4.177}$$

Taking into account (4.166), we determine the electron momentum **p** (4.176), neglecting the small value k_n (4.165), where $\mathbf{1}_p$ is the unit vector in the direction of **p** [2]

$$\mathbf{p} = m_e C_0^2 \frac{d(\gamma_n)}{dv} = m_e \gamma_n^3 v \cdot \mathbf{1}_p \tag{4.178}$$

Momentum **p** (4.178) is connected with the effect of the transverse force $\mathbf{F}_\perp$ which tries to deflect the electron from the straight trajectory when the initial direction of the speed vector **v** does not coincide with the direction of the momentum **p** and force $\mathbf{F}_\perp$. In fact, if the electron moves by inertia with speed **v**, the deflection of its trajectory is connected with the variation of electron energy as a result of the variation of the direction of speed vector **v**, determining the value of momentum **p** (4.176) and (4.178). If the direction of speed vector **v** does not change and only the speed modulus changes, the variation of energy in direction **x** which coincides with the speed vector **v** is determined by a longitudinal force on the basis of (4.177)

$$\mathbf{F}_n = m_e C_0^2 \frac{d(\gamma_n)}{vdt} = m_e \gamma_n \frac{dv}{dt} \tag{4.179}$$

Momentum **p** (4.170) determines the magnitude of the transverse force

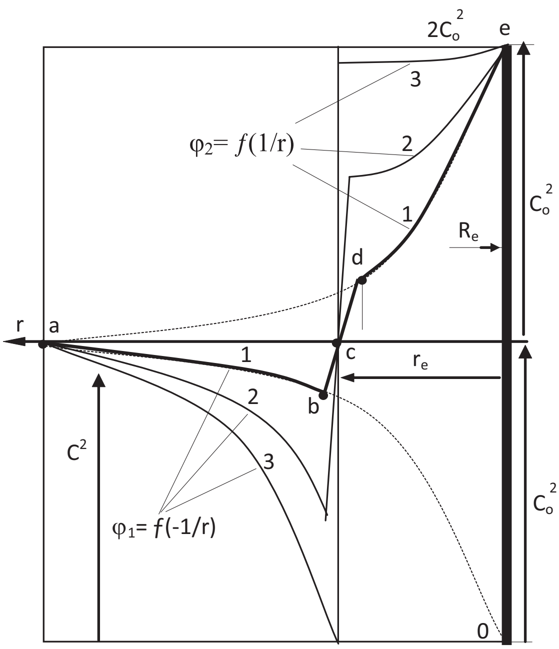

Fig. 4.14. Family of the curves 1, 2, 3 of gravitational potentials of the electron in relation to speed.

$$\mathbf{F}_{\perp} = \frac{d\mathbf{p}}{dt} = \frac{d(m_e\gamma_n^3\mathbf{v})}{dt} = m_e\gamma_n^3\frac{d\mathbf{v}}{dt} \tag{4.180}$$

The longitudinal force $\mathbf{F}_n$ (4.179) determines the magnitude of the longitudinal momentum

$$\mathbf{p} = m_e\gamma_n\mathbf{v} \tag{4.181}$$

In longitudinal acceleration of the electron from the condition of absolute rest $v = 0$ to the speed of light C_0 we determine the limiting value of the momentum $p_{\max}$ of the electron taking (4.30) into account

$$p_{\max} = m_e\frac{r_e}{R_e}C_0 = m_{\max}C_0 = \frac{W_{\max}}{C_0} = \frac{C_0^3}{G}r_e \tag{4.182}$$

In a general case in which the direction of perturbing force $\mathbf{F}$ does not coincide with the direction of electron speed $\mathbf{v}$, the dynamics equation is represented by expression (4.177) for which the partial dynamics equations (4.179) and (4.180) have been derived. A distinguishing feature of the equations (4.175)...(4.181) is that they include the normalised relativistic vector γ_n which restricts the limiting parameters of the electron in the entire speed range from 0 to the speed of light C_0.

The dynamics equation (4.177), (4.179) and (4.180) differ only slightly from the well-known relativistic equations describing formally the dynamic state of the electron in the quantised medium. The physical principle of the electron dynamics is described most accurately by the energy balance of the electron (4.173) in the quantised medium in the entire range of velocities from 0 to C_0. The energy balance (4.173) is the equivalent of the balance of the dynamic mass of the electron m. The dynamic balance of the electron mass in the quantised medium is expressed as the difference between its limiting mass m_{max} and hidden mass ms, transforming (4.173)

$$m = m_{\max} - m_s = m_e \gamma_n \quad (4.183)$$

In the process of acceleration of the electron its energy changes (4.173) like the energy of spherical deformation of the quantised medium whose equivalent is the variation of the electron mass m (4.183). Therefore, the physical principle of the electron dynamics is reflected most accurately by the equation which links the variation of the electron mass m along the acceleration path x with the accelerating force **F** [2]

$$\mathbf{F} = C_0^2 \frac{dm}{dx} = C_0^2 \frac{dm}{vdt} \quad (4.184)$$

Continuing analysis of the electron energy balance (4.173), we examine the range of low velocities $v << C_0$, expanding γ_n into a series and rejecting the terms of higher orders as insignificant

$$W = m_e C_0^2 \gamma_n = m_e C_0^2 + \frac{1}{2} m_e v^2 \quad (4.185).$$

The equation (4.185) is well known in mechanics and determines the electron momentum **p** and the force **F** acting on the accelerated electron as derivatives of energy (4.185) with respect to speed v direction x and time t

$$\mathbf{p} = \frac{dW}{dv} = m_e \mathbf{v} = m_e \frac{dx}{dt} \quad (4.186)$$

$$\mathbf{F} = \frac{dW}{dx} = \frac{d(0.5 m_e v^2)}{vdt} = m_e \frac{dv}{dt} = m_e \mathbf{a} \quad (4.187)$$

Since the pulse **p** and force **F** are derivatives of electron energy (4.185), they are independent of the rest energy and depend only on the actual value of kinetic energy W_k

$$W_k = 0.5 m_e v^2 \quad (4.188)$$

It should be mentioned that the momentum **p** and force **F** are linked together

$$\mathbf{F} = \frac{d\mathbf{p}}{dt} = \frac{d(m_e\mathbf{v})}{dt} = m_e\mathbf{a} \quad (4.189)$$

The reasons for the formation of forces **F** (4.189) have been explained in detail in [2] and relate to the electron theory. In acceleration of the electron with the increase of its mass determined by the spherical deformation of the medium, the quantised medium with the density ρ_2^i is also redistributed inside the gravitational boundary with radius r_e, and the gradient of this medium is directed in the direction of the effect of inertia force **F** and determines the additional deformation vector $\mathbf{D}_2^i$ inside the gravitational boundary of the electron [2]

$$\mathbf{D}_2^i = \text{grad}(\rho_2^i) \quad (4.190)$$

The additional vector of non-spherical deformation $\mathbf{D}_2^i$ (4.190) is equivalent to the acceleration vector of the electron **a** and determines the inertia force **F** (4.189) [2]

$$\mathbf{F} = m\mathbf{a} = m\frac{C_0^2}{\rho_0}\mathbf{D}_2^i \quad (4.191)$$

Figure 4.15a shows that the effect of the perturbing force **F** on the electron with the mass m in the direction **x** results in acceleration of the electron **a** which leads to the redistribution of the quantum density of the medium inside the gravitational boundary of the electron r_e. In fact, there are phase transitions of the quantised space-time taking place inside the electron during acceleration of the latter. It may be seen that the quantum density of the medium inside the electron in the direction **r** increases from ρ_2^{i1} to ρ_2^{i2}, forming a gradient of the quantum density of the medium inside the electron. This gradient determines the direction and magnitude of the deformation vector $\mathbf{D}_2^i$ (4.190) of the quantised medium inside the gravitational boundary (Fig. 4.15b). Figure 4.15c shows that the absence of the gradient of the quantum density of the medium inside the electron, with the medium represented by a uniform grid, indicates that the electron is not accelerated. In this case, the electron is in the absolute rest state or in the state of uniform and rectilinear movement by inertia in the quantised space-time [2].

In particular, the presence of the additional deformation vector $\mathbf{D}_2^i$ (4.190) inside the gravitational boundary of the electron creates additional tensioning of the medium during its movement with acceleration leading to a paradoxic situation in which, depending on the acceleration regime, the kinetic energy of the electron $W_k = 0.5m_ev^2$ (4.188) is determined ambiguously and is characterised by the presence of energy bifurcation points on the acceleration (deceleration) curve. The bifurcation points form on the acceleration curve of the electron when the electron is accelerated in the pulsed regime. The pulsed regime is characterised by the effect of the pulsed accelerating force **F** when the movement with acceleration is replaced by movement by inertia, and vice versa. The electron as a dynamic system changes from the state of the non-inertial system to an inertial one, and vice versa. At this transition, the electron is released from the additional stresses of the medium determined by the presence of the quantum density gradient $\mathbf{D}_2^i$ (4.190) and changes to the regime of motion by inertia [2].

It is characteristic that the pulsed regimes of acceleration of the electron are used in different types of accelerator and have not been investigated in the conditions of energy bifurcation. This has been caused by the fact that the relativistic regimes of acceleration of the electron did not treat the electron as the inertial and non-inertial system in the special theory of relativity. In addition to this, the special theory of relativity does not examine motion in the absolute quantised medium whose specific features reflect the fundamental nature of the relativity principle as the unique properties of the absolute quantised space-time, treating the electron as an open quantum mechanics system [2].

The problem of bifurcation of the electron energy in acceleration of the electron in different conditions relates mainly to the relativistic electron whose energy balance is determined by the equation (4.173). We can describe the appearance of bifurcation point on the acceleration curve of the relativistic electron. However, in this case, the calculation equations, which include the normalised relativistic factor, become more complicated. In principle, the physical pattern of the electron acceleration changes only slightly, if we start investigations of the acceleration of the electron in the range of nonrelativistic velocities characterised by the quadratic dependence

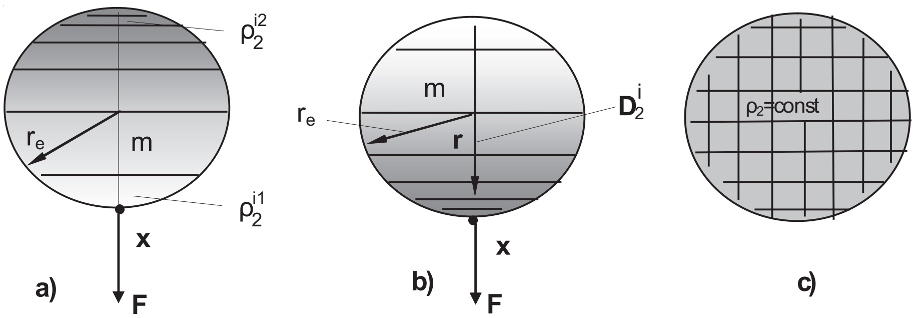

Fig. 4.15. Redistribution of the quantum density of the medium inside the electron as a result of the effect of accelerating force **F** (a), deformation of the quantised medium during its acceleration (b) and the uniform grid of quantum density of the medium in the absence of acceleration (c).

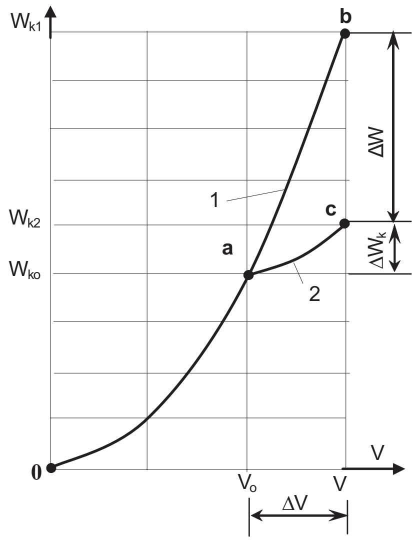

Fig. 4.16. Quadratic dependences of the absolute 1 and relative 2 electron energies on speed v in the absolute space-time.

of the electron energy on its speed (4.188).

Figure 4.16 shows the quadratic dependences of the absolute 1 and relative 2 electron energies on the speed of movement v in the absolute space-time. The situation is paradoxic because the quadratic dependence of kinetic energy on speed does not provide an unambiguous value of the electron energy in movement of the electron in the regime of pulsed acceleration in the quantised medium.

We examine a situation in which the electron is continuously accelerated along the path (0–a–b) under the effect of force **F** (4.191). At point (0), the electron is in the absolute rest state in the stationary quantised medium, i.e. $v = 0$. The speed at point (a) is assumed to be v_0. The electron speed v determines the speed at the calculation point (b) as the absolute speed $v = v_0 + \Delta v$, where v is the increase of speed in the sections (a–b) and (a-c). Consequently, the kinetic energy of the electron W_{k1} is determined by the final speed v

$$W_{k1} = \frac{1}{2} m_e v^2 = \frac{1}{2} m_e (v_0 + \Delta v)^2 = \frac{1}{2} m_e (v_0^2 + \Delta v^2 + 2v_0 \Delta v) \qquad (4.192)$$

Kinetic energy W_{k1} (4.192) of the electron is determined by the continuous acceleration regime under the effect of force **F**. We consider the second acceleration regime of the electron when force **F** at the point (a) is destroyed for a short period of time and it is then restored. In this case, further acceleration of the electron already takes place along the acceleration curve (a–c), and energy W_{k2} at point (c) is determined as the sum of the kinetic energies W_{k0} and ΔW_k in the sections (0-a) and (a-c), respectively

$$W_{k2} = W_{k0} + \Delta W_k = \frac{1}{2} m_e v_0^2 + \frac{1}{2} m_e \Delta v^2 = \frac{1}{2} m_e (v_0^2 + \Delta v^2) \qquad (4.193)$$

It may be seen that kinetic energy W_{k2} (4.193) differs from W_{k1} (4.193), regardless of the fact that the electron has accelerated to the same speed v. We determine the difference ΔW of the energies W_{k1} (4.192) and W_{k2} (4.193)

$$\Delta W = W_a - W_{ka} = m_e v_0 \Delta v \qquad (4.194)$$

In the second case (4.193), to reach the speed v, the electron has lost the energy smaller by the value $m_e v_0 \Delta v$ in comparison with the energy W_{k1} (4.192), regardless of the fact that the electron has acquired the same pulse (4.186). However, in the second case, the electron has travelled a shorter distance and did not reach the point c and, correspondingly, has lost a smaller amount of energy along its path.

The expressions (4.192) and (4.193) show convincingly that the movement of the electron is connected with the exchange energy processes with the quantised medium. From the relativity viewpoint, in the first case the electron should be regarded as a non-inertial system. In the second case, the electron transferred at point a from the non-inertial system to an inertial one, and vice versa. Point a is the point of bifurcation of the electron energy in which the acceleration curve is split, depending on the acceleration regime. At the moment of this transition at the bifurcation point a the electron discards its internal stress determined by the additional deformation vector $\mathbf{D}_2^i$ of the medium (4.190) as a result of the effect of accelerating force $\mathbf{F}$ (Fig. 4.14). It appears that the electron starts a new count of the movement under the new acceleration from the bifurcation point (a), determining the fundamental nature of the relativity principle.

The problems of relative motion have been studied quite extensively. It is again important to show that the relativity principle is the property of the quantised medium which reacts only to acceleration of motion. The Superintegration theory formulates of the principle of relative–absolute dualism where one of the fundamental properties of the absolute quantised medium (quantised space-time) is the relativity of motion [2].

4.18. Tunnelling of the charge and wave transfer of electron mass

The quantised medium is a superhard, superelastic quantised medium having no analogues with the known physical media and externally regarded as physical vacuum. In particular, it was not understood how another solid body, including elementary particles and the electron, could move in the superhard medium. It appears that one solid body freely penetrates through another solid body. This contradicts all the experience accumulated on this subject. The problem is completely solved when the movement of the electron is regarded as wave transfer of mass as a result of tunnelling of the electrical charge in the quantised medium [2].

In this section no attention is given to the problems of movement of the electron in space which are also associated with its inertial property and relative motion. In uniform and straight movement, the body (particle) does not seem to be subjected to any force effect from the side of space-time. However, the quantised medium exerts resistance to movement only in acceleration of the particle and work must be used to overcome this resistance. When the particle is arrested, the resistance to movement disappears and in the restored only during new acceleration of the particle.

Thus, the quantised medium reacts only to accelerated motion. All the known physical media exert resistance to straight and uniform motion. This is the main difference between vacuum and other media. However, this is only the external difference. In reality, the wave transfer of mass as transfer in the space of the local region of the spherically deformed quantised medium is connected with carrying out continuous work in deformation of the medium. Like the energy losses, the work carried out in deformation of the medium determines the resistance of the medium to movement of the electron in the medium on the front and rear edges.

On the other hand, after the moving particle, the local region of the spherically deformed quantised medium also disappears, like the rear front of the electron, releasing the energy used previously for deformation in the leading front. The release of energy without electromagnetic radiation into space is associated with the formation of forces with the direction opposite to that of the forces of resistance to motion. Consequently, energy is conserved. The force of resistance to movement is fully compensated by the force reciprocal to the resistance to movement. Externally, this fact is perceived as if the particle moved in a straight line and uniformly without resistance in the quantised medium.

We investigate the specific forces of the resistance to motion of a non-relativistic electron in the quantised medium, restricting our considerations to the wave transfer of only rest mass m_0, although the electron has colossal hidden mass m_{max} (4.29). Figure 4.7 shows the truncated gravitational diagram of the electron which defines the mass of the electron as the energy of spherical deformation of the quantised medium.

In movement of the electron, the gravitational diagram describes a cylindrical tube in space whose energy determines the total energy of deformation in movement. However, calculations can be carried out more efficiently for a continuous cylindrical tube within the boundaries of the spherical radius of the electron r_e. It has been proven that the energy of deformation of the medium inside the classic radius of the electron r_e is equivalent to half the electron mass. This makes it possible to determine the deformation energy of the medium W_1 carried out by the electron during its movement in the section x with the normalised relativistic factor γ_n taken into account [2]:

$$W_1 = \gamma_n m_e C_0^2 \frac{x}{r_e} \tag{4.195}$$

Resistance force $\mathbf{F}_{1C}$, exerted by the quantised medium on the front edge during movement of the electron, is determined as the derivative of energy W_1 (4.195) in the direction x

$$\mathrm{F}_{1C} = \frac{dW_1}{dx} = \frac{\gamma_n m_e C_0^2 x}{r_e dx} = \frac{\gamma_n m_e C_0^2}{r_e} \mathbf{1}_x = F_{D\max} \gamma_n \mathbf{1}_x \tag{4.196}$$

Attention should be given to the fact that the resistance force $\mathbf{F}_{1C}$ includes the limiting value of the force $F_{D\max}$ (4.47) on the conventional surface of the electron with a radius r_e which determines the deformation force of the quantised medium and its excess tension in the formation of the electron and its rest mass. This is so regardless of the fact that the tension of the medium in the direction of movement is determined by the diametral section of the electron and equals only ¼$F_{D\max}$ (4.53). However, this tension is characteristic only of the static state of the electron. Possibly, further investigations should make it possible to describe this position more accurately.

The magnitude of force $\mathbf{F}_{1C}$ (4.196) determines the total resistance to movement of the electron in the quantised medium. It is possible that the value of force $\mathbf{F}_{1C}$ (4.196) for the internal region of the electron, restricted by its classic radius r_e, is four times too high because of a number of reasons. Firstly, force $\mathbf{F}_{1C}$ (4.196) takes into account the transfer of the entire gravitational field of the electron, including in the external region behind the gravitational radius R_g. This means that the resistance force inside the gravitational boundary with radius r_e should already be halved. Secondly, in movement of the electron, deformation of the medium is carried out by the leading front of the electron further halving the resistance inside the gravitational boundary. Consequently, the resistance to movement of the quantised medium, exerted by the diametral cross-section of the electron with radius r_e, should fully corresponds to the tension force ¼ $F_{D\max}$ (4.53), which tries to rapture the electron in the diametral cross-section.

On the other hand, the rear front of the particle in wave motion in the quantised space-time releases spherical deformation of the medium, releasing energy W_2 whose magnitude is equal to energy W_1 (4.195). This results in the formation of pushing force $\mathbf{F}_{2T}$ whose magnitude is equal to resistance force $\mathbf{F}_{1C}$ (4.196) but acts in the opposite direction, ensuring energy balance and compensation of the forces:

$$W_1 - W_2 = 0, \quad \mathbf{F}_{1C} - \mathbf{F}_{2T} = 0 \tag{4.197}$$

The energy balance and compensation of forces (4.197) result in movement of the electron by inertia. Externally, this is perceived as a process which does not require energy or forces. However, the movement of the electron by inertia is a highly energy consuming (4.195) and powerful (4.196) electromagnetic process resulting in the exchange of reactive energy between the moving electron and the quantised medium. This sustains the wave transfer of mass by inertia [2].

In acceleration of the electron, the balance of energy and forces (4.197) is disrupted as a result of the effect of the external force **F** which carries out the work W (4.173) minus rest energy W_0 in acceleration of the electron and determines the dynamics equation of the electron (4.184)

$$\mathbf{F} = \mathbf{F}_{1C} - \mathbf{F}_{2T} = \frac{d(W - W_0)}{dx} = \frac{d(\gamma_n C_0^2 m_e)}{dx} = C_0^2 \frac{dm}{dx} \tag{4.198}$$

Movement of the electron in the quantised medium can be treated as the wave transfer of the quantum density of the medium ρ and gravitational potential φ (or C^2). This transfer of the parameters ρ and φ of the medium with speed v is described by the classic three-dimensional wave equations in partial derivatives which were derived in [2]:

$$\frac{\partial^2 \rho}{\partial t^2} = v^2 \left(\frac{\partial^2 \rho}{\partial x^2} + \frac{\partial^2 \rho}{\partial y^2} + \frac{\partial^2 \rho}{\partial z^2} \right) \tag{4.199}$$

$$\frac{\partial^2 \varphi}{\partial t^2} = v^2 \left(\frac{\partial^2 \varphi}{\partial x^2} + \frac{\partial^2 \varphi}{\partial y^2} + \frac{\partial^2 \varphi}{\partial z^2} \right) \tag{4.200}$$

$$\frac{\partial \rho}{\partial t} = v \left(\frac{\partial \rho}{\partial z}\mathbf{i} + \frac{\partial \rho}{\partial z}\mathbf{j} + \frac{\partial \rho}{\partial z}\mathbf{k} \right) \tag{4.201}$$

$$\frac{\partial \varphi}{\partial t} = v \left(\frac{\partial \varphi}{\partial z}\mathbf{i} + \frac{\partial \varphi}{\partial z}\mathbf{j} + \frac{\partial \varphi}{\partial z}\mathbf{k} \right) \tag{4.202}$$

For a single wave moving in a uniform fashion and in a straight line without emission of the inertial electron, the solution of the equations (4.199)...(4.202) determines the distribution of the quantum density of the medium (ρ_1 and ρ_2) and gravitational potentials (φ_1 and φ_2) [2]:

$$\begin{cases} \rho_1 = \rho_0\left(1 - \dfrac{\gamma_n R_e}{r}\right), & r \geq r_e \\ \rho_2 = \rho_0\left(1 + \dfrac{\gamma_n R_e}{r}\right) \leq 2\rho_0, & r_e \geq r \geq \gamma_n R_e \end{cases} \tag{4.203}$$

$$\begin{cases} \varphi_1 = C^2 = C_0^2\left(1 - \dfrac{\gamma_n R_e}{r}\right), & r \geq r_e \\ \varphi_2 = C_0^2\left(1 + \dfrac{\gamma_n R_e}{r}\right) \leq 2C_0^2, & r_e \geq r \geq \gamma_n R_e \end{cases} \tag{4.204}$$

The solutions of (4.203) and (4.204) correspond to the condition of spherical invariance when the gravitational field of the inertial electron remains spherically symmetric, regardless of the speed of movement of the inertial electron. For a non-inertial electron, moving with acceleration, the spherical symmetry of the gravitational field of the electron is disrupted as a result of the displacement of its point charge from the centre. In the case of the effect of high acceleration, the electron is not capable of maintaining the spherically symmetric field.

To return to the stable symmetric state, the electron is forced to release part of the field into radiation in order to regain its spherical symmetry of the field. This process is detected cyclically in the form of synchrotron radiation [22]. Consequently, the spherical symmetry and additional photon radiation are added to the solutions of the equations (4.199)...(4.202).

The wave equations (4.199)...(4.202) describe the movement of the electron as wave transfer of mass in the form of a single wave of the spherical field of quantum density (4.203) and gravitational potential (4.204). Differentiation of (4.203) and (4.204) with respect to time and direction leads to wave equations. The divergence of the gradient (4.203) and (4.204) leads to Poisson gravitational equations [2], confirming the uniqueness of the phenomena in the quantised medium (here ρ_m is the density of matter, kg/m^3):

$$\operatorname{div}\operatorname{grad}\rho = 4\pi G\rho_m \frac{\rho_0}{C_0^2} \tag{4.205}$$

$$\operatorname{div}\operatorname{grad}\phi = 4\pi G\rho_m \tag{4.206}$$

The wave equations (4.199)...(4.202) describe the parameters of movement of the electron. However, inside the quantised medium the movement of the point charge of the electron is accompanied by complicated electromagnetic processes associated with the wave transfer of the electrical and magnetic fields of the electron.

Undoubtedly, of special interest is the structure of the point charge of the electron situated inside the electrical radius R_e (4.19) which is included in the solutions of (4.203) and (4.204). At the moment, not much is known about this structure. It is obvious that the correspondence between the gravitational R_g and electrical R_e radii enables us to refer to the point charge of the electron as a unique electrical microhole which is a source of colossal energy.

The electron itself is not the black microhole, with the exception of the case in which the electron reaches the speed of light. At $v = C_0$, the gravitational potential on the internal surface of the gravitational boundary of the electron reaches the limiting value $\varphi_{2\max} = 2C_0^2$ (4.204) and $r = r_e$.

The gravitational potential on the surface of the electrical radius R_e of the point charge is always equal to the limiting potential $\varphi_{2\max} = 2C_0^2$ (4.204)

$$\text{at } r = R_e, \quad \varphi_{2\max} = C_0^2\left(1 + \frac{R_e}{r}\right) = 2C_0^2 \tag{4.207}$$

The electrical potential on the surface of the electrical radius R_e of the point charge is equal to the limiting potential $\varphi_{e\max}$ which is $4.2\cdot10^{42}$ times greater (4.30) than the electrical potential 0..511 MeV (4.4) for the classic electron radius r_e

$$\varphi_{e\max} = \frac{1}{4\pi\varepsilon_0}\frac{e}{R_e} = 2.13\cdot10^{48}\ \text{eV} = 2.13\cdot10^{42}\,\text{MeV} \tag{4.208}$$

The colossal value of the gravitational $\varphi_{2\max} = 2C_0^2$ (4.207) and electrical $\varphi_{e\max}$ (4.208) potentials characterises the electrical microhole with radius R_e as the source of colossal electrical energy $W_{\max}$ (4.28) and the electrical field. This energy is responsible for the spherical deformation of the quantised space-time and the formation of the gravitational potential of the electron and its mass. The point elementary charge, like an electrical microhole, is a source of energy. However, if there is a source changes, then an energy sink should also exist in nature.

In this respect it is quite difficult to advance assuming that the universe should have some circulation of energy maintaining its energy stability. In particular, this energy circulation prevents the thermal or cold death of the universe. It is not even necessary to consider the entire universe, it is sufficient to examine only our galaxy, assuming that its centre contains a black hole which is a source of colossal energy.

The well-known astrophysicist Stephen Hawking assumes that even black holes can tunnel through the space-time [16]. The presence of gaps between the quantons in space-time makes the tunnelling of energy from a black hole to the electron realistic. Previously, it was shown that the presence of tunnels whose role is played by gaps between the quantons, explains the movement of the electron in the superhard quantised medium.

The tunnels in the quantised medium are invisible filaments (unique conductors), connecting the point charge with the black hole of the galactic system, forming a closed circuit. Through this circuit, the radiation of the electron is transferred by the quantised medium and subsequently absorbed by the black hole. The energy state of the electron is maintained by tunnelling of the energy from the black hole of the galaxies to the point charge, acting as an electrical microhole.

If we examine the quantised space-time in the section, then there is one tunnel in the quantised medium for every quanton. Surface density σ_q of the tunnels in the cross-section of the medium is determined by surface density σ_q of the quantons, taking into account the diameter $L_{q0}=0.74\cdot 10^{-25}\,m$ of quantons and the packing coefficient $k_\sigma = 1.15$ when filling the section with the spherical quantons

$$\sigma_q = \frac{k_\sigma}{L_{q0}^2} = 0.63\cdot 10^{50}\,\frac{\text{quantons}}{\text{m}^2} \tag{4.209}$$

The EQM theory and the Superintegration theory provides a suitable basis for the development of the theory of quantised space-time using the tunnelling theory. At the present time, the rate of propagation of energy is not known and possibly there is no information on tunnels in the quantised medium. Since these energy channels are not connected with the wave transfer of energy as a result of the displacement of the charges in quantons, it may be assumed that the rate of transfer of energy through the tunnels may prove to be very high, almost instantaneous. It is pleasing to see that many processes of tunnelling have already been described by the well-known theoretical physicists, including Stephen Hawking. The EQM theory and the Superintegration theory provide new mechanisms for realisation of new concepts.

It is interesting to examine the electrical microhole which appears as a black microhole, absorbing energy and acting as its sink. On the external side, the electrical microhole is treated as a source of the electrical field of the point charge. The electrical microhole is in the stable state, determining the stability of the electron. At the moment, it is not known whether the charges inside the quantons are connected with the energy tunnelling channels in the quantised medium or whether they initially accumulate energy and act only as energy accumulators?

Thus, the problem of tunnelling of energy helps to propose new hypotheses regarding the nature of the electrical and magnetic charges which are regarded in the EQM theory and Superintegration theory as the basis of the theory, as the most stable constants [1].

4 .19. Conclusions

1. New fundamental discoveries of the space-time quantum (quanton) and superstrong electromagnetic interaction enable us to investigate the quantised structure of the electron and the positron as an open quantum mechanical system, being the compound part of the quantised space-time. The electron and the positron as elementary particles are in fact not so elementary and their composition includes a large number of quantons which together with the central electrical charge form the particle inside the quantised medium.

2. It has been established that the mass of the electron (positron) forms as a result of attraction of the quantons to the central electrical charge under the effect of ponderomotive forces of the nonuniform radial electrical field of the central charge. At the same time, a spherical magnetic field, a spin analogue, forms around the central charge. In particular, the spherical magnetic field of the electron (positron) is the main factor which ensures spherical deformation of the quantised medium leading to the formation of the mass of the particle. In contrast to the nucleons, the electron (positron) does not have any distinctive gravitational boundary in the quantised medium. The conventional gravitational boundary of the electron (positron) is represented by its classic radius, producing a 'jump' in the quantum density of the medium.

3. The gravitational diagram of the electron (positron) has been analysed. Several characteristic energy zones were found in the electron (positron):

- the zone of gravitational attraction (gravitational well);
- the zone of gravitational repulsion (gravitational hillock);
- the zone of hidden mass and energy

The effect of the zone of gravitational repulsion is evident at the distances smaller than the classic electron radius (of the order of 10^{-15} m). This explains the capacity of the electron to move away from the proton nucleus of the atom, with the exception of the electron capture regime. This also explains the change of the nuclear attraction forces to the repulsion forces when the alternating shells of the nucleons come together to distances smaller than the effect of the nuclear forces 10^{-15} m.

4. The balance of the energy and electron mass (positron) in the entire range of speeds in the quantised medium, including the speed of light, have been determined. The electron energy is manifested as a difference between its limiting and hidden energies. The electron mass is a difference between its limiting and hidden masses. With the increase of the electron speed, the hidden energy and mass of the electron change to the observed forms.

5. The tensioning of the quantised medium around the electron has been investigated. The maximum tension force reaches the value 29 N on the surface of the gravitational boundary of the electron, and the tension is estimated at $0.29 \cdot 10^{30}$ N/m^2 for the electron in the rest state and increases with the increase of the speed in proportion to the normalised relativistic factor. As a result of the colossal tension of the medium, the electron retains its spherical shape. At the same time, the spherical gravitational field is retained in the entire speed range, including the speed of light, with the principle of spherical invariance valid in this case.

6. In addition to the well-known dynamics equation in the electron, it has been shown that the physical nature of the phenomenon is explained most accurately by the dynamics equation with the variation of the mass and energy of the electron along the acceleration path. Continuous acceleration of the electron is accompanied by the redistribution of the quantum density of the medium inside its gravitational boundary, generating the force of resistance to movement. This is a non-inertial movement regime. In transition to the regime of movement by inertia (inertial regime), the electron releases the internal stress determined by the redistribution of the quantum density of the medium during acceleration. Repeated acceleration of the electron is accompanied by bifurcation of the energy in which the electron appears to count its motion anew, determining the fundamentality of the relativity principle as a unique property of the quantised space-time.

7. It has been established that the movement of the electron (positron) in the superelastic and superhard quantised medium is determined by the wave transfer of mass and by tunnelling of the point charge in the channels between the quantons of the medium. Annihilation of the electron and the positron is accompanied by the disruption of the spherical magnetic field and the released energy of spherical deformation of the medium, as a mass defect, transforms to radiation gamma quanta. The released mass free charges merge into an electrical dipole, forming an electronic neutrino, which is an information bit relating to the existence of a pair of particles: electron and positron. The laws of conservation in annihilation of the electron and the positron are valid only in this case.

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5
Quantised structure of nucleons The nature of nuclear forces

In 1966, the structure of nucleons with the sign-changing shell with integer charges – quarks was proposed in the theory of the elastic quantised medium (EQM). This concept proved to be fruitful for the Superunification theory and enabled the nature of nuclear forces to be investigated as contact forces acting between the sign-changing shells of the nucleons. These forces act over short distances and their magnitude and nature correspond to the nuclear forces, but they are characterised by electrical attraction of shells and their anti-gravitational repulsion.

5 .1. Introduction

In chapter 4, we investigated the quantised structure of the electron and the positron within the framework of the Superunification theory, where the generalising factor is the superstrong electromagnetic interaction (SEI). To continue the development of the Superunification theory, in this chapter we examine the quantised structure of the nucleons (positron and neutron), because the nature of nuclear forces cannot be explained without knowing this structure. The chapter is based on the study by the author 'Electrical nature of nuclear forces (Agroprogress, Moscow, 2001), supplemented by information on the zones of gravitational repulsion of the shells of the nucleons.

The criticism of the modern physics of elementary particles and of the atomic nucleus has been reduced to concluding that the number of successes in this area of scientific investigations is very small, regardless of the huge means spent by the government of various countries to this area.

The atomic and hydrogen bombs were constructed, but this was done by purely empirical methods because of huge investments necessary. These are not achievements, these development are the misfortune of mankind because modern physics does not know the nature of nuclear forces, and has not explained the structure of any of the elementary particles, including the main ones: proton, neutron, electron, positron, photon, electronic neutrino. Energy generation in nuclear physics is based on the mass defect. However, the nature of formation of mass of the elementary particles during their nucleation could not be explained.

Without understanding the problem, work started on nuclear power energy. Finally, we had the Chernobyl accident and other technogeneous failures. The fact that the nature of nuclear forces is not known does not enable us to deactivate charged zones, etc.

Why is my criticism of such an elite area of science as the physics of elementary particles and the atom nucleus so fierce? It is because these problems are answered by the completely new theory of the elastic quantised medium which I developed in the period 1996–2000. The theory of the elastic quantised medium is the theory of the united electromagnetic field (TUEF), which describes the structure of elementary particles and nature of nuclear forces. The Superunification theory was the first theory which can combine all the known interactions from the single viewpoint: electromagnetic, gravitation, strong (nuclear) and weak (neutrino) [1–15].

At present, the Superunification theory is the most powerful analytical means of investigating matter. The theory combines the theory of relativity and quantum theory and represents a new stage in the development of quantum theory. It has been proven that the principle of relativity is the fundamental property of quantised space-time.

The origins of the theory of the elastic quantised medium date back to January 1996, when I discovered a new elementary quantum of space - quanton, establishing the static electromagnetic structure of the quantised space-time for discrete space-time. The electromagnetic quantisation of space is based on the discrete geometry and the physics of interaction of monopoles: electrical and magnetic. In order to separate a minimum volume in space, it is necessary to have only four points from the viewpoint of the geometrical minimisation of the volume. In transition from geometry to physics, the four points are replaced by four monopole charges – quarks: two electrical ones ($-1e$ and $+1e$) and two magnetic ones ($-1g$ and $+1g$), forming the further indivisible quantum of space-time.

In principle, the four monopole integer charges – quarks represent new quarks from which matter is constructed, replacing the old hypothesis of quarks as fractional charges in quantum chromodynamics (QCD). In quantum chromodynamics, quarks were compared with the structure of the nucleons in order to explain the nature of nuclear forces. In the theory of the elastic quantised medium and Superunification theory, the charges – quarks (or monopoles) are included in the structure of space-time from which all the elementary particles representing the integral part of the quantised space-time are already constructed with participation of quantons and a surplus of electrical monopoles. Whilst quantum chromodynamics has to deal gradually with greater and greater problems, the Superunification theory has no contradictions.

It is not now necessary to discussing details of the fundamentals of the theory of the elastic quantised medium and Superunification, which have already been published in different sources (more than 50), for example [1–15], because the subject of these investigations is the substantiation of the electrical or, more accurately, electromagnetic nature of nuclear forces. However, it is necessary to publish the main assumptions and the results of the EQM and Superunification theories.

1. Limiting energy W_{max} (4.28) and mass m_{max} (4.29) of the particles

$$W_{\max} = \frac{C_0^4}{G} R_s \tag{5.1}$$

$$m_{\max} = \frac{C_0^2}{G} R_s \tag{5.2}$$

where $G = 6.67 \cdot 10^{-11}$ Nm²/kg² is the gravitational constant; $C_0^2 = 8.99 \cdot 10^{16}$ m²/s² is the gravitational potential of the non-perturbed quantised space-time (C_0^2 = const); R_s is the radius of the elementary particle, m.

For a relativistic proton with the radius $R_s = 0.8 \cdot 10^{-15}$ m, the limiting mass is only 10^{12} kg in accordance with (5.2). This is a higher but not an infinite value, corresponding to an iron asteroid with the diameter of the order of 1 km. For a relativistic electron whose radius does not have a distinctive gravitational boundary, in the determination of the limiting parameters it is evidently necessary to take into account the dimensions of the proton with some clarification.

2. The balance of the gravitational potentials of the particle (3.58), (3.71)

$$C_0^2 = C^2 + \varphi_n \gamma_n \tag{5.3}$$

where C^2 is the gravitational potential (potential of action) of the quantised space-time perturbed by gravitation, m^2/s^2 ($C^2 \neq$ const); φ_n is the Newton gravitational potential for the mass m, m^2/s^2, where γ_n (3.70) is the normalised relativistic factor for the particle moving with speed v:

$$\varphi_n = \frac{Gm}{r} \tag{5.4}$$

where r is the distance ($r > R_s$), m

$$\gamma_n = \frac{1}{\sqrt{1 - \left(1 - \frac{R_g^2}{R_s^2}\right)\frac{v^2}{C_0^2}}} \tag{5.5}$$

where R_g is the gravitational radius of the source of gravitation (without the multiplier 2), m

$$R_g = \frac{Gm}{C_0^2} \tag{5.6}$$

For the elementary particles and non-collapsing objects, the gravitational radius is a purely calculation parameter.

The normalised relativistic vector γ_n (5.5) restricts the limiting energy of the particle to the value (5.1) when the particle reaches the velocity of light.

3. Velocity of light in a vacuum field perturbed by gravitation

From (5.3) we obtain

$$C = \sqrt{C^2} = C_0\sqrt{1 - \frac{\varphi_n \gamma_n}{C_0^2}} \tag{5.7}$$

Equation (5.7) determines the velocity of light in the perturbed vacuum in the vicinity of a moving solid (particle) and shows that with the increase of the mass and velocity of the solid, the velocity of light in the vacuum, perturbed in this fashion, decreases. This corresponds to the experimental observations of the distortion of the trajectory of the light beam in a strong nonuniform gravitational field. In a limiting case, the light is arrested completely on the surface of a black hole at $\varphi_n \gamma_n = C_0^2$, does not penetrate into the black hole or does not leave the black hole, making the black hole invisible.

4. Energy balance (3.75) for the particle in the quantised space-time

$$W_{\max} = W_v + m_0 C_0^2 \gamma_n \tag{5.8}$$

The balance (5.8) shows that the limiting energy of the particle (5.1) consists of the latent energy W_v of the quantised space-time and the actual (this should not be confused with the complex number) energy $m_0 C_0^2 \gamma_n$. The energy balance (5.8) shows that the only source of energy of the particle (solid) is the colossal energy hidden in the vacuum field. In fact, the balance (5.8) is a generalised Lagrange function which determines the energy parameters of the moving particle in the deformed vacuum field. The movement of the particle in the vacuum is connected with the redistribution of energy in accordance with balance (5.8).

5. Balance of surface tension forces of quantised space-time

$$F_{vT} = \frac{dW_v}{dR_s} = \frac{C_0^4}{G} - 4\pi R_s^2 \rho_m C_0^2 \gamma_n \tag{5.9}$$

Equation (5.8) can be used to determine the dynamic balance of forces F_{vT} (5.9) of the surface tension of the quantised space-time around a moving particle determined by the spherical deformation of the quantised space-time as a derivative with respect to R_s taking into account (5.1) and expressing the mass in (5.8) through the density of matter ρ_m.

6. Surface tension force of quantised space-time by particle F_T

$$F_T = 4\pi R_s^2 \rho_m C_0^2 \gamma_n \tag{5.10}$$

The surface tension force of the quantised space-time by the particle F_T (5.8) is the sum of all tensions of the forces acting on the surface of the particle from the side of the quantised space-time. This force is spherically balanced and manifests itself externally during movement of the particle by inertia.

7. The tensor of the force of surface tension of the quantised space-time by a particle

$$\mathbf{T}_n = \rho_m C_0^2 \gamma_n \mathbf{1}_n \tag{5.11}$$

The surface tension tensor $\mathbf{T}_n$ determines the effect of tension forces on the unit surface of the particle from the side of the quantised space-time ($\mathbf{1}_n$ is the unit vector normal to the spherical surface of the particle). Tensor $\mathbf{T}_n$ depends on the density of the matter of the particle and its speed in vacuum. For a proton at $\gamma_n = 1$, the density of matter is $\rho_m = 0.723 \cdot 10^{18}$ kg/m^3, and the tension tensor has a colossal high value, $T_n = 6.56 \cdot 10^{34}$ N/m^2.

8. Limiting force of surface tension in vacuum

$$F_{T\max} = \frac{C_0^2}{G} = 1.2 \cdot 10^{44}\,\mathrm{N} \tag{5.12}$$

The force $1.2 \cdot 10^{44}$ N (5.22) is a limiting force which can only exist in nature as a result of the deformation of the quantised space-time, acting on the entire surface of the black hole or black microhole.

9. The quanton diameter L_q for non-perturbed quantised space-time

$$L_q = \left(\frac{4}{3}k_3 \frac{G}{\varepsilon_0}\right)^{\frac{1}{4}} \frac{\sqrt{eR_s}}{C_0} = 0.74 \cdot 10^{-25}\,\mathrm{m} \tag{5.13}$$

where $k_3 = 1.44$ is the coefficient of filling of the quantised space-time by spherical quantons; $R_s = 0.8 \cdot 10^{-15}$ m is the radius of the proton (neutron).

Equation (5.13) was obtained from the conditions of tensioning of the quantised space-time as a result of its spherical deformation in the formation of an elementary particle (proton, neutron) from the quantised space-time, and takes into account the interactions of the quantons between themselves in the deformed space.

10. Quantum density ρ_0 of the medium of non-perturbed quantised space-time

$$\rho_0 = \frac{k_3}{L_q} = 3.55 \cdot 10^{75} \frac{\mathrm{quanton}}{\mathrm{m}^3} \tag{5.14}$$

11. Vector of deformation of the quantised space-time D

$$\mathbf{D} = \operatorname{grad}(\rho) \tag{5.15}$$

12. Poisson equations for the deformed quantised space-time

$$\rho_m = k_0 \operatorname{div}\operatorname{grad}(\rho) \tag{5.16}$$

$$\rho_m = \frac{1}{4\pi G} \operatorname{div}\operatorname{grad}(C_0^2 - \phi_n \gamma_n) \tag{5.17}$$

where $1/k_0 = 3.3 \cdot 10^{49}$ particles/kg·m^2 is the constant of the quantised space-time non-perturbed by deformation; ρ_m is the density of the matter of the perturbing mass, kg/m^3.

$$\frac{1}{k_0} = 4\pi G \frac{\rho_0}{C_0^2} \tag{5.18}$$

$$\rho = \varphi \frac{\rho_0}{C_0^2} = C_0^2 \frac{\rho_0}{C_0^2} \tag{5.19}$$

The Poisson equations are written for the quantum density of the medium (5.16) and the gravitational potentials (5.17) of quantised space-time.

13. Solutions of Poisson equations for the spherically deformed quantised space-time

$$1)\ \begin{cases} \rho_1 = \rho_0\left(1 - \dfrac{R_g\gamma_n}{r}\right) \\ \rho_2 = \rho_0\left(1 + \dfrac{R_g\gamma_n}{R_s}\right) \end{cases} \quad 2)\ \begin{cases} \varphi_1 = C_0^2 = C_0^2\left(1 - \dfrac{R_g\gamma_n}{r}\right) \\ \varphi_2 = C_2^2 = C_0^2\left(1 + \dfrac{R_g\gamma_n}{R_s}\right) \end{cases} \tag{5.20}$$

The solutions of the Poisson equation (5.20) are presented in the form of a system for the external region of space (ρ_1 and φ_1) and also for the internal region of the particle (ρ_2 and φ_2), restricted by the particle radius R_s. Radius R_s is the gravitational interface in the medium. This is caused by the fact that the solutions (5.20) were obtained for the spherically symmetric deformation of quantised space-time with the generation of elementary particles in it.

The physical principle of divergence of the gradient of the quantum density of the medium (5.16) may be described as follows. If we define some spherical boundary in the vacuum field and start to compress it uniformly to radius R_s together with the medium, the quantum density inside the sphere increases as a result of the decrease on the external side. This property of the absolutely elastic medium is described by the distribution of the quantum density of the medium and gravitational potentials in accordance with expression (5.20).

The presence of two components: external (ρ_1 and φ_1) and internal (ρ_2 and φ_2) in the solutions (5.20) ensures the equilibrium of the quantised space-time (quantised medium) during its spherical deformation. The internal component compresses the quantised medium, the external component counteracts compression as a result of tensioning of the medium on the external side beyond the radius R_s. This explains the stability of the space-time.

14. Gravitational diagram of the nucleon in vacuum (Fig. 5.1, see also Fig. 3.11)

The gravitation diagram (Fig. 3.11) reflects the distribution of the quantum density of the medium and gravitational potentials in statics (at $\gamma_n = 1$) in accordance with the solutions (5.20) and determines the balance of the quantum density of the medium and gravitational potentials. It can be seen that at the gravitational interface $r = R_s$ there is a jump of the quantum density of the medium $\Delta\rho$ and the gravitational potential $\Delta\varphi$, with the formation of a gravitational well in the medium

$$\Delta\rho = 2\rho_{ns} \qquad \Delta\varphi = 2\varphi_{ns} \tag{5.21}$$

where φ_{ns} is the Newton gravitational potential at the gravitational interface R_s in the medium determined by the decrease of the quantum density of the medium ρ_{ns} on the external side of the gravitational boundary in the spherical deformation of the quantised space-time, m^2/s^2.

The presence of multiplier 2 in (5.21) is determined by the physical model of participation of two components, ensuring the stability of the vacuum space as a result of its simultaneous compression and tension of the elastic medium resulting from the gravitational interactions, excluding also the multiplier 2 from the gravitational radius (5.6) which was erroneously introduced by Schwartzschild because of the absence of the physical model of gravitational deformation of the quantised space-time.

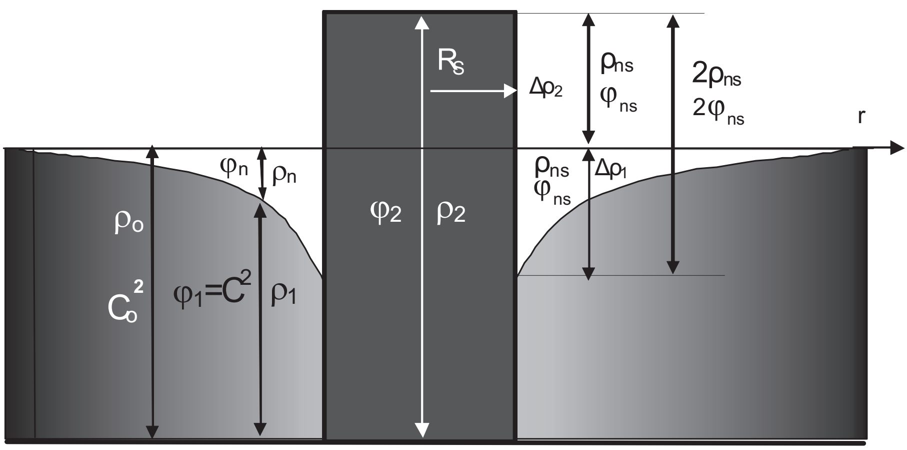

Fig. 5.1. Gravitational diagram of the nucleon in vacuum.

15. Equivalence of mass and energy

$$W_0 = \int_0^{C_0^2} m_0 d\varphi = m_0 C_0^2 \tag{5.22}$$

The presence of the intrinsic gravitational potential C_0^2 of the non-deformed quantised space-time enables us to determine the rest energy W_0 (5.22) of the particle during its nucleation and vacuum as the work of transfer of mass m_0 from infinity to the region of the potential C_0^2. This is the simplest and easiest to understand conclusion of the equivalence of mass and energy.

16. Equivalence of electromagnetic and gravitational energies

The equivalence of mass and energy (5.22) may be used to formulate the principle of equivalence of electromagnetic and gravitational energies; this has been fully confirmed in [4]. In fact, mass is a gravitational charge and is a carrier of the gravitational field in the form of the spherically deformed quantised space-time. The energy of spherical deformation of the quantised space-time is determined by its gravitational potential C_0^2 in accordance with (5.22). In particular, the gravitational energy of the spherical deformation of the quantised space-time was not taken into account by the modern theory of gravitation. In annihilation of mass, its gravitational energy (energy of deformation of quantised space-time) transforms fully to electromagnetic radiation.

17. What is the mass of the particle?

The Poisson equation (5.16) for the deformation vector (5.15) of the quantised space-time has the form

$$\rho_m = k_0 div\ \mathrm{D} \tag{5.23}$$

Applying the Gauss theorem to the Poisson equation (5.23), we determine the mass of the particle in the form of the flow of the deformation vector penetrating the closed surface S around the mass in the spherically deformed vacuum

$$m = k_0 \oint_S \mathbf{D} dS \tag{5.24}$$

Thus, equation (5.23) determines that the particle mass forms as a result of the spherical deformation of quantised space-time and is its integral part. In experiments, this is detected in the manifestation by the particle of the features of corpuscular-wave dualism. The mass is the energy of spherical deformation of quantised space-time. This determines the equivalence of the mass and its energy (5.22). Movement of the particle, having a mass, is the transfer of spherical deformation of the quantised space-time and the gravitational interface of the medium.

This study is concerned with analysis of the gravitational interface of the nucleons in the vacuum field. The structure of the gravitational interface determines the structure of the nucleons and the nature of nuclear forces. A brief introduction to the EQM and Superunification theories will help to deal with the presented material.

5 .2. Problem of the nucleon mass

The structure of nucleons can be examined separately from the quantised space-time. All the attempts to develop physical models of the problem of the neutron as free from the quantised space-time of particles have been unsuccessful. This is due to the fact that the interaction of nucleons should result not only in the generation of nuclear forces in the process of formation of the nucleon structure of the atom nucleus and its mass but it also determines the entire set of the physical properties of the nucleons, the atomic nucleus and the atomic structure, including interaction with orbital electrons.

Which physical properties of the nucleons should be discussed? In particular, this relates to the formation of the nucleon mass as the manifestation of the gravitational properties of the particles in the vacuum field. Without knowing the mechanism of formation of the nucleon mass we cannot explain and describe the reasons for the formation of the mass defect in splitting and synthesis of the atomic nucleus and, consequently, we cannot understand the mechanisms of release of the colossal energy of the quantised space-time in these reactions, referred to as nuclear and thermonuclear energy.

If we want to be more punctual, then in accordance with the Superunification theory the energy is a common basis and represents the entire variety of electromagnetic manifestations expressed in different forms and methods of its release from the quantised space-time. When discussing nuclear and thermonuclear energy, then from the viewpoint of the current level of knowledge this refers to the release of the energy of the atomic nucleus in nucleon–nucleon interactions. However, from the viewpoint of Superunification theory, the occurrence of nucleon–nucleon interactions in the reactions of splitting and synthesis of the atom nucleus is only one of the methods of release of the colossal amount of energy, initially accumulated in the vacuum field (in the quantised space-time).

I have already criticised many times the quantum chromodynamics as the theory which appears to be directed to explaining the strong interactions between the nucleons the nuclear processes. However, chromodynamics has not even touched the main problem of the nucleons – the problem of formation of nucleon mass. Quantum chromodynamics is a fantastic theory which has nothing in common with the actual nuclear processes taking place in the vacuum field in nucleon synthesis, and is in fact a collection of unsolved problems in elementary particle physics.

Naturally, the problem of formation of the nucleon mass is associated with the structure of the nucleons. The structure of the nucleons should already determine the entire set of their physical properties, including the spherical deformation of the quantised space-time which is far greater than in the electron and the positron and results in the large mass of the nucleons [3, 4].

At the same time, the structure of the nucleons must ensure nucleon–nucleon attraction inside the nucleus taking into account the general approaches of the Superunification theory which regards the nuclear forces as manifestation of static electricity (electromagnetism) in contact interaction of sign-changing nucleon shells. The Superunification theory does not regard the nuclear forces as the manifestation of special independent interactions which can not be explained on the basis of classic electromagnetism.

In addition, the structure of the nucleons should be connected inseparably with the vacuum field and have gravitational, electrical and magnetic properties. The gravitational properties are reflected in the deformation of the quantised space-time (its distortion), and the electrical and magnetic properties should be reflected in the capacity of nucleons for polarisation, regardless of the presence of the free nuclear charge.

Finally, the structure of the nucleons must explain the reasons for the stability of the proton and instability of the neutron, and also the mechanism of their mutual transformation. At the same time, the separately considered proton should ensure that the simplest atomic structure of the proton and the electron is stable without allowing the orbital electron to fall on the proton and, in more complicated nuclei, to fall on the nucleus, maintaining the electron in the orbit [3].

I have only mentioned some of the properties of the nucleons investigated in this book. However, these are the main and fundamental properties, and the reasons for the existence and manifestation of these properties are explain for the first time by the Superunification theory only from the viewpoint of classic electromagnetism, taking into account the interaction of the particles inside the electromagnetic structure of the quantised space-time.

5 .3. Shell sign-changing model of the nucleon

In solving the problem of constructing a shell model of the nucleon it is assumed that the nucleon shell should represent a distinctive gravitational interface in the vacuum field. This shell should generate forces of colossal spherical tension of the quantised medium, carrying out the spherical deformation of the quantised space-time and thus forming the mass of the nucleon from the quantised space-time.

The shell model of the nucleon was proposed for the first time in [1]. Since then, I have attempted to develop alternative models of nucleons, bypassing the shell model, for example, in the form of spherical formations filled completely with electrical monopoles. However, this model did not permit spherical deformation of the quantised space-time.

In principle, when constructing models of elementary particles, the range of structural materials is not large, in fact it is small. We have at our disposal the discrete structure of the quantised space-time, consisting of quantons and a surplus of electrical monopoles (massless charges) [1–4].

Two electrical monopoles have already been used in constructing the structure of the electron and the positron: negative and positive polarity, which in interaction with the vacuum field form the complicated structure of the polarised and deformed quantised space-time referred to as the electron and the positron [3, 4].

The deformation of the quantised space-time by the massless electrical monopole determines the specific mass of the electron (positron) which is ~1836 times smaller than the proton mass and to ~1840 times smaller than the neutron mass. The proton carries an elementary electrical charge of positive polarity of the monopole type. However, the monopole electrical charge of positive polarity, being in the free state in the vacuum field, is capable of synthetising only the positron with the mass 1836 times smaller than the proton mass.

How to increase the positron mass in order to transform the positron into the proton? Of course, to increase the mass, it is necessary to intensify the spherical deformation of quantised space-time. If this method is used (the method was applied in the process of formation of positron mass as a result of spherical deformation of the quantised space-time) deformation can be intensified by increasing the magnitude of the central electrical charge with positive polarity. However, in practice this can not be carried out because it is not possible to combine into a single central charge even two electrical monopoles of the same polarity. This is so because Coulomb repulsive forces can not be overcome over such short distances.

Thus, the proton mass forms in vacuum by a mechanism which differs completely from that in the formation of the positron mass. It can be seen that the excess elementary charge of positive polarity has no effect in the formation of proton mass. It should be mentioned that the electron mass forms as a result of pulling of the quantons to the central monopole charge with negative polarity under the effect of ponderomotive forces [3, 4].

It can be assumed that the proton mass is increased by a large number of monopole electrical charges of positive polarity which are compensated by the monopoles with negative polarity, with the surplus of one elementary charge with positive polarity. In this formulation of the problem, the neutron can be regarded as a completely electrically compensated particle. In this case, the interaction of the electrical monopoles with different polarity results in the formation of a large number of electronic neutrinos included in the nucleon structure. However, such a neutrino particle (conglomerate) has no mass because even a large number of neutrinos, filling the volume of the particle, represents a massless formation or has a hardly perceptible mass which has nothing in common with the nucleon mass.

However, with the exception of some surplus of the electrical monopoles, there is no structural material in the quantised space-time. This is determined by the electrical asymmetry of the quantised space-time. This means that there is only one method of formation of the nucleons in which the electrical monopoles should form a shell of electrical and monopoles combined into a neutrino. In the cross-section, this shell is a system of sign-changing charges which determine the colossal tension of the shell capable of carrying out spherical deformation of the quantised space-time (quantised medium) thus forming the large nucleon mass.

The Superunification theory treats the structure of the electronic neutrino ν_e as an electrical dipole consisting of electrical monopoles of negative and positive polarity which forms as a result of annihilation of the electron e^- and the positron e^+ with the formation of two gamma quanta γ_q [1–3]

$$e^- + e^+ \rightarrow 2\gamma_q + \nu_e \tag{5.25}$$

Thus, the only possible method of ensuring sufficiently extensive spherical deformation of the quantised space-time, capable of distorting (deforming) the space and ensuring that the space has gravitational features, is the formation of the sign-changing nucleon shell. This shell forms from electrical monopoles bonded in pairs into an electronic neutrino.

On the whole, the sign-changing shell is electrically neutral and has the neutron structure. The presence of a surplus positive charge in the shell forms the proton structure. Contact interaction of the shells results in the effect of colossal Coulomb attractive forces between the nucleons over short distance. These forces are regarded as nuclear forces.

However, most importantly, the presence of the sign-changing shell in the nucleon enables us not only to calculate the tension of the shell and correlation of this tension with the formation of the quantised space-time but also carry out for the first time analytical calculations of nuclear forces. These are Coulomb attractive forces of a large number of electrical dipoles acting between the nucleon shells in contact, regardless of the presence of a surplus electrical charge in the nucleon.

It can be assumed that the shell model of the nucleon is the most non-contradicting model embracing almost all aspects of the interaction of the nucleons not only inside the atomic nucleus but also between the atomic nucleus and the orbital electrons. At present, description of the well-known interactions of the atomic nucleus of the orbital electrons without knowing the structure of the particles is no longer sufficient in order to understand the complicated processes taking place in the vacuum field during operation of the atomic structures.

With all its manifestations, the shell model does not differ at all from the existing experimental data collected in the physics of elementary particles and the atomic nucleus. Most importantly, the shell model satisfies the assumptions of the Superunification theory regarding the spherical deformation of the quantised space-time, ensuring the gravitational properties of the nucleons.

The main problems which had to be solved in the development the shell model of the nucleon are associated with two aspects:

1. It was necessary to link the stability of the proton with complete filling of the cells of the shell model by electrical monopoles with the presence of a surplus elementary positive charge.
2. It was necessary to explain the instability of the neutron and its mass being $\sim 1.3 m_e$ greater in comparison with the proton.

It should be mentioned that most accurate measurements were taken of the difference between proton mass m_p and neutron mass m_n and not of the neutron mass [6]:

$$m_n - m_p = 1.29344(27)\,\text{MeV} \approx 1.3\,\text{MeV} \approx 2.53 m_e \tag{5.26}$$

Here, doubts are cast ??? on the encyclopedic values of proton mass $m_p \sim 1836\ m_e$ and neutron mass $m_n \sim 1840\ m_e$, which were used as handbook values in the calculations [16, 17], and also that the difference between them is $4m_e$, and not $\sim 2.53\ m_e$ (5.26). I assume that the small differences in the handbook data for the proton and neutron masses must be brought into correspondence.

Important features of the Superunification theory are not only the accurate difference between the proton and neutron masses, equal to

~1.3 m_e, but also the accurate values of the masses themselves since the mass determines tensions in the nucleon shell and the structure of the shell and the nucleon. The fact that the accurate neutron mass has not as as yet been determined indicates only the existence of theoretical and experimental difficulties.

When searching for analogues of shell models in other directions of science, a significant positive role in the development of shell models of the nucleons has been played by investigations in the area of fullerenes [18]. The attractive feature of these analogues is that the fullerenes are capable of self-organisation of spatial shell structures in the region of the small dimensions of the nanoworld. The fullerene is a shell of carbon cluster C_{60} containing 30–40 or more atoms.

The fact that arbitrary formations of shell models can form in nature permits the formation of an identical nucleon model, but the carbon in the nucleon shell is replaced by electrical monopoles merged into an electronic neutrino, not only of the dipole type but also more complicated formations.

The basis of the shell model of the nucleon is a grid whose nodes contain electrical monopoles. This grid is characterised by colossal surface tension capable of spherical deformation of quantised space-time, forming the nucleon mass. The equilibrium condition of this structure is determined, on the one hand, by the tension of the grid (shell) and, on the other hand, by the tension of the deformed quantised space-time which is balanced by the tension of the shell. At the same time, the structure should ensure the transfer of spherical deformation of quantised space-time in the stationary space, resulting in the transfer of the nucleon mass in space.

There are two grid models of the nucleon shell:

1. The surplus charge of positive polarity is situated in the centre of the proton outside its completely neutral shell. This model was investigated in [1]. The neutron forms as a result of the electrical monopole with negative polarity.
2. The surplus charge of positive polarity is harmonically included in the nucleon shell thus forming a proton. The neutron forms as a result of annexation of the electrical monopole with negative polarity to the shell of the proton.

5 .4. Shell models of the proton

In principle, these two models of the nucleons ensure stable construction of the proton and unstable construction of the neutron, fulfilling the condition of correspondence of the properties of stability and instability of the nucleons with the experimental data. The stability of the proton forces us to assume that the proton model must be the initial model of the nucleon.

Figure 5.2 shows the shell model of the nucleon with a built-in central electrical charge of the monopole type with positive polarity (*a*) and the model of the nucleon when the charge is built into the shell (*b*). These two shell models of the proton greatly differ from each other and can determine the stability instability of the proton. However, only one of them is found in nature. It is necessary to define scientific approaches to the analysis of these models which would enable us to select the required model.

So far, we have not examined the construction and structure of the nucleon shell and have only concluded, on the basis of previous investigations, that the nucleon shell structure has the form of a grid model with the sign-changing distribution of the monopole electrical charges in the nodes of the grid [1].

Only this sign-changing structure is capable of developing tension inside the shell. It is now important to understand that the shell of the proton represents the gravitational interface in vacuum ensuring spherical deformation of the quantised space-time.

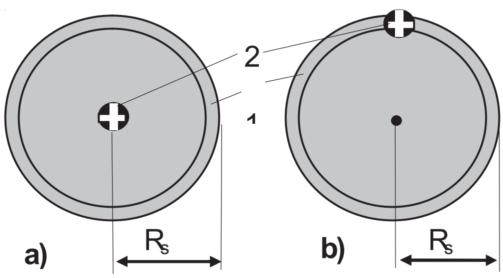

Fig. 5.2. Shell model of the proton with a surplus central charge: positive polarity (a) and with the charge built into the shell (b); 1) the shell, 2) the electrical charge of positive polarity of the monopole type.

The radius R_s of the gravitational interface of the proton is determined by the equation [19]:

$$R_s = (0.814 \pm 0.015)\mathrm{F} \approx 0.81 \cdot 10^{-15}\,\mathrm{m} \tag{5.27}$$

Regardless of the fact that the physics of deformation of quantised space-time of the proton by the sign-changing shell differs from the physics of deformation of quantised space-time by the central electron charge, in the general form the equations linking the vectors of deformation of the quantised space-time in the formation of the proton mass were derived previously in the EQM theory (5.24), (5.16), (5.23), (5.18):

$$m = \frac{1}{4\pi G}\frac{C_0^2}{\rho_0}\oint_S \mathbf{D}\,dS \tag{5.28}$$

$$\rho_m = k_0 \operatorname{div}\mathbf{D} = k_0 \operatorname{div}\operatorname{grad}(\rho) \tag{5.29}$$

Integrating (5.28), we determine proton mass m_p by deformation $\mathbf{D}_s$ of the gravitational interface R_s between the proton and the medium:

$$m_p = R_s^2 D_s \frac{C_0^2}{\rho_0 G} \tag{5.30}$$

Using (5.30), we determine the vector of deformation of the quantised space-time on the surface of the gravitational interface of the proton in vacuum

$$D_s = \frac{\rho_0}{C_0^2}\frac{Gm_p}{R_s^2} = 6.7\cdot 10^{51}\,\frac{\text{quanton}}{\text{m}^4} \tag{5.31}$$

Naturally, the concept of deformation of quantised space-time has not as yet been accepted in physics, and the value (5.31) does not yield much information without comparative analysis.

Thus, for example, deformation of the quantised space-time on the Earth surface reaches $4.9\cdot10^{60}$ quanton/m^4, and on the Sun surface $1.4\cdot10^{62}$ quanton/m^4. In relation to these values, the deformation of the quantised space-time by the proton (5.31) is tens of orders of magnitudes smaller, but as regards the quantised space-time, the deformation is defined by a very high value.

5.5. Shell models of the neutron

The neutron differs from the proton by its electrical neutrality, instability and a slightly larger mass. The decay time of the neutron in the free state in the vacuum field is ~15.3 min, and the decay time of the proton is more than 10^{30} years.

In particular, the instability of the neutron excludes its structure in the form of the fully neutral shell with all filled monopole charges in the nodes of the grid of the nucleon shell. It would appear that, losing the electrical charge of positive polarity, the proton transforms into the neutron (Fig. 5.2). In this case, the neutron should have a completely neutral shell which should have the form of a stable and durable particle, with the stability identical with that of the proton. However, this does not correspond to the observed results. At the same time, the loss of the charge by the proton during its hypothetical transition to the neutron should reduce its electromagnetic mass. The neutron mass is greater than the proton mass. Naturally, we are discussing here free particles in the vacuum field.

Thus, all the experimental investigations showed that the neutron is formed by the annexation of the electron or monopole electrical charge of negative polarity to the proton. In this case, the positive charge of the proton is compensated and is transferred to a neutral particle. In addition, this annexation increases the electromagnetic mass of the neutron.

The electromagnetic mass of the neutron is the total energy of the particle, including the energy of deformation of the quantised space-time and the energy of its additional polarisation associated with the annexation of the additional charge. Evidently, the annexation of the additional charge to the proton, resulting in its transformation into the neutron, is not associated with any increase of its gravitational mass. It may be assumed that only the binding energy of the charge annexed to the proton increases.

We can calculate the increase of this energy ΔW_p as the difference of energy in the transition of the monopole charge from the distance of the classic radius r_e of the electron to the radius R_s of the gravitational boundary of the proton $0.81\cdot 10^{-15}$ m

$$\Delta W_p = \frac{e^2}{4\pi\varepsilon_0}\left(\frac{1}{r_e} - \frac{1}{R_s}\right) = \frac{e^2}{4\pi\varepsilon_0}\frac{(R_s - r_e)}{R_s r_e} = \\ = 2.02\cdot 10^{-13}\,\text{J} = 1.26\ \text{MeV} \approx 1.3\,\text{MeV} \tag{5.32}$$

It can be seen that the energy (5.32) annexed to the neutron is not the gravitational energy and is the energy of interaction of the annexed charge with the neutron. It may be assumed that equation (5.32) is not quite accurate, but all the results of calculations of the interaction of the annexed charge with the neutron are reduced to the determination of the value of

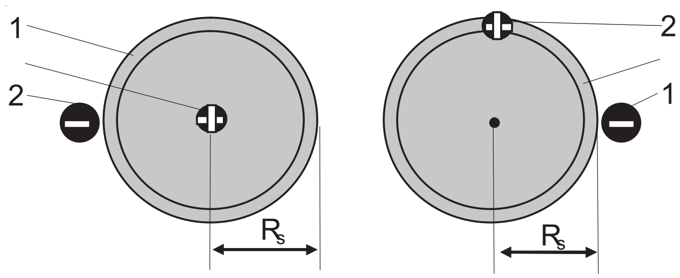

Figure 5.3 The shell model of the neutron by annexation of the external charge of negative polarity. 1) shell, 2) electrical charge of positive polarity of the monopole type, 3) the annexed charge of the monopole type of negative polarity.

the order of 1.3 MeV.

Figure 5.3 shows the shell model of the neutron by annexing the external charge of negative polarity to the proton.

To verify the correspondence of the particle models, it is often necessary to use handbook encyclopaedic materials because they contain the concentration of the required information on the particles. The electron capture effect is well-known in elementary particle physics. The concept of electron capture is characterised literally by a physics encyclopaedia as follows:

'Electron capture is the beta decay of nuclei, consisting of capture by a nucleus of an electron from one of the internal shells of the atom. The proton of the nucleus transforms into the neutron, i.e., the atom (*Z*, *A*) transforms to the atom (*Z*–1, *A*), where *Z* is the atomic number, *A* is the mass number. This transformation takes place by the scheme:

$$(Z, A) + e^- \rightarrow (Z - 1, A) + \nu_e \tag{5.33}$$

Here e^- is the electron capture by the atom nucleus (*Z*, *A*) from *K*, *L* and other shells, ν_e is the electronic neutrino.

The electron capture process is accompanied by the emission of characteristic x-ray radiation of the atom (*Z*–1, *A*), formed in filling of vacancies in its shell, and also by low-intensity electromagnetic radiation with a continuous spectrum whose upper boundary is determined by the difference of the masses of the initial and final atoms (less the energy of the quantum of characteristic radiation). This radiation is referred to as internal bremsstrahlung. If the nucleus (*Z*–1, *A*) is in the excited condition as a result of electron capture, the process is also accompanied by gamma radiation. If the difference of the masses of the atoms (*Z*, *A*) and (*Z*–1, *A*) is greater than the double rest mass of the electron, then beta decay with emission of the positron starts to compete with electron capture' [20].

The characteristic of electron capture [20] fully corresponds to the annexation (capture) model of the electrical charge by the proton and its transformation to the neutron (Fig. 5.3). It should be mentioned that prior to the development of the EQM theory, the processes of transformation of elementary particles were described only by Feynman diagrams [21]. However, these diagrams do not describe the mechanisms of internal processes taking place in the structure of the particles.

Electron capture is a spontaneous process and represents the anomaly of the incidence of the orbital electron on the atomic nucleus. However, any spontaneous process must be preceded by appropriate conditions. For the electron to leave the orbit and be captured by the proton of the nucleus, it is necessary to fulfil at least two conditions:

1. The electron orbit should pass in the immediate vicinity of the nucleus.
2. The electron orbit should intersect a specific barrier which reduces the velocity of the orbital electron and changes its trajectory in the direction of capture by the proton.

Previously, when examining the structure of the electronic neutrino and the process of synthesis of the electron and the positron from the quantised space-time [3], it was assumed that there is a certain number of the electronic neutrinos in the excited state in the vicinity of the proton. The electronic neutrino can be captured by the proton and form a specific environment of the proton, without increasing its mass. Evidently, the orbital electron can be captured by the proton with intervention of the electronic neutrino, excited by the proton.

It should be mentioned that the capture of the orbital electron by the proton is accompanied by the ejection of an entire spectrum of electromagnetic radiation, including the radiation of gamma quanta, which can be ejected if the electron loses part of its mass. This is natural because the electron interacts with the proton charge, and the distance between the charges of the electron and the proton may prove to be smaller than the critical radius of annihilation of the particles $r_a = 1.4\cdot10^{-15}$ m, smaller than the classic electron radius $2.8\cdot10^{-15}$ m.

Therefore, the expression for the reaction of capture of the electron by the proton in accordance with (5.33) does not appear to be quite accurate

$$p+e^{-}\rightarrow n+\nu_e \tag{5.34}$$

since the expression (5.34) does not reflect the energy conservation law. For this reason, equation (5.34) is not used in elementary particle physics.

In fact, the neutron mass is greater than the sum of the proton mass and the mass of the annexed electron, without mentioning the emission of electromagnetic radiation and ejection of the electronic neutrino. It is assumed that the energy-balanced regime is the beta decay of the electron [22]

$$n\rightarrow p+e^{-}+\tilde{\nu} \tag{5.35}$$

Equation (5.35) shows that if the electron has separated from the neutron (Fig. 5.3), the neutron transforms into the proton (Fig. 5.2). Since the electromagnetic mass of the neutron is greater than the sum of the proton and electron masses, it is then assumed that the difference in the energy is carried away by the electronic anti-neutrino $\tilde{\nu}$. Until recently, this explanation was satisfactory to physicists. The energy carried away by the antineutrino can also be calculated:

$$\tilde{\nu} \rightarrow n - p - e^{-} \rightarrow 0.782\ \text{MeV} = 1.53 m_e \qquad (5.36)$$

As indicated by (5.36), the energy carried away by the antineutrino in the reaction of neutron decay (5.35) is equivalent to ~$1.5m_e$. However, the antineutrino does not have such a mass. Knowing the structure of the antineutrino and the neutrino in the form of the electrical dipole with the opposite orientation in space [5], we can determine the distance between the charges inside the dipole structure of the electronic neutrino:

$$r = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{1.53 m_e C_0^2} = 1.84 \cdot 10^{-15}\,\text{m} \qquad (5.37)$$

As indicated by (5.37), the resultant distance between the charges exceeds the annihilation distance $r_e = 1.4 \cdot 10^{-15}$ m. The antineutrino cannot exist in this extremely excited state and must split into two electrical charges which form an electron and a positron in the vacuum field. However, this phenomenon is not detected in neutron decay. This means that neutron decay (5.35) does not reflect the entire complexity of the processes taking place in the vacuum field during neutron decay. This reaction is written down incorrectly.

It is assumed that neutron decay takes place spontaneously. The spontaneity of the phenomenon can be discussed when reasons for it are not known. The reasons for neutron decay are natural fluctuations of the zero level of the energy of the quantised space-time whose bursts are capable of separating the electrical charge with negative polarity from the neutron.

In a general case, the phenomenon of fluctuation of the zero level of the quantised space-time is not found in the region of the macroworld. however, in the microworld, there are many reasons for fluctuations. All the processes taking place in the vacuum field are associated with the effect of the laws of high numbers, starting with the reality of the quantum density of the medium (quantised space-time), which is expressed by the value of 75 orders (5.14). In addition to this, the quantised space-time is filled with neutrinos of different type whose concentration and velocity distribution have been studied insufficiently. In addition, the vacuum field contains a large number of elementary particles which deform and polarise the vacuum, shaking and stretching quantons from side to side. All this takes place on the background of the spectrum of all kinds of electromagnetic radiation which penetrates through the quantised space-time.

Therefore, when discussing the spontaneity and randomness of the phenomenon, it is the external manifestation of the effect of the laws of high numbers (statistical laws) inside of the quantised space-time. The internal reasons for these phenomena are connected with the behaviour of elementary particles in the presence of the fluctuations of the quantised space-time. Taking into account that in the range of distances of 10^{-15} m the interactions of the elementary particles take place at colossal strengths of the electrical and magnetic fields in the conditions of discrete space, possible fluctuations of the quantised space-time result in the disruption of the equilibrium in the medium. In the final analysis, this causes that the fluctuations of the quantised space-time, as an element of chaos, result in the specific value of the decay time of the free neutron in vacuum which equals ~15.3 min. This phenomenon can occur if there is a reason for it, i.e. fluctuations of vacuum

If we do not examine the random occurrence of the fluctuations of the quantised space-time, the models of the elementary particles, proposed by the Superunification theory, can be used to analyse the purely physical systems of manifestation of fluctuations and perturbations in vacuum. We examine the interaction of the electron with the proton in the case of electron capture up to the moment of formation of a neutron shown in the scheme (Fig. 5.4), taking into account the fact that the dimensions of these particles are approximately the same [3, 4]. When an electron is captured by a proton and they come together to contact with the gravitational boundaries, the structure of this formation, shown in in Fig. 5.4, is highly unstable and exist for a very short period of time. Naturally, the electron, impacting on the shell of the proton, is decelerated as a result of plastic deformation of its shell. As already mentioned, the electron does not have a distinctive gravitational boundary [3, 4], and its shell has lowered elasticity in comparison with the proton shell. At the moment, we should accept the dimensions of the electron with respect to its conventional gravitational

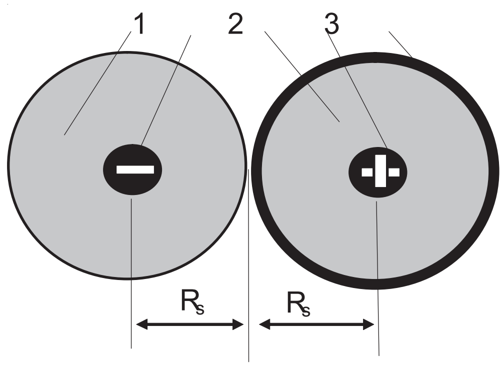

Fig. 5.4. Diagram of interaction of the electron 1 and proton 3 in the case of electronic capture up to the moment of formation of a neutron. 1) the electron, 2) the monopole electron charge, 3) proton, 4) the monopole charge of the proton, 5) sign-changing proton shell.

boundary which is comparable with the radius of the gravitational boundary of the proton R_s.

Naturally, the kinetic energy of the electron, incident on the proton, changes to bremsstrahlung at the moment of capture of the electron. This bremsstrahlung is detected in experiments. It is possible that the deformation of the electron at the moment of collision generates a wide spectrum of electromagnetic radiation. In addition, it is necessary to take into account the additional mass defect as a result of the electron falling into the gravitational well of the proton (Fig. 5.1) [3]. Finally, the scheme in Fig. 5.4 shows the annihilation of the electron on the proton with the emission of gamma radiation. The electron mass changes to the radiation gamma quantum and its monopole charge is annexed to the proton shell transforming the proton into a neutron (Fig. 5.3).

The main advantage of these schemes is that real models can be used to examine the energy transformations in the vacuum field in capture of the electron by the proton and confirm that there are no disruptions of the laws of conservation of energy in the neutron decay reaction (5.34) and formation of the neutron from the proton taking the polarisation of the quantised space-time into account. Here, it is not necessary to use the electronic neutrino (antineutrino) to maintain the energy balance because its energy does not have any specific value in relation to the type of given reactions. The neutrino simply accompanies these reactions because of the specific features of the quantised space-time.

The main error of elementary particle physics is that it does not take into account the interaction of monopole charges in the vacuum field. To show the total energy balance of the system, shown in Fig. 5.4, it is necessary to take into account the mass of not only the electron and the proton but also to take into account the energy W_e of interaction of the charges of the particles with each other. This energy W_e determines the polarisation of quantised space-time by charges for the moment shown in Fig. 5.4

$$W_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{2R_s} = 1.42\cdot 10^{-13}\,\mathrm{J} = 0.89\,\mathrm{MeV} = 1.73 m_e \tag{5.38}$$

Naturally, the expression for the energy of interaction of the charges is determined by the distance between the charges. At short distances, in the vicinity of particles, equation (5.38) is not completely accurate from the viewpoint of electrostatics because it does not take into account the change of the electrical properties of the structures of the particles as a result of spherical deformation of the quantised space-time during formation of mass of the particles. The exact solution of this problem is associated with the solution of relatively complicated boundary-value electrostatics problems

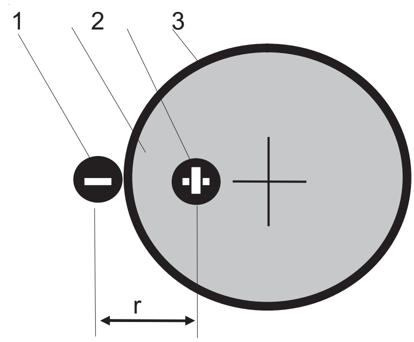

Fig. 5.5. Calculation of additional energy of the neutron, 1) the annexed monopole charge of negative polarity, 2) the neutron, 3) the intrinsic excess charge of the neutron with positive polarity) the neutron shell.

taking into account the deformation of quantised space-time, both inside and outside the gravitational boundary.

The model of the neutron shown in Fig. 5.2 also confirms that the energy of interaction of the charges exists inside the neutron and determines its large electromagnetic mass. At the moment, it is difficult to derive an exact analytical equation which would determine the additional energy of interaction between the annexed and natural charges, but this additional energy is not linked with the gravitational mass of the neutron. Unfortunately, it is this additional energy of interaction of the charges that has not been considered in elementary particle physics.

Nevertheless, some 'reconnoitering' calculation parameters of the additional energy of interaction of the charges inside the neutron can be presented. To some extent, these calculations make it possible to predict the selection of the proton model with an internal charge or a charge implanted in the shell.

Figure 5.5 shows the calculation diagram of the additional energy of the neutron as a result of interaction of the annexed and natural excess charges. In this stage, we do not take into account the effect of the sign-changing shell of the neutron which may have both a screening effect or be the factor of interaction causing generation of additional energy.

If the additional energy of the neutron is determined by the interaction of these charges, then irrespective of whether the charge is situated inside the gravitational boundary behind the shell or is implanted in the shell, the approximate value of the energy can be calculated taking into account the distance r between the charges under the condition that this energy is equal to 1.3 MeV (5.26)

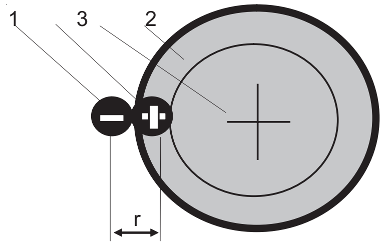

Fig. 5.6. Model of the neutron with the positive electrical charge built into the shell and compensated on the external side by the monopole charge of negative polarity. 1) the annexed monopole charge of negative polarity, 2) neutron, 3) intrinsic excess charge of the neutron of positive polarity, 4) neutron shell.

$$W_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r} = 1.3\,\text{MeV} = 2.1\cdot 10^{-13}\,\text{J} \tag{5.39}$$

From (5.39) we determine the required distance between the charges

$$r = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{W_e} = 1.1\cdot 10^{-15}\,\text{m} \tag{5.40}$$

As indicated by (5.40), the required distance between the charges is greater than the radius of the gravitational boundary of the neutron $0.81\cdot 10^{-15}$m. This means that the internal charge with positive polarity should not be displaced in the direction of the external charge with negative polarity and should be repulsed in the opposite direction. However, this contradicts the known laws of electrostatics. The neutron is already produced at capture of the orbital electron by the proton shell.

It can be assumed that these calculations are highly approximate and the model of the proton with the central charge can exist. However, in this case the neutron formed from such a proton should have a dipole electrical momentum equal to the value of the order:

$$p_e = eR_s = e\cdot 0.8\cdot 10^{-15}\,\text{C·m} \tag{5.41}$$

However, in reality, the neutron does not have any dipole electrical moment (5.41). This confirms that the excess electrical charges of the proton is built in into its shell, and the neutron forms as a result of annexation of the electrical charge of negative polarity by the proton shell.

$$p_e \le e\cdot 2\cdot 10^{-23}\,\text{C·m} \tag{5.42}$$

Figure 5.6 shows the model of a neutron with a positive electrical charge built into the shell and compensated on the external side by the monopole charge with negative polarity. In principle, this model can satisfy all the properties of the neutron. It is completely neutral and has in fact a very small dipole momentum and is capable of electrical and magnetic polarisation. Most importantly, the model is capable of spherical deformation of quantised space-time, forming the gravitational mass of the neutron. This model is characterised by a larger electromagnetic mass in comparison with the proton, and is unstable. The external electrical charge of negative polarity can be separated from the neutron and injected into the quantised space-time, transforming into an electron, and the neutron itself transforms to a proton.

Further difficulties in matching this neutron model are reduced to the determination of the initial energy of the bond of the connected charge with the neutron shell which has a single monopole charge of positive polarity. To solve this problem, it is necessary to analyse the possible structure of nucleon shells.

5.6. Structure of nucleon shells

It can be seen that the the Superunification theory removes quite easily many contradictions in the physics of nucleons, starting with the analysis of possible structures of nucleons in interaction with the vacuum field and by taking into account the known properties of elementary particles. In particular, the need for strong spherical deformation of the quantised space-time in the formation of the nucleon mass determines the presence of a sign-changing shell of the nucleon, capable of strong spherical tension in compression of the quantised medium (Fig. 5.1). In addition, the presence of the sign-changing shell of the nucleon enables two or more nucleons to interact with the electrical charges of the shells thus generating nuclear

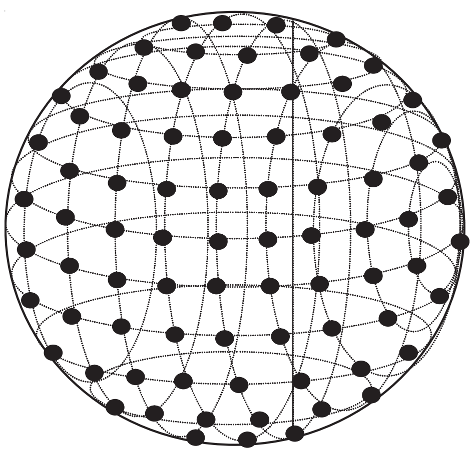

Fig. 5.7. The model of the nucleon shell with square cells of the grid

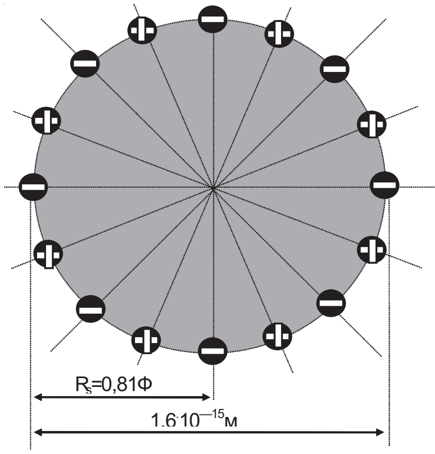

Fig. 5.8. Section of the nucleon shell with the sign-changing distribution of electrical charges in the grid nodes.

forces. These are contact Coulomb attractive forces of the nucleon shells and the forces acting through the monopole sign-changing charges built into the shell. The interaction forces of the sign-changing structures are characterised as short range forces [1, 2].

The calculated shell model of the nucleon can be substantiated by selecting the configuration of the cell of the grid shell. In this stage of investigations, we can investigate only possible variants of formation of the cell of the grid shell and, further, carrying out calculations, we can provide estimates of the extent to which the given grid model corresponds to the physical parameters of the nucleon. Naturally, the basic shell should be represented by the stable shell of the proton. The structure (configuration) of the cells is important for such a stable shell.

Figure 5.7 shows the model of the shell of the nucleon with the square cells of the grid, with the nodes containing the monopole charges with sign-changing polarity, forming a sign-changing shell. This model was proposed for the first time in [1]. The characteristic properties of the sign-changing fields have been examined in [1]. In this stage of investigations, it is important to show the bonds of the charges in the nodes of the grid and determine at least the approximate number of the monopoles in the nucleon shell.

Figure 5.8 shows the equatorial section of the nucleon shell with the sign-changing distribution of the electrical charges in the grid nodes. In particular, the sign-changing shell determines the gravitational boundary between the internal (compressed) region of the nucleon and the external region of the quantised space-time in the formation of nucleon mass. That this shell has the spherical compression effect is determined by the fact that the electrical monopoles, included in the composition of the shell, are distributed with alternation of the polarity of the charges resulting, under the effect of electrical forces, in the constantly acting tension inside the sign-changing shell.

The described section of the shell does not contain any excess positive charge whose existence is determined by the structure of the proton as the initial nucleon. The presence of the excess charge in the shell is a special separate problem. At the moment, we shall try to estimate at least approximately the number of electrical monopoles in the nucleon shell. For this purpose, we shall use the previously developed methods of evaluation of the tension forces in the shell during the formation of electron mass [3, 4].

As established previously, the electron mass forms by the tension of spherical magnetic shells (electron spins) [3, 4]. In contrast to the electron, the nucleon mass forms by the tension of the electrical shell. Since the proton mass is 1836 times greater than the electron mass, it is evident that the tension forces in the nucleon shell should be 1836 greater than the tension forces in the electron shell. This is justifiable because the deformation of the quantised space-time by the elementary particles in the non-relativistic velocity range takes place in the zone of small deformation displacements and is therefore linear.

The tension of the magnetic shell of the electron is determined the strength of the spherical magnetic field induced by the radial electrical field of the central charge. For the electrical shell, the tension is determined by the strength **E** of the electrical field acting on the electrical charge inside the shell. Evidently, the equivalent strength of the electrical field in the nucleon shell can be calculated on the basis of the strength of the magnetic field of the electron at the distance equal to its classic radius, increasing the strength 1836 times

$$E = \frac{1836}{4\pi\varepsilon_0}\frac{e}{r_e^2} = 3.4\cdot 10^{23}\,\frac{\text{kV}}{\text{m}} \tag{5.43}$$

As indicated by (5.43), the strength of the electrical field acting on the charge in the sign-changing nucleon shell should reach colossally high values to ensure the required tension of the shell. Further calculations are reduced to determining the function of the strength of the field of a system of sign-changing charges, situated on the spherical shell (Fig. 5.7). A ready solution could not be found and since this is a demanding calculation task, in the first approximation we can use the equation of the strength of the electrical field for half the sign-changing string [1, 2] which in the presence of the large number of charges in the shell should be fully acceptable for estimating the field in Fig. 5.8. For the total string we use the actual strength of the field which is twice as high:

$$E = \frac{1.64}{4\pi\varepsilon_0} \frac{e}{r_n^2} \tag{5.44}$$

where r_n is the distance between the charges in the nucleon shell (neutron and proton), m.

Taking into account that two sign-changing strings intersect in a grid node, the actual strength of the field in the shell is doubled

$$E = \frac{3.28}{4\pi\varepsilon_0} \frac{e}{r_n^2} \tag{5.45}$$

Equating (5.43) and (5.45), we determine the square of the distance and the distance between the charges in the nucleon shell:

$$r_n^2 = \frac{3.28}{1836} r_e^2 = \frac{r_e^2}{560} = 1.41 \cdot 10^{-32}\,\text{m}^2 \tag{5.46}$$

$$r_n = \frac{r_e}{23.7} = 1.2 \cdot 10^{-16}\,\text{m} \tag{5.47}$$

It can be seen that the distance between the electrical charges in the sign-changing shell of the nucleon is smaller than the annihilation distance and almost an order of magnitude smaller than the radius of the gravitational boundary of the nucleon. The annihilation distance of $1.4 \cdot 10^{-15}$ m is determined from the reaction (5.25) and indicates that all the charges, included in the shell, have no mass and are monopoles. The electron and the positron restore their mass in vacuum at distances between them smaller than the annihilation distance between the charge centres.

The calculations described previously are of the reconnoitering type and linked with the state of the electron as if its mass has been increased 1936 times. More accurately, the distance between the charges in the nucleon shell can be calculated on the basis of the equivalence of the energy of the gravitational field and of the energy of the electrical field of the nucleon.

The energy of the electrical field of the sign-changing shell of the nucleon is used for the deformation of the quantised space-time, i.e., for the formation of the nucleon mass and its gravitational field. Consequently, we can write the equation of the balance of the energies of the nucleon in the vacuum field in the statics, equating the electrical energy W_{en} of the shell of the nucleon and its gravitational energy W_0 (rest energy)

$$W_{en} = W_0 \tag{5.48}$$

$$W_{en} = \frac{3.28}{4\pi\varepsilon_0}\frac{e^2}{r_{en}} n_{en} \tag{5.49}$$

where n_{en} is the number of electrical charges in the nucleon shell, number; r_{tn} is the distance between the charges in the nucleon shell, m.

$$W_0 = m_p C_0^2 \tag{5.50}$$

The rest energy of the nucleon is attached to the proton. The number of charges in the nucleon shell is determined on the basis of the surface of the shell and the area of the grid cell

$$n_{en} = \frac{4\pi R_s^2}{r_{en}^2} \tag{5.51}$$

Equating (5.49) and (5.50), and taking (5.51) into account, we obtain the equality

$$\frac{3.28}{4\pi\varepsilon_0}\frac{e^2}{r_{en}}\frac{4\pi R_s^2}{r_{en}^2} = m_p C_0^2 \tag{5.52}$$

Consequently, we obtain

$$r_{en}^3 = \frac{3.28}{\varepsilon_0}\frac{e^2 R_s^2}{m_p C_0^2} = 41.4\cdot 10^{-48}\,\mathrm{m}^3 \tag{5.53}$$

$$r_{en} = \sqrt[3]{\frac{3.28}{\varepsilon_0}\frac{e^2 R_s^2}{m_p C_0^2}} = 3.46\cdot 10^{-16}\,\mathrm{m} \tag{5.54}$$

The resultant distance $3.46\cdot10^{-16}$ m between the charges in the cells of the grid of the nucleon shell is in satisfactory agreement with the reconnoitering distance of $1.2\cdot10^{-16}$ m (5.47). This shows that the method used for calculating the dimensions of the grid cells for the nucleon shell is fully suitable for application in practice, although its accuracy can be improved.

Knowing the distance between the charges (5.54), which determines the area of the cell of the great in the shell, we determine the number (5.51) of electrical monopoles charges, included in the nucleon shell:

$$n_{en} = \frac{4\pi R_s^2}{r_{en}^2} = \frac{4\pi(0.81\cdot 10^{-15})^2}{(3.46\cdot 10^{-16})^2} \approx 69 \tag{5.55}$$

Thus, the number of the electrical monopoles included in the structure of the nucleon shell is determined by a number of the order of 69. I would like to repeat that this number is approximate and its accurate determination requires both experimental and theoretical investigations. Only 69 charges in the proton shell result in the proton mass 1836 times greater than the electron mass.

Up to now we have examined the structure of the nucleon shell and even estimated the possible number of electrical monopoles forming the shell. Naturally, we face the question of the mechanisms of formation of such a shell in the vacuum field. Evidently, the square configuration of the shell cell is not optimum from the viewpoint of minimisation of the number of bonds between the charges inside the shell.

Figure 5.9 shows that the square cell of the grid of the nucleon determines bonding of a single charge with positive polarity with four charges of negative polarity. However, the minimum number of the bonds required to form the grid surface is determined by only three bonds. In particular, these three bonds have been used in the natural formation of the shell structures of fullerenes [18].

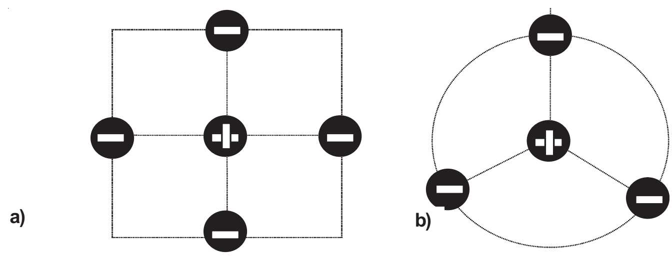

Fig. 5.9. The number of bonds between the charges inside the grid shell of the nucleon for the square cell (a) and the rational cell (b).

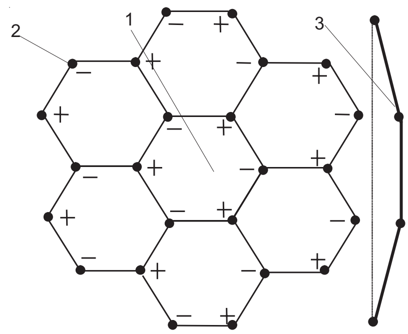

Fig. 5.10. Fragment of the grid shell of a nucleon according to the type of fullerene cluster C_{60}; 1) the cell, 2) the monopole charge.

Figure 5.10 shows a fragment of the grid shell of the nucleon according to the type of fullerene cluster C_{60}. This shell is based on the cell of the grid with the rectangular hexagon configuration. The grid nodes contain electrical monopole charges 2. In particular, the hexagonal grid cell determines the minimum number of bonds (three) of charges in the shell (Fig. 5.9*b*). A characteristic feature of the hexagonal cell is its total electrical neutrality in the case of sign-changing distribution of the charges inside the cell.

Naturally, this electrically neutral shell would be an ideal shell for the neutron. However, this shell is too stable and resistant. This means that in order to transfer the neutron into the proton from the shell, it is necessary to separate one electrical charge of negative polarity using external force for this. However, the neutron is unstable and decays spontaneously into a proton under the effect of fluctuations of quantised space-time emitting an electron.

On the whole, the ideal neutral shell, shown in Fig. 5.10, is not suitable for the neutron shell because of its physical properties. On the other hand, as shown by analysis, the alternatives of the shell model of the nucleons capable of spherical deformation of the quantised space-time, are not foreseen. The shell with the square cell can be used only in preliminary simplifed calculations and is not optimum. Optimum is the shell based on a hexagonal cell of the grid, but even this shell does not fully satisfy all the physical properties of the nucleon.

The situation can be solved by further analysis of the shell with the hexagonal grid cells. The attempts to roll up the surface consisting of hexagons into a sphere are associated with the deformation of the hexagons themselves on the sphere, i.e., with the variation of the topology in space. In fact, producing a surface from regular hexagons we can produce only the flat surface 1 (Fig. 5.10). To produce a sphere or a section of the spherical surface 3, it is necessary to the form the grid cells. However, this is not a simple task, taking into account that we must deal with the colossal tensions in vacuum.

The grid shell can be rolled up into a sphere only in the presence of defects in some cells of the grid when the hexagonal cells are deformed into pentagonal. Many readers will remember leather footballs produced from hexagonal and pentagonal fragments. The sphere can be produced only in this case. In the fullerenes, the formation of the spherical surface is also associated with the presence of defective pentagonal cells [18].

Figure 5.11 shows a fragment of the formation of a spherical surface by rolling into a cup the grid cells defective cells present in the grid. In particular, the defective internal cell makes it possible to produce an excess charge of positive or negative polarity in the cell.

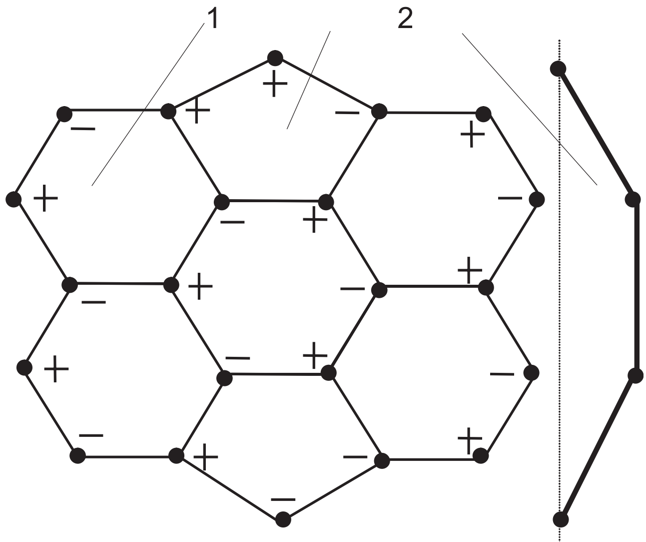

Fig. 5.11. Fragment of rolling into the spherical surface (cup) 3 the grid of hexagons 1 in the presence of defective pentagonal cells 2.

Consequently, we can substantiate the proton shell with an excess positive charge. However, the main point is that the presence of defects in the nucleon shell makes this shell active.

It is important to mention the comparison of the quantised space-time with a superhard solid, because of the colossal tensions acting in it. If we make some analogy between the vacuum field and traditional solid-state physics, the work of semiconductor crystals is related with the presence of impurities and defects in the crystal which activate the work of the crystal. All the processes taking place in the vacuum field with the nucleons are

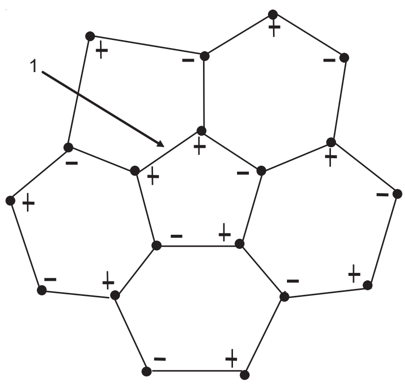

Fig. 5.12. Defects in the nucleon shell (fragment).

also related with the presence of defects in their shell. This also applied to other elementary particles having a mass whose appearance is the result of formation of a new formation in the form of spherical deformation of quantised space-time. This process can be regarded as the formation of local defects in the vacuum field.

To ensure that the nucleon shell is active and capable of spontaneously transferring the electrical charge of negative polarity at the neutron and of transforming the neutron into the proton under the effect of fluctuations of the quantised space-time, there must be defects in the nucleon shell. However, the proton, because of the activity of the nucleon shell, is capable of traping the orbital electron and transforming to a neutron.

Figure 5.12 shows a fragment of the formation of defects in the grid structure of the nucleon shell. It may be assumed that even in the presence of the defects, the shell remains electrically neutral with the exception of the final fragment when the presence of the defect 1 (indicated by the arrow) results in the formation of a surplus of a single positive charge in the shell. This corresponds to the state of the proton. Defect 1 is represented by a bond of two electrical charges with positive polarity. This is an anomalous zone on the surface of the shell. This anomalous zone can capture the orbital electron and hold it in the shell.

It is possible that the described models of the nucleon shells are not perfect. However, these are initial models which require further development. It is important to mention that the transition from purely phenomenological investigations to investigations of the structure of elementary particles has been made in the physics of elementary particles for the first time.

Ending this section, attention should be given to the fact that the contradictions in the properties of the models in relation to the properties of the particle, formed as a result of investigations, are gradually removed by improving the model itself. I believe that the publication of this book will activate investigations in this direction.

It is necessary to solve the problem of the transfer of energy of the electrical charge, annexed to the proton, in capture of the orbital electron. For the calculated dimensions of the gris, the capture of an additional electrical charge by the neutron increases the binding energy of the captured charge to a considerably greater degree than the difference between the electromagnetic masses of the neutron and the proton. Evidently, the decrease of the binding energy may be reduced by the energy of elastic tensioning of the shell itself because the captured charge is forcefully introduced into the shell. By analogy, if we press on the surface of an elastic ball made of table tennis plastic, the resultant depression generates stresses in the shell of the sphere directed against the compression forces and, after some time, the sphere rapidly restores its initial form.

Evidently, this also takes place with the electrical charge of negative polarity which as a result of the fluctuations of the quantised space-time is ejected from the shell of the neutron by the forces of its elastic tension. The neutron decays into a proton and an electron which captures the electronic antineutrino, fluctuating in the strong fields of the shell.

Thus, the Superunification theory has been used to construct the model of nucleons and indicate directions of investigations aimed at optimising the topology of their shell structure. Whilst there were no significant problems in the development of the physical model of the electron, and the model harmonically followed from the conditions of spherical deformation of the quantised space-time by the central charge, in the optimisation of the models of the structure of nucleons there is a large number of problems whose solution is described in the Superunification theory.

5.7. Prospects for splitting the nucleon into elementary components

The equivalence of the energy of electrical and gravitational fields of the nucleon determines the binding energy of the electrical charges in the proton shell (5.49) even is the number of monopole charges is only 69:

$$W_{en} = \frac{3.28}{4\pi\varepsilon_0}\frac{e^2}{r_{en}}69 = 1.5\cdot 10^{-10}\ \text{J} = 938.3\ \text{MeV} \qquad (5.56)$$

It would appear that to fracture a nucleon consisting of a single electrical shell requires an energy greater than 938.3 MeV, which is the energy of the order of 1 GeV. These energies have already been generated in currently available elementary particle accelerators but no decay of the nucleon to individual electrical monopoles has been detected.

Quantum chromodynamics (QCD) predictied proton decay at energies of the order of 200 GeV/nucleon [23]. However, even at these energies the nucleon does not decay to elementary components. The elementary components of the nucleons in QCD are quark-gluon plasma and in the Superunification theory is the electrical monopoles in the form of a sign-changing shell ensuring the spherical deformation of quantised space-time.

It would appear that the resultant energy is 200 times greater than the energy of decay of the nucleon shell. However, the nucleon resists. So what is the matter?

I think that the point is that an increase of the velocity of the proton in accelerator increases the proton mass, i.e., the energy of the gravitational field of the particle increases. In accordance with the principle of equivalence between the gravitational energy of the proton and its electrical energy of the shell, an increase of velocity results in an automatic increase of the energy of electrical bonds of the charges in the shell. This is caused by the change of the electrical and magnetic properties of the quantised space-time as a result of its deformation. The shell becomes automatically stronger ensuring the balance of tensions of the quantised space-time.

Let us assume that a proton is accelerated to high energies of the order of 200 GeV/nucleon and it hits another stationary proton with the energy of only 1 GeV. Seemingly, the proton with the binding energy between the charges in the shell of 1 GeV should disintegrate into fragments under the effect of a proton with 200 GeV.

It can be assumed that in this case the proton does not fracture as a result of the elastic transfer of energy to the second proton which accelerated as a result of the effect of the received momentum which automatically increased its strength. To break up the proton, the proton must run into an absolutely stationary barrier which would prevent acceleration of the proton as a result of elastic impact. Even if the experiment is carried out with proton beams propagating in the opposite directions, it is not possible to prevent elastic collision and dispersion of the protons and, consequently, the proton cannot be split into elementary components. However, these are only additional hypotheses which require experimental confirmation.

Physicists throughout the world are waiting impatiently for the results of experiments with the detection of quark-gluon plasma in more powerful accelerators. There were reports on positive results. However, what is the reliability of conclusions that fractional charges of the quarks have been discovered? Nobody has measured the magnitude of these charges. I have previously presented several hypotheses which could also be useful in obtaining new effects on powerful accelerators. I would like to express my doubts regarding advanced theoretical physics in the area of investigation of elementary particles and the atomic nucleus because it can not describe, even in the first stage, the structures of not even a single elementary particle and explain the presence of mass in these particles.

Naturally, these experiments attract the attention of mass information media expressing fears that these experiments could create conditions similar to the initial moment of creation of the universe as a result of the Big Bang. These experiments appear to place the Earth at the edge of annihilation. From the viewpoint of the Superunification theory this is the result of unfounded fantasies. In order to release all the colossal energy of quantised space-time in the nucleon volume, it is necessary to apply external energies many orders of magnitude greater than those achieved in the currently available accelerators.

In order to split the quanton, it is necessary to supply an energy greater than 10^7 GeV/quanton. The energy of the quantons in the nucleon volume is already of the order of 10^{39} GeV/nucleon. This colossal energy of the quantised space-time cannot be compared with the value of 200 GeV/nucleon, obtained in the accelerators. Therefore, the fears regarding the experiments causing possible splitting of the structure of space and inducing a Big Bang do not have any scientific basis and are the result of pure fantasy.

It may be assumed that the Superunification theory is some sort of modernisation of the QCD, only the three initial quarks with fractional electrical charges are replaced by four quarks with integer charges, two of which are electrical and the other two magnetic. This is not completely accurate. The QCD is based on the interactions between quarks, and the theories of EQM and TUEF are based on the interaction with the vacuum field.

The Superunification theory enables us to determine the limiting energy (5.1) of the nucleon when the latter reaches the velocity of light as the finite energy ($R_s = 0.81 \cdot 10^{-15}$ m)

$$W_{MAX} = \frac{C_0^4}{G} R_s = 9.8 \cdot 10^{28}\,\text{J} = 6.1 \cdot 10^{47}\,\text{eV} \qquad (5.57)$$

5 .8. Electrical nature of nuclear forces

The Superunification theory regards the quantised space-time as the only source of energy in the universe. This energy is accumulated in the vacuum by means of the space quantum (quanton) whose structure has the form of a static electromagnetic quadrupole. The size of the quantons is of the order of 10^{-25} m. The electromagnetic energy in vacuum is accumulated both inside the quanton and in the form of energy of interaction of adjacent quantons [3, 4].

The Superunification theory reduces all the types of known interactions to the interaction inside the quantised space-time. It has been possible to combine gravitation with electromagnetism. Gravitation is based on the processes of spherical compression of quantons, without disrupting their electrical equilibrium. The processes in the electromagnetic wave are determined by the electromagnetic polarisation of the quantons manifested in the form of laws of electromagnetic induction. They are not associated with the gravitational deformation of the quantised space-time. Therefore, the laws of electromagnetic induction do not permit the production of excess energy.

Up to now, the excess energy has been produced as a result of the mass defect mass of elementary particles and the atomic nucleus, more accurately, nucleons, included in the composition of the atom nucleus. The Superunification theory shows that the release of chemical energy is due to the mass defect of valence electrons during their rotation inside the gravitational well (Fig. 5.1) formed by the atom nucleus. The presence of the well has not been taken into account by anybody [3]. The release of nuclear energy is caused by the mass defect of the nucleons during the merger of the nucleons or splitting in the nucleus. This energy release takes place through the variation of the spherical deformation of the quantised space-time.

The spherical deformation of the quantised space-time by the nucleon is possible in one case only – if the gravitational boundary in the deformed medium is capable of sustaining deformation of the quantised space-time. This property is observed only in the case of the sign-changing shell of the nucleon consisting of electrical monopoles (massless electrical charges).

This approach makes it possible to reduce the interaction between the nucleons inside the nucleus to the electrostatic attraction of the monopole charges of the sign-changing shells of the nucleons. The properties of the sign-changing fields of the shells of the nucleons are clearly evident in this case and they have the form of short-range fields, determined by the radius of the effect of nuclear forces comparable with the step of the cell of the grid of the nucleon shell (54):

$$r_{en} = 3.46 \cdot 10^{-16} \text{ m} \tag{5.58}$$

The proton shell contains approximately 69 (5.55) monopole electrical charges with a single excess charge of positive polarity. The remaining charges of the shell are divided equally between the charges with negative and positive polarity. The neutron forms by capture of an electron with the annexation of the shell of the proton of the monopole charge with negative polarity, making the shell completely neutral. The Coulomb interaction of the shells of the nucleons is due to the interaction of the charges included in the composition of the shells, irrespective of the presence of the excess charge.

Undoubtedly, the strong interactions become evident not only in nuclear forces as a result of the electrostatic attraction of nucleon shells but also represent a wide range of gravitational and electromagnetic interactions. The sign-changing shell of the nucleon provides for the spherical deformation of the quantised space-time which results in the formation of the gravitational field of the nucleon and its mass as a gravitational charge. In interaction of the nucleons, as a result of distortion of the spherical shape, the total deformation of the quantised space-time decreases. This deformation is detected in experiments in the form of electromagnetic radiation as a result of the mass defect of the nucleon.

The Superunification theory combines for the first time the nuclear forces, gravitation and electromagnetism through the superstrong electromagnetic interaction (SEI), whose carrier is the quantised space-time. When scientists discuss the theory of Grand Unification, away from the actual world and with complete ignorance of the structure and properties of the quantised space-time, it appears necessary to return the problem formulated by Faraday and subsequently developed by Einstein. This is the problem of unification of gravitation with electromagnetism. Without solving this problem it is not possible to solve the problems of strong interactions.

If we examine in detail the EQM theory used as the basis for the Superunification theory, it appears that this theory is constructed practically on the known assumptions of physical science. Only one particle has been introduced, i.e., quanton - the static quantum of the stationary space-time (or the quantum of the static electromagnetic field which can not be further divided). This means that an integrating particle has been found instead of the unified equation of nature. This immediately remedies the situation. It is possible to integrate informally in the nucleon gravitation with electromagnetism through the spherical deformation of the quantised space-time by the sign-changing shell of the nucleon and, subsequently, the strong, gravitational and electromagnetic interactions are unified through the contact interaction of the sign-changing nucleon shells.

The energy parameters of the nucleon indicate that the electrical energy of bonding of the charges in the shell is fully balanced by the gravitational energy of deformation of the quantised space-time. To calculate the nuclear forces, it is necessary to analyse the contact interaction of the sign-changing shells of the nucleons. It is the electrostatic attraction of the shells that ensures the effect of nuclear forces.

5 .9. Analytical calculation of nuclear forces

At present, nuclear physics does not have any procedure for analytical calculation of the nuclear forces because it does not have any real physical model of the nucleons. This is due to the fact that the nucleus is a relatively complicated object and understanding of the structure of this object is based on a purely phenomenological description [24–26]. In the last 50 years, regardless of QCD attempts, the nature of the nuclear forces has not been discovered.

The assumption that the nuclear interactions cannot be based on Coulomb interactions was the largest mistake of nuclear physics. Evidently, the physicists were confused by the fact that the nuclear forces are capable of overcoming the Coulomb repulsion of the protons in the nucleus and also of bonding together the completely electrically neutral neutrons and neutrons with the protons, regardless of the presence of the electrical charge. It therefore appeared as if the nuclear forces represented a completely independent category not associated with the Coulomb interaction.

Rejecting the electrical nature of nuclear forces, the theoretical physicists could not therefore construct a satisfactory physical model of interaction of the nucleons inside the nucleus [27]. The nature of nuclear forces was ignored due to the fact that the theoretical physicists, working in the physics of elementary particles and the atomic nucleus, did not know any unique properties of the sign-changing fields, regardless of the fact that these properties were well known in electrical engineering. The sign-changing fields with the sign-changing charges are electrical fields generating short-range forces perceived as nuclear forces in the interaction of nucleons [1].

We examine the contact interaction of the shells of the nucleons using a real physical model in which the charges with the changing sign are placed in the shell and form a system of sign-changing fields. It is necessary to estimate the interaction energy of the shells of the nucleons and the attractive forces of the nucleons and also show that these forces are of the short-range time. For this purpose, it is necessary to find the functional dependence of weakening of the force when the nucleons travel away from each other.

Figure 5.13 shows the scheme of Coulomb interaction of the sign-changing shells of the nucleons. A specific feature of Coulomb interaction is that two (or more) sign-changing shells of the nucleons are attracted to each other under the effect of the forces of electrostatic attraction of the charges with the opposite signs. The scheme shows that in the area of contact of the shells the positive polarity charge of one shell is connected by Coulomb interaction with the negative polarity charge of another shell, and vice versa. Consequently, the area of contact of the shells is characterised by the Coulomb attractive forces from the group of interacting

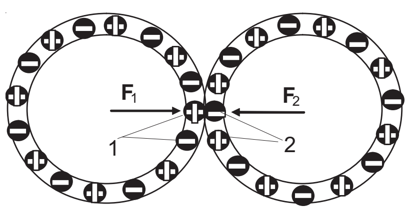

Fig. 5.13. Contact Coulomb interaction of nucleon shells. 1 and 2 are the monopole charges.

charges whose overall effect is perceived as the nuclear attraction force of the nucleons.

The model in Fig. 5.13 reduces the nuclear forces to the Coulomb interaction forces $\mathbf{F}_1$ and $\mathbf{F}_2$ of the charges in the nucleon shells. This model fits completely the concept of the Superunification theory in which all the existing interactions in nature are reduced to the electromagnetic interactions (electrical and magnetic) through the superstrong electromagnetic interaction (SEI).

The solution of this electrostatic problem of interaction of the nucleon is associated with the determination of the function of the strength of the electrical field in the space for the system of sign-changing charges situated on the surface of the sphere. Knowing this distribution function, we can accurately analyse the forces acting on the electrical charge in such a field and also the variation of forces when the shells travel away from each other. Unfortunately, I couldn't find a ready exact solution of the given electrostatic problem for the function of the strength of the electrical field. I believe that the experts concerned with the calculation of complicated fields have now a stimulus to find the exact solution of this problem.

At present, we can use the approximate solution. Naturally, the nucleon shells have the form of elastic spheres whose contact interaction is restricted by a specific distance within which the nucleons cannot approach each other. Without discussing the physics of this phenomenon, it is assumed that this distance is the same as the distance between the charges in the nucleon shell r_{en}=3.46·10^{-16} m (5.54).

At these distances, the energy of interaction between two electrical charges is:

$$W_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{en}} = 0.665 \text{ J} = 4.15 \text{ MeV} \tag{5.59}$$

For the scheme of the two-nucleon interaction shown in Fig. 5.13 which connects together a proton and a neutron in a stable system, i.e., deutron, the binding energy is only 2.25 MeV [28]. As indicated by (5.59), the interaction energy of two electrical charges at the distances between them equal to ~3.5·10^{-16} m (5.54) is 4.15 MeV, i.e., higher than 2.25 MeV. Thus, we have solved, at least approximately, the first task which confirms that the nuclear forces can be electrical. The results showing that the interaction of two charges in the shell is stronger than the actual value of the binding energy of the nucleons in the deutron is associated with the approximations made in the calculations.

To determine more accurately the energy of interaction of the charges in the nucleon shell, instead of analysing the interaction of two charges it is

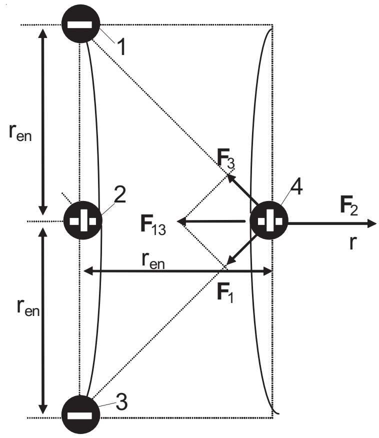

Fig. 5.14. Diagram of formation of the repulsive force $\mathbf{F}_2$ and attractive force $\mathbf{F}_3$ by a system of sign-changing charges (1, 2, 3) in the shells of the nucleons acting on the excess charge 4 of positive polarity.

necessary to analyse the interaction with a bunch of three or more sign-changing charges (Fig. 5.9). This is essential in order to confirm the presence of forces, both Coulomb attraction and repulsive forces, acting between the sign-changing nucleon shells (neutron and proton).

Figure 5.14 shows a system of a bunch of only three charges (1, 2, 3), in which the charges 1 and 3 have negative polarity and the central charge 2 positive polarity. The charges 1, 2, 3 belong to the first nucleon (neutron). The distance between the charges is r_{en} (5.54). The system of three charges acts on the fourth charge 4 with negative polarity which situated on the axis r and belongs to the second nucleon (proton).

The situation, shown in Fig. 5.14, is very close to the actual situation since the proton shell contains a single excess electrical charge 4 with positive polarity and the remaining charges in the shell compensate each other in pairs.

To estimate the effect of Coulomb forces between the nucleon shells and the energy parameters of these forces, it is necessary to take into account if only the effect of the nearest charges situated on the sphere. For this purpose we determine the number of the charges n_s situated in the diametral section of the sign-changing nucleon shell:

$$n_s = \frac{2\pi R_s}{r_{en}} = 14.7 \approx 15 \tag{5.60}$$

The angular sector α_s of a single charge in the nucleon shell is 24°:

$$\alpha_s = \frac{360°}{15} = 24° \tag{5.61}$$

Therefore, at present we confine ourselves to examining the forces acting only on the excess charge 4 with positive polarity of the proton on the side of the group consisting of three charges (Fig. 5.14) and also real four charges bonded in the node of the neutron shell (Fig. 5.9*b*). The remaining proton charges are not considered at the moment and we assume that they are bonded in pairs and fully compensate each other. Undoubtedly, we must take into account the effect of other proton and neutron charges.

Analysis of the scheme shown in Fig. 5.14 shows that the interaction of the charges 2 and 4 forms the repulsive force $\mathbf{F}_2$. The combined interaction of the charges 1 and 3 with the charge 4 generates the attraction force $\mathbf{F}_{13}$ which consists of two forces $\mathbf{F}_1$ and $\mathbf{F}_3$. We estimate force $\mathbf{F}_1$ on the basis of the modulus as the function in the removal of the charge 4 in the direction $\mathbf{r}$ connected with the distance r_{en} between the charges in the sign-changing nucleon grid:

$$\mathbf{F}_1 = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{(r_{en}^2 + r^2)} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{en}^2}\frac{1}{(1+k_r^2)} \tag{5.62}$$

where k_r is the coefficient of departure of the charge 4 in the direction $\mathbf{r}$

$$k_r = \frac{r}{r_{en}} \tag{5.63}$$

The modulus of the attractive force $\mathbf{F}_{13}$ is determined as the composition of the vectors of forces $\mathbf{F}_1$ and $\mathbf{F}_3$ in the direction $\mathbf{r}$

$$\mathbf{F}_{13} = 2\mathbf{F}_1\frac{r}{\sqrt{r_{en}^2 + r^2}} = 2\mathbf{F}_1\frac{k_r}{\sqrt{1+k_r^2}} \tag{5.64}$$

Taking (5.62) into account, we obtain

$$\mathbf{F}_{13} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{en}^2}\frac{1}{(1+k_r^2)}\frac{2k_r}{\sqrt{1+k_r^2}} \tag{5.65}$$

Taking into account that another additional charge is bonded in the node of the shell grid (Fig. 5.9b), we determine the magnitude of the attractive force for the node of the grid of four charges for the case shown in Fig. 5.14

$$\mathbf{F}_{13} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{en}^2}\frac{3k_r}{(1+k_r^2)^{\frac{3}{2}}} \tag{5.66}$$

The modulus of repulsion force $\mathbf{F}_2$ is determined by the interaction of the charges 2 and 4 in the direction **r** with (5.63) taken into account

$$\mathbf{F}_2 = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r^2 \frac{r_{en}^2}{r_{en}^2}} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r_{en}^2} \frac{1}{k_r^2} \tag{5.67}$$

Regarding the repulsive forces the positive side force, and the attractive force as the negative sign force, we can write the balance of forces in the direction **r** as the sum $\Sigma\mathbf{F}_r$

$$\sum \mathbf{F}_r = \mathbf{F}_2 - \mathbf{F}_{13} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r_{en}^2} \left(\frac{1}{k_r^2} - \frac{3k_r}{(1+k_r^2)^{\frac{3}{2}}} \right) \tag{5.68}$$

Equation (5.60) includes the force F_e of interaction of two charges at the distance r_{en} (5.54)

$$F_e = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r_{en}^2} = 1.9 \cdot 10^3 n \approx 2 \text{ kN} \tag{5.69}$$

It may be seen that the forces of interaction of the charges in the nucleon shell are very large and estimated by the value of the order of 2 kN. This value of the force is regarded as the adjusting force and we shall use it in the analysis of the forces of interaction between the proton and the neutron using the functional dependence f_r included in (5.68)

$$\sum F_r = F_e \cdot f_r \tag{5.70}$$

$$f_r = \left(\frac{1}{k_r^2} - \frac{3k_r}{(1+k_r^2)^{\frac{3}{2}}} \right) \tag{5.71}$$

In particular, the functional dependence (5.71) enables us to analyse the variation of the interaction force of the nucleons with the nucleons moving away from each other. It is evident that at a large distance, slightly greater than r_{en} (5.54), the positive excess charge of the proton in its shell is subjected to the attractive force of the neutron shell. When the nucleons come close to each other, the attractive force weakens and reaches zero at a certain distance. The electrical repulsive force will start to operate then. We determine the distance r_{e0} at which the attractive and repulsive forces are balanced, using the condition:

Table 5.1. Calculated values of the variation of electrical interaction forces of nucleon shells on the distance between them

	Parameter	1	2	3	4	5	6	7	8	9
1	k_r	0.5	0.75	1.0	1.25	1.5	2.0	3.0	4.0	5.0
2	$r \cdot 10^{-15}$ m	0.17	0.26	0.35	0.44	0.53	0.7	1.05	1.4	1.75
3	f_r	+2.9	0.62	0	–0.27	–0.33	–0.29	–0.17	–0.11	–0.07
4	ΣF, kN	+5.5	+1.2	0	–0.5	–0.63	–0.55	–0.32	–0.21	–0.13

$$\frac{3k_r}{(1+k_r^2)^{\frac{3}{2}}} = \frac{1}{k_r^2} \tag{5.72}$$

from which

$$k_r = 0.96 \approx 1 \tag{5.73}$$

Taking into account (5.63), we determine the distance r_{e0} between the nucleons at which the forces of interaction of the shells are balanced

$$r_{e0} = k_r r_{en} \approx 3.5 \cdot 10^{-16} \text{m} \tag{5.74}$$

It may be seen that the distance travelled by the nucleons when coming closer to each other can be estimated by the value (5.74) which comparable with the dimensions of the grid cell of the nucleon shell. This is natural because it reflects the radius of action of the nuclear forces acting between the nucleons. To determine the range of the radius of the effect of nuclear forces, we analyse function (5.71) in the graphical form, after compiling the calculated data in Table 5.1.

Analysis of the graphic dependence of the electrical interaction forces of the nucleon shells in Fig. 5.15, shows convincingly that as regards their characteristics, these forces fully correspond to the nuclear forces:

1) The forces are characterised by the regions of attraction and repulsion of the shells. A region at a larger distance attracts nucleons, whereas a

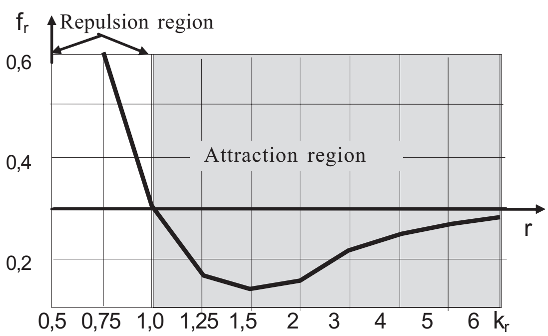

Fig. 5.15. Variation of the electrical repulsive and attractive forces in interaction of nucleon shells as a function of f_r (k_r) (71).

region situated at a shorter distance prevents the nucleons from coming closer to a distance smaller than

$$r_{e0} = 3.5 \cdot 10^{-16}\,\text{m}\,. \tag{5.75}$$

2) The radius of the effect of the attractive forces of the nucleons is in the range from k_r to $5k_r$, i.e. from $3.5 \cdot 10^{-16}$ m to $\sim 2 \cdot 10^{-15}$ m. According to all the currently available experimental data, this range corresponds to the radius of action of nuclear forces. At the distances greater than $2 \cdot 10^{-5}$ m the attractive forces between the nucleon shells start to decrease very rapidly.
3) The experiments show that only the proton and the neutron form a stable pair of nucleons in the two-nucleon interaction. This corresponds to the scheme shown in Fig. 5.14 when the neutron may capture the proton by the excess charge of positive polarity in the proton shell, and vice versa. No stable two nucleon formations formed from the neutrons were found in experiments.

Naturally, this scheme of interactions of the nucleons is not final because it does not take into account the effect of other charges in the nucleon shells. At present, it was important to show that the nuclear interaction forces may be based on electrical processes of attraction and repulsion of the charges in the nucleon shells. This corresponds to the assumption on the unification of all interactions from the viewpoint of electromagnetism in the Superunification theory.

At the present time, the problem of the stability of the given interaction scheme has not as yet been solved. At distances of the radius of the effect of nuclear forces the excess charge of the proton is captured by the neutron. This process is stable and consistent. However, in the range of shorter distances of $3.5 \cdot 10^{-16}$ m which can be characterised as the contact region of interaction of the nucleon shells, the excess charge 4 (Fig. 5.14) of the positive polarity may roll onto the side under the effect of the repulsive forces penetrating into the region of further attraction. This phenomenon has not been observed in the experiments.

Now we could offer a simple answer assuming that the region of contact interaction of the proton and the neutron is characterised by the constant exchange of positive charges between the nucleons. The proton constantly transfers into the neutron and vice versa. This process also ensures the stability of the two-nucleon system consisting of the proton and the neutron.

However, this process is dynamic and before we discuss it, it is necessary to attempt to utilise all the possibilities of electrostatics. It may happen that the stability of the given system is determined by the unique manner of distribution of the charges on the spherical surface of the nucleon. However, for this purpose it is necessary to calculate efficiently the nucleon shell matching it with the experimental results.

At present, it is clear that if all the charges in the shell are taken into account, the function $f_r(k_r)$ (5.71) will show a more rapid decrease of the attractive force with the increase of the distance between the nucleons. However, additional investigations are essential for constructing the overall structure of the nucleon shell.

5.10. Electrical energy of nuclear forces

Naturally, in addition to the force function $f_r(k_r)$ (5.71) of the two-nucleon electrical interaction, it is interesting to analyse the energy function of energy W_r of nuclear interaction in the electrical parameters. For this purpose, we integrate of the force function $f_r(k_r)$ (5.71) in the direction **r** with (5.68) taken into account

$$W_r = -\int \sum F_r dr = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r_{en}} \left(\frac{1}{k_r} - \frac{3}{\sqrt{1+k_r^2}} \right) \tag{5.76}$$

or

$$W_r = W_e \cdot f_{rw} \tag{5.77}$$

The expressions (5.76) and (5.77) include the energy W_e of interaction (5.59) of two elementary charges at the distance r_{en}=3.46·10^{-16} m (5.54)

$$W_e = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r_{en}} = 0.665 \text{ J} = 4.15 \text{ MeV} \tag{5.78}$$

The equations (5.76) and (5.77) also include the function of distance f_{rw} for the energy of the system of two nucleons when they are displaced to the distance r/r_{en} (5.63)

$$f_{rw} = \left(\frac{1}{k_r} - \frac{3}{\sqrt{1+k_r^2}} \right) \tag{5.79}$$

Function f_{rw} characterises the dependence of the variation of the energy of the system for the nucleons moving away from each other. We examine this function for the presence of an extremum, equating the derivative with respect to $2k_r$ to zero

Table 5.2. Calculated values of the variation of the electrical energy of interaction of the nucleon shells on the distance between them

Parameter	1	2	3	4	5	6	7	8	9	10	11
k_r	0.2	0.3	0.4	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0
$r \cdot 10^{-15}$ m	0.07	0.1	0.14	0.17	0.26	0.35	0.53	0.7	1.05	1.4	1.75
f_{rw}	2.1	0.46	–0.29	–0.68	–1.07	–1.12	–1.0	–0.84	–0.62	–0.48	–0.39
W_r, MeV	8.7	1.9	–1.2	–2.8	–4.4	–4.6	-4.15	–3.5	–2.6	–2.0	–1.6

$$f'_{rw} = \frac{3k_r}{(1+k_r^2)^{\frac{3}{2}}} - \frac{1}{k_r^2} = 0 \tag{5.80}$$

From (5.80) we determine the coefficient of distance k_r (5.63)

$$k_r = 0.96 \approx 1 \tag{5.81}$$

Taking (5.63) into account, we determine the distance r_{e0} of the extremum value of the energy of the system

$$r_{e0} = k_r r_{en} \approx 3.5 \cdot 10^{-16}\,\text{m} \tag{5.82}$$

The distance (5.82) corresponds to the zero force on the graphs in Fig. 5.15 and, therefore, to the minimum level of the energy of the system.

Table 5.2 shows the calculated data for the functional dependence of the energy of interaction of the shells of two nucleons (neutron and proton) when they move away from each other.Figure 5.17 shows the functional dependence of energy (5.76) on the distance between the nucleons as the function of moving away (5.79) on the basis of the calculated data in Table 5.2. It can be clearly seen that the minimum level of the interaction energy

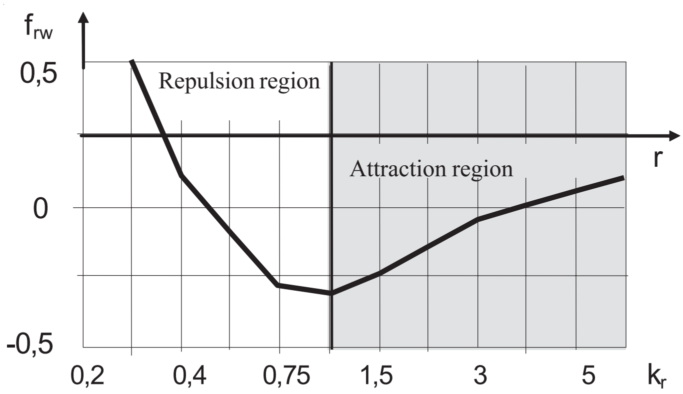

Fig. 5.17. Variation of the electrical energy of interaction of shells with the nucleons moving away from each other.

corresponds to the zero value of the interaction force (Fig. 5.15) at $k_r \approx 1$. Attention should be given to the fact that the negative range of energy does not necessarily indicate that the given region belongs to the attractive forces. The direction of the forces determined by the sign of the derivative with respect to the interaction energy.

In a general case, the introduction of the sign of the energy, as already mentioned several times, is a conventional concept. For example, at the zero energy of the system ($k_r \approx 0.36$, the graph in Fig. 5.16), the attractive force of the nucleons is 14 kN. All this depends on which level is regarded as the zero level in the given case in the vacuum field. In the analysed case, the zero energy level is represented by two points on the axis **r**. The first point is situated at infinity and corresponds to the zero force of interaction of the nucleons. The second point is situated inside the system of the nucleons and corresponds to the colossal force of 40 kN, acting between the nucleon shells (Table 5.1 and 5.2).

The contradicting nature of nuclear forces, as attractive and repulsive forces at short distances, is not explained in the physics of elementary particles and the atomic nucleus in analysis of these forces in similar situated in [27, Fig. 2]. However, all is well when these processes are investigated taking into account the colossal energy of the quantised space-time and of the interaction of sign-changing nucleon shells.

The calculations determine the value of the energy which must be used for the complete separation of the proton from the neutron, or vice versa. For this purpose, we calculate the integral (5.76) in the unification range from to $k_r = 1$ to $k_r = \infty$

$$W_r = -\int_1^\infty \sum F_r dr = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{en}}\left(\frac{1}{k_r} - \frac{3}{\sqrt{1+k_r^2}}\right) = -4.6 \text{ MeV} \qquad (5.83)$$

They energy of fracture of the nucleons is twice the actual energy of 2.25 MeV. This is explained by the fact that the interactions did not take into account other charges of the nucleon shells whose effect reduces the magnitude of the force and results in a more rapid decrease of this force when the nucleons move away. I assume that more accurate calculations would yield the absolute value of the energy corresponding to the experimental data. However, in this case we no longer need to solve simple problems of electrostatics with the volume distribution of the sign-changing charges on the sphere. It is now important to take into account that a method of calculating nuclear forces as forces of electrical nature has been developed. Improvement of the calculation procedure would increase the accuracy of the results.

The binding energy of the nucleons in a complicated multi-nucleon nucleus is approximately 8 MeV [24]. For example, a tritium nucleus (triton) consists of one proton and two neutrons. The binding energy of the three nucleons in the trition its 8.5 MeV. Naturally, the colossal forces of interaction of the nucleons in the nucleus result in deformation of their sign-changing shells and cause that the mass of the nucleus is not equal to the sum of the masses of the nucleons.

Regarding the nucleons as spheres, it can be assumed that in interaction of three nucleons the interaction forces are determined by three contact areas of the shells. Consequently, the binding energy can be increased by more than three times in comparison with the binding energy of the nucleons in the deutron. Taking into account the fact that nuclear physics is a very large area of knowledge, we must find approaches to this area which would enable us to carry out analysis of the forces and energies by the classic methods, without any need for phenomenological description. This classic approach in the calculation of nuclear forces yields the model of nucleons with the sign-changing shell, regarding the nuclear forces as the forces of electrical attraction and repulsion of the charges between the nucleon shells.

5 .11. Electrical potential of nuclear forces

The Superunification theory operates with the concepts of gravitational, electrical and magnetic potentials. In nuclear physics, the strong interactions are described using special nuclear potentials (Yukawa potential, etc.) [24]. The nuclear forces can now be characterised by electrical potential φ_e taking into account energy W_r (5.76) of interaction of the neutron shell with the excess proton charge

$$\varphi_e = \frac{W_r}{e} = \frac{1}{4\pi\varepsilon_0}\frac{e}{r_{en}}\left(\frac{1}{k_r} - \frac{3}{\sqrt{1+k_r^2}}\right) \tag{5.84}$$

Expression (5.34) includes the potential φ_{en} of the elementary electrical charge at the distance $r_{en} = 3.46\cdot10^{-16}$ m (5.54) and the distance function f_{rw} (5.79)

$$\varphi_{en} = \frac{1}{4\pi\varepsilon_0}\frac{e}{r_{en}} = 4.2\cdot10^6\ \frac{\text{V}}{\text{m}} \tag{5.85}$$

In a general case, the electrical potential (5.84) ensures that the nuclear forces operate as forces of electrical interaction of the nucleons. It is evident that the potential of the nuclear forces can be expressed by the electrical potential (5.84)

$$\varphi_e = \varphi_{en} f_{rw} \tag{5.86}$$

Thus, the determination of the potential of the nuclear forces as the electrical potential (5.86) enables us to regard the nuclear forces in the calculations of these forces as forces of electrical origin and not as independent forces. Undoubtedly, it is important to increase the accuracy of the calculation procedures in the determination of nuclear forces in order to determine more accurately the number of charges in the nucleon shell and the configuration of the cells of the shell grid. However, in any case, the sign-changing shell of the nucleons, spherically compressing the quantised space-time, produces the nucleon mass by unifying the gravitation and electricity.

5.12. Calculation of neutron interaction

In contrast to the proton, the neutron does not have any excess positive charge in its shell and is a completely neutral particle. Regardless of this, the interaction of the neutrons in the atom nucleus is ensured by the contact interaction of the nucleon shells through the attraction of the charges of positive polarity in the shells.

Whilst the proton–neutron unification into the deutron is characterised by high stability, there is no unification of the neutron with the neutron. Neutron unification is possible only through interaction with a proton as is the case in the triton. The unification of the proton with the neutron is explained by the capture of an excess charge with positive polarity of the proton by the neutron shell. In this case, the radius of the effect of the nuclear forces as electrical forces is approximately 10^{-15} m, i.e., it is comparable with the dimensions of the nucleons.

Evidently, in interaction of the two neutrons, the absence of the excess charge in their shells prevents nucleon capture. However, the neutrons inside the nucleus interact with each other leading to the formation of nuclear forces at contact of the shells.

Figure 5.13 shows that the neutrons can interact in the area of contact of the shells through the attraction of electrical charges with opposite polarity. It is necessary to calculate such an interaction and determine the attractive force and the nature of variation of this force when the neutrons are removed. For this purpose, it is important to find the function of the strength of the electrical field of the sign-changing neutron shell. This is a relatively complicated task of electrostatics and has no exact solution so far.

In [1] the calculation model of interaction of the neutrons was represented by a flat grid of sign-changing charges. Since we have an exact solution of the field for the lattice of sign-changing axes, this solution was interpreted for the field of point charges. For this purpose, the continuous linear density of charges τ_e is replaced by the density of discrete charges with a step equal to the length r_{en} (5.54) of the grid cell:

$$\tau_e = \frac{e}{r_{en}} = \frac{1.6 \cdot 10^{-19}}{3.46 \cdot 10^{-16}} \approx 0.5 \cdot 10^{-3} \frac{\text{C}}{\text{m}} \tag{5.87}$$

We substitute equation (5.87) into the function of the strength of the field of sign-changing charges for $b = r_{en}$ and obtain the dependence of the strength of the electrical field in movement away from the grid of sign-changing charges [1]

$$E_r = \frac{1}{2\varepsilon_0} \frac{e}{r_{en}^2} \frac{1}{sh(\pi \frac{r}{r_{en}})} \tag{5.88}$$

The strength of the field (5.88) of the flat grid of the sign-changing charges can be approximated with respect to a sphere at a sufficiently large number of sign-changing charges on the sphere surface. For a proton, the calculated number was approximately 69 charges distributed on the sphere. For a neutron, the number of charges was increased by 1 and equals 70 charges. In this case, the function (5.88) can be used with a certain degree of approximation for calculating the electrical field of the sign-changing nucleon shell.

Knowing the strength of the field of the sign-changing neutron shell, we can calculate the electrical force acting on the charge in the shell of the second neutron at their contact interaction for $r = r_{en}$

$$F_r = \frac{1}{2\varepsilon_0} \frac{e^2}{r_{en}^2} \frac{1}{sh(\pi \frac{r}{r_{en}})} = 1 \text{ kN} \tag{5.89}$$

The equation derived previously for the force of interaction of the proton and the neutron (5.68) gives the maximum attractive force of 0.63 kN (Table 5.1). As indicated by (5.89), the attractive force of the neutrons during their contact interaction is 1 kN, i.e., it is determined by the same order as (5.68). However, the equations (5.68) and (5.89) are completely different functional dependences. Expression (5.89) is characterised by a more rapid decrease of the force in the case of the nucleons moving away and can be represented by an exponent under the condition $r > r_{en}$

$$F_r = \frac{1}{2\varepsilon_0} \frac{e^2}{r_{en}^2} \exp\left(-\pi \frac{r}{r_{en}}\right) \tag{5.90}$$

Analyses of the exponential function (5.90) shows that the attractive force of two neutrons appears only as a contact force and equals only 1.4 N at a distance of 10^{-15} m, i.e., this force decreases by more than 70 times when the nucleons move away from each other. For the proton–neutron interaction, the attractive force of the nucleons at the same distance of 10^{-15} m is 0.32 kN, i.e., it is 230 times greater than the attractive force of the neutrons.

Regardless of the approximate nature of the calculations, it may be assumed that the nature of the attractive forces both on the proton and the neutron and between the neutrons greatly differ from each other by the radius of the effect of nuclear forces. If the radius of the nuclear forces for the proton–neutron interaction is slightly greater than the distance 10^{-15} m, the radius of the effect of nuclear forces for the neutron–neutron interaction is smaller than $0.5 \cdot 10^{-16}$ m. This shows that the interaction between neutrons can take place only when their shell come into contact.

In order to determine the energy required for fracturing the bond in the interaction of two neutrons, we determine the difference of the electrical potentials $\Delta\varphi_r$ which must be overcome by a single charge bonded in the neutron shell during its movement away from the second neutron. For this purpose, we integrate (5.18) with respect to distance r

$$\Delta\varphi_r = \frac{1}{2\varepsilon_0}\frac{e}{r_{en}^2}\int_{r_{en}}^{\infty}\frac{dr}{sh(\pi\frac{r}{r_{en}})} = \frac{1}{2\pi\varepsilon_0}\frac{e}{r_{en}}\ln\left|\frac{\hat{e}^{\pi\frac{r}{r_{en}}}-1}{\hat{e}^{\pi\frac{r}{r_{en}}}+1}\right|_{r_{en}}^{\infty} = 0.72\ \text{MV} \qquad (5.91)$$

Under the logarithm in (5.91) there is the number $\hat{e}$ (this number should not be confused with the elementary charge e).

To determine the total energy W_{n2} of interaction of the neutrons in the contact area of their shells, it is necessary to take into account the number of pairs n_{e2} of the interacting charges between the shells which is 4–5 pairs in the node of the neutron shell

$$W_{n2} = e\Delta\varphi_r n_{e2} \approx 2.9 - 3.6\ \text{MeV} \qquad (5.92)$$

Evidently, the energy (5.92) of the contact bond of two neutrons is slightly higher because the edge effect of interaction of the adjacent charges on the sphere has not been taken into account.

5 .13. Proton–proton interaction

In interaction of protons up to contact it is necessary to overcome repulsion of their excess positive charges in the shells. In order to obtain the exact functional dependence of the electrical force on the distance between the protons which takes into account the repulsion of protons at long distances, their attraction in the region of the effect of nuclear forces, and repulsion in the region smaller than the radius of the nuclear forces, it is necessary to solve the previously formulated problems:

1. Determine the exact structure of the proton and neutron shells with the distribution of the charges on the sphere and tension of the electrical forces in the nucleon shell.
2. Determine the exact function of the strength of the electrical field of the sign-changing spherical nucleon shell.
3. Determine the effect of deformation of the quantised space-time by the nucleon shells on the electrical magnetic parameters of the quantised space-time inside and outside the gravitational interface of the medium taking into account the additional forces of mirror reflection in the local zone at the interface between the nucleons and the medium.
4. Take into account possible configurations of the cells of the grid with the distribution of the charges in the nodes and the presence of defects in the nucleon shell affecting the function of the strength of the electrical field and, correspondingly, the nature of nuclear forces.

Possible defects in the nucleon shell are associated with the structure of the grid cell of the shell, with the deformation of the cell when nucleons approach each other and with the orientation of the nucleon shells in relation to each other during their approach. Possibly, it will be necessary to take into account the effect of the induced magnetic quantum space-time between the charges of the nucleon shell, as was the case when taking into account the magnetic field of the electron as a result of spherical deformation of the quantised space-time by its spin [4].

Only after these investigations have been carried out, when the possibilities of electromagnetostatics have been exhausted, we shall be able to discuss some other new effects accompanying the interaction of the nucleons. However, in any case, the nuclear interactions are based on the laws of Coulomb attraction and repulsion of the system of sign-changing charges of the nucleon shells.

5.14. Nuclear forces in quantum mechanics

The Superunification theory is directed at developing quantum considerations in physics for the case in which the electromagnetic static space-time quantum (quanton) acts in addition to the radiation quantum. On the other hand, the current level of quantum theory is only capable of describing the nature of particles by wave functions on the basis of their group behaviour.

This also relates to the calculation facilities of nuclear interactions of the nucleons.

The advances made in quantum theory are obvious. The authority of the scientists who developed the fundamentals of quantum theory cannot be doubted. In particular, because of this it has not been possible to develop the electrical nature of nuclear forces. This is how Heisenberg, one of the founders of quantum theory, formulated the attitude to the nature of nuclear forces: 'this force cannot be of the electrical nature, if only because the neutron is not charged. In addition, the electrical forces are too weak to lead high binding energies in the nucleus, determined on the basis of the mass defect' [29].

Thus, cutting off in this fashion the directions of investigation in the development of real physical models of the nucleons based on the electrical nature of nuclear forces, theoretical physicists were forced to fantasize and develop formal mathematical models. Results are important in any study. In the last 50 years, theoretical physics, moving in the erroneous direction, could not therefore describe the nature of nuclear interactions.

However, most importantly, it has not possible to link together gravitation and electromagnetism, placing this relationship as the basis of the formation of nucleons and their mass, and also determine the reasons for the mass defect. For this it would have been necessary to investigate the unique properties of the sign-changing fields as the field category of the quantised space-time whose importance for describing the microworld could have lead to the discovery of the EQM theory.

On the basis of erroneous considerations, Heisenberg proposed to treat the nuclear forces as exchange forces between the nucleons which form as a result of exchange by other particles (photons, electrons, positrons, etc). Naturally, priority in the exchange of nucleons by the particles was given to wave considerations which enabled Heisenberg to develop a large area of quantum theory [30].

In the exchange theory, the small radius of the effect of nuclear forces is obtained if it is assumed that the particles, corresponding to photons, have the rest mass. This approach, developed by Pauli, resulted in the development of the meson theory of nuclear forces [31]. According to Pauli's proposal, radius $r_n = 2{\cdot}10^{-15}$ m, which determines the action of nuclear forces, is determined by the particles whose rest mass m_0 determines the given radius

$$r_n = \frac{\hbar}{m_0 C}, \tag{5.93}$$

from which we determine the rest mass of the particle

$$m_0 = \frac{\hbar}{r_n C} \approx 200 m_e \tag{5.94}$$

Particles with the rest mass of approximately 200 electronic masses were initially found in cosmic rays and referred to as mesons. A large number of the attempts to construct the functional dependence of the nuclear potential on the basis of the theory of meson–nucleon interactions and other theories using particles with a large mass prove to be unsuccessful. This problem also could not be solved by the quantum chromodynamics (QCD) [23].

At the same time, the quantum mechanics approaches based on the application of wave functions are fully suitable for the determination of a number of parameters in nucleon interactions. I would like to mention the reasons for wave processes taking place in a vacuum field during a perturbation of nucleon–nucleon interactions.

According to these reasons, the interaction between the nucleons is determined mainly by the electrical field of the nucleon shells which acts through the elastic quantised medium which has the form of an ocean filled with a huge number of quantons taking part in nuclear interactions.

The interacting nucleons can be treated as an elastic stressed system, where the oscillation perturbation of any element results in the wave perturbation of the entire system linked inseparably with the vacuum field.

The description of the perturbation of the elastic system by wave functions is already classic and has been included in textbooks. The Schrödinger equation describes the interaction of the proton and the neutron in the deutron through the wave function ψ:

$$\frac{1}{r^2}\frac{d}{dr}\left(r^2\frac{d\Psi}{dr}\right) = -\frac{2m_n}{\hbar^2}(W-U)\Psi \tag{5.95}$$

Equation (5.95) includes: the distance between the nucleons r, the nucleon mass m_0, the binding energy W of the nucleons and the depth of the potential well U. Naturally, by solving this equation we can determine one unknown parameter included in the equation, and all other parameters must be given. In particular, for the given first three parameters in equation (5.95) we can determine only the depth of the potential well [32].

Thus, the possibilities of quantum mechanics description of the interaction of the nucleons by the wave function are not so extensive. The physics of nucleon interactions is determined by the structure of nucleons which is examined by the Superunification theory.

On the other hand, equation (5.95) does not take into account the presence of a gravitational well around the nucleon (Fig. 5.1). Therefore, if this important parameter is not taken into account, the calculation apparatus becomes more and more complicated. The Superunification theory, possessing actual physical models, makes it possible to simplify greatly the calculations and physical understanding of the phenomenon. A suitable example of this is the explanation of the electrical nature of nuclear interactions.

5.15. The zones of anti-gravitational repulsion in the nucleon shells

Additions in the form of section 5.15 I wrote in November 2005. At that time, it had been five years since the moment of preparation of the text 'Electrical nature of nuclear forces' for printing, and almost 10 years since I introduced the sign-changing model of the nucleon shell [1]. Now, when I decided to post this study on the Internet, I had to re-examine it. Regardless of the fact that new and interesting material appeared on the examination of the zones of anti-gravitational repulsion between the charges of the nucleon shells, I made only a small number of corrections and left the old version almost without any change. In addition to the theory of the elastic quantised medium restricted by the investigations of the quantised structure of space-time, the Superunification theory investigates the nature of matter and fundamental interactions. Therefore, the text contains corrections in terminology.

I left the old version of the text unchanged because it shows clearly all the difficulties in the path of further development of the calculation facilities of the electrical nature of nuclear forces within the framework of the concept of Superunification which combines the fundamental interactions. The weakest area in the study is in my opinion the incorrect substantiation of the forces of electrical repulsion between the sign-changing shells of the nucleons at the distances smaller than the classic electron radius (Fig. 5.15). The presence of the repulsion region (zone) observed when the nucleon shells approach each other is essential. This is determined by restrictions of the further approach of the nucleons in the atomic nucleus in order to avoid their collapse. The functional dependence of the nuclear force of attraction of the nucleons has an extreme value in the graph (Fig. 5.15) which cannot be formed in the absence of repulsive forces.

Therefore, in order to compensate in some manner the obvious shortage of the repulsive forces, a calculation scheme was proposed for describing the interaction of the excess charge of the positive polarity of the proton with the sign-changing charges in the neutron shell (Fig. 5.14). I knew that this calculation scheme is highly vulnerable because it does not ensure the stability of the charges of the shells in the given approach coordinates. The excess proton charge should be displaced in the direction of the negative charge of the neutron shell, erasing the results of the calculations. To prevent this from taking place, several assumptions which were not very convincing were investigated.

However, the calculation scheme in Fig. 5.14 played its positive role, showing that in the presence of repulsive forces the nature of attraction of the shells of the proton and the neutron fully corresponds to the nuclear forces whose nature is electrical. This is in agreement with the concept of the Superunification theory. It was therefore necessary to find the missing repulsion force between the shells of the nucleons at distances smaller than the classic electron radius resulting in stability of the calculation scheme. Since the compulsory presence of such a repulsion force was predicted, in the final analysis this force was discovered as the force of anti-gravitational repulsion taking into account that gravitation and antigravitation are secondary formations of the superstrong electromagnetic interaction (SEI).

At the moment, I can say with a high degree of reliability that the antigravitation, like gravitation, is widely encountered in nature. It is sufficient to mention a fundamental cosmological effect of the anti-gravitational recession of galactics with acceleration (see chapter 3). In the microworld of the elementary particles and the atomic nucleus, the antigravitation occupies the area as large as the areas occupies by electricity and magnetism. In theoretical physics, it is assumed that in the microworld of elementary particles the effect of gravitational forces is negligible in comparison with electrical forces and can be ignored. This holds with respect to the Newton force of gravitational attraction but not with respect to the energy of the gravitational field because, as confirmed in the Superunification theory, the energy of the gravitational field is determined by the potential of action potential $C^2 = C_0^2 - \varphi_n$, not by the Newton potential φ_n. However, the force is a derivative of energy and does not depend on constant C_0^2.

The forces of anti-gravitational repulsion operate in the microworld of elementary particles at distances shorter than the classic electron radius $r_e = 2.8 \cdot 10^{-15}$ m. Taking into account that this force is greater than the forces of electrostatic attraction of the nucleon shells, then the total effect of the forces determines the characteristic manifestation of the nuclear forces, as shown in Fig. 5.15. In order to avoid rewriting the entire text, I added to the description of the nature of nuclear forces anti-gravitational repulsion forces.

I should mention that antigravitation differs from the gravitation by the presence of a hillock (not a well) on the gravitational diagram. Figure 5.1 (Fig. 3.11) shows the gravitational diagram of the nucleon, characterising the composition of the quantised medium inside the sign-changing shell of the nucleon and tensioning of the medium outside the shell. Consequently, a gravitational well forms in the quantised medium and represents 'a jump' in the quantum density of the medium.

The region of the gravitational well characterises gravitation as gravity. The region of the jump of the quantum density contains a very steep hillock (wall), a unique potential barrier responsible for the effect of antigravitation. It is noteworthy that the forces of anti-gravitational repulsion for the gravitation wall on the ideal diagram in Fig. 5.1 are infinite because the force is characterised by the derivative of energy over distance. In the case of the jump of the quantum density, the gravitational energy also changes in a jump. Naturally, when the nucleons come together in the ideal case, the gravitational wall (potential barrier) can be overcome by the forces of electrostatic attraction. In reality, the potential barrier of repulsion is not a wall and has the form of a hillock but, in any case, here we have the concept of nuclear forces as the electrical attraction forces restricted by anti-gravitational repulsion.

As already mentioned, the gravitational boundary of the nucleon, formed by the sign-changing shell (Fig. 5.7 and 5.8) is not ideal and has the form of a complicated relief of the fields on the sphere. This relief of the fields also contains zones of anti-gravitational repulsion and tunnelling. The exact calculations of the very complicated relief of the fields of the sign-changing

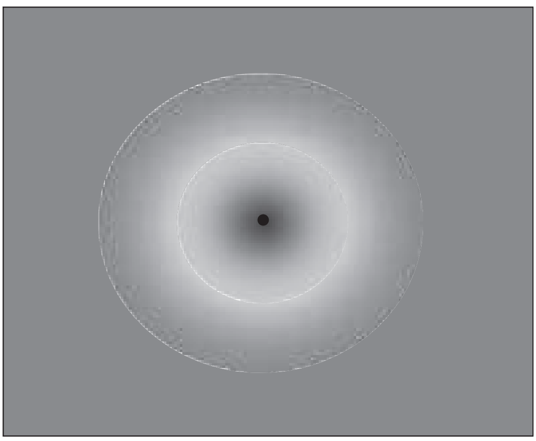

Fig. 5.18. Computer simulation of the structure of the electron (neutron) in the quantised space-time as a result of its spherical deformation by the field of the central electrical point charge.

shell of the nucleons are time-consuming. The process of understanding moves from simple to complicated. Examining a simple jump of quantum density of the medium on the gravitational diagram in Fig. 5.1 we have in principle explain the nature of anti-gravitation for the nucleon. Now, after determining this position more accurately, it is essential to examine the zones of anti-gravitation separately for every charge of the sign-changing shell of the nucleon in order to explain the complicated relief of the nucleon fields on the sphere.

To understand the structure of the gravitational field around the charge of the sign-changing shell of the nucleon, we examine the formation of characteristic zones of the electron (positron), described in chapter 4.

Figure 5.18 shows the graphical computer simulation of the electron (positron) in the quantised space-time without the scale to simplify understanding. The dark spots in the centre of the electron shows a point electrical charge to which the quantons of the medium are pulled, spherically deforming the space-time. The dark region around the point charge shows the zone of compression of the quantised medium which is then smoothly replaced by the tension zone (lighter region). In movement away from the electron, the quantum density of the medium is restored to that in the equilibrium condition. The electron does not have any distinctive gravitational interface and appears to be 'smeared' in the space-time, being the compound part of the quantised medium. The movement of the electron should be regarded as the wave transfer of its structure (Fig. 5.18), retaining the spherical symmetry of the spectra of the speed of movement. This corresponds to the principle of the corpuscular–wave dualism in which the particle has both wave and corpuscular properties.

Since the quantum density of the medium is an equivalent of the gravitational potential, then in a general case the gravitational field of the non-relativistic electron can be represented by the known function (5.20) of the distribution of the gravitational potentials φ_1 and φ_2 as a result of solving the Poisson equation (5.16) and (5.17)

$$\begin{cases} \varphi_1 = C^2 = C_0^2\left(1 - \dfrac{R_g}{r}\right), & r > r_e \\ \varphi_2 = C_0^2\left(1 + \dfrac{R_g}{r}\right), & r < r_e \end{cases} \tag{5.96}$$

Figure 5.19 shows the gravitational diagram of the electron (positron) corresponding to the solution (5.96) regardless of the polarity of the point charge. The centre of the electron contains the point charge e which is represented by a narrow band with radius R_e (4.19) on the gravitational two-dimensional diagram. The gravitational potential reaches the value $2C_0^2$ on the surface of the charge at the point (*e*). In reality, the point charge of the electron in three-dimensional measurements has the form of a sphere with radius R_e, and in two-dimensional measurements the form of a strip (R_e is the electrical radius of the electron equal to its gravitational radius).

In imaging on a plane by the curve of distribution of the gravitational potentials, the point charge of the electron can be conveniently represented by a narrow strip with the characteristic radii of the electron: r_{e1}, r_e, r_{e2}, R_e, plotted in the direction from the centre of the strip along the horizontal axis *r*. The vertical axis gives the values of the gravitational potential in the range 0... $2C_0^2$. The level of the potential C_0^2 determines the potential depth of the quantised medium for the non-perturbed quantised space-time. Potential C_0^2 can be termed the equilibrium vacuum potential.

When moving away from the point charge, the gravitational potential $\varphi_2 = f(1/r)$ decreases along the path (e-d) and, consequently, the quantum density of the medium decreases. The conventional interface (b-c-d) is characterised by a small jump of the gravitational potential and the quantum density of the medium. For better understanding, the gravitational diagram of the electron is presented without the scale otherwise the jump $\Delta\varphi$ of the gravitational potential would not be visible because of the small value.

We examine briefly the characteristic zones of the electron (positron) as a result of spherical deformation of the quantised space-time by a central electrical charge:

1. The compression zone (c-d-e) of the quantised medium. The gravitational potential φ_2 inside the compression zone is higher than the equilibrium potential C_0^2 of the quantised medium.

2. The tensions zone (a-b-c) of the quantised medium. The gravitational potential φ_1 inside the tension zone is lower than the equilibrium potential C_0^2 of the quantised medium. In particular, this section in the gravitational theory determines the curvature of the space which is regarded as the manifestation of mass.

3. The gravitation zone (b-a) characterises the gravitational well by the section $\varphi_1 = f(1-/r)$ (5.96). The gradient of the gravitational potential in the given section has a positive sign, establishing the direction of the gravity force to the centre of the point charge.

4. The antigravitation zone (b-c-d-e) characterises the gravitational hillock by the section $\varphi_2 = f\ (1/r)$. In this section, the gradient of the gravitational potential is negative and determines the direction of the repulsive forces in the centre of the point charge.

As regards the structure of the nucleon and its sign-changing shell, the

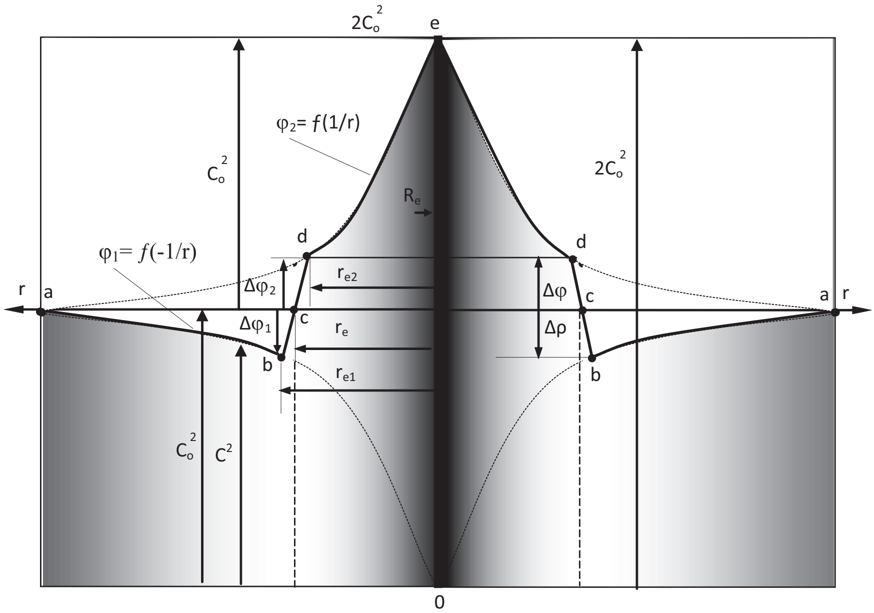

Fig. 5.19. Gravitational diagram of the electron (positron) in the form of distribution of the gravitational potential of the spherically deformed quantised space-time.

gravitational diagram (Fig. 5.19) of the electron (positron) shows a number of changes:

1. As already mentioned, the formation of the nucleon mass is determined by its gravitational interface in the form of a shell of sign-changing point charges with no mass. This means that the structure of the nucleon shell includes charges whose gravitational diagram does not contain the gravitational well (sections a-b-c). The gravitational well changes to the structure of the nucleon itself and is formed by its shell as a whole, forming a complicated relief of the fields.

2. The zones of anti-gravitational repulsion (d-e) are retained at a distances smaller than the classic electron radius around the point charges of the nucleon shell. In particular, the presence of the zones in the complicated relief of the fields of the nucleon shell results in the stable effect of the nuclear forces between the nucleons, as short-range forces.

3. The sign-changing shell of the nucleon is characterised by a highly complicated relief of the electrical, magnetic in gravitational fields, with the zones of compression and tension of the quantised medium, the zones of attraction and repulsion, potential wells and hillocks (potential barriers). In particular, the repulsion zones are important in the formation of the dimensions of the nucleons, to prevent the collapse of the shells and

characterise their stability. Tunnelling of the electron into the atomic nucleus in the effect of electronic capture is possible only in the presence of the complicated relief of the fields of the shells of the nucleons and the atomic nucleus, assembled from the nucleons, where potential barrier is not continuous and contains actual tunnels.

The sign-changing shells of the nucleons have the property of mutual electrostatic attraction at short distances, comparable with the steps of distribution of the charges in the shell.

In particular, the sign-changing structure of the nucleon shells, including the zones of electrostatic attraction and anti-gravitational repulsion, has made it possible to formulate a concept of the electrical nature of nuclear forces within the framework of the Superunification theory.

To conclude, I must pay attention to the fact that the knowledge of the nature of nuclear forces provides a basis for the critical evaluation of the prospects for controlled thermonuclear synthesis in the ITER project. The concept of controlled thermonuclear synthesis was initially based on false assumptions, erroneously assuming that the reason for synthesis is high temperature. Initially, it was assumed that it is sufficient to reach a temperature of 15 million degrees and synthesis of nuclei with generation of energy would start. The temperature in the plasma reaches 70 000 000° and there is no synthesis. The temperature concept of nuclear synthesis does not work.

Now when the nature of the nuclear forces is known, it would be difficult to include in also the temperature factor as a factor of overcoming electrostatic repulsion of the protons. The temperature concept of controlled nuclear synthesis is based on positive experience with the explosion of hydrogen bombs detonated by a preliminary atomic explosion accompanied by the generation of colossal energy. However, in this case, the temperature is one of the energy generation factors. Other factors include high-pressure and acceleration which ‘push’ protons into each other to the distances of the effect of electrical forces of sign-changing nucleon shells, overcoming electrostatic repulsion of the nuclei.

Evidently, the colossal pressures and acceleration cannot be produced in the conditions of thermonuclear reactors in the laboratory because of purely technical reasons. Heating of the plasma in a magnetic trap has no real basis. Knowing the magnitude of the nuclear forces and the cross-section of their effect, it is quite easy to calculate the pressures which must be overcome for the nucleons to come together despite their electrostatic repulsion. For this purpose, the proton nuclei of the light elements must be ‘squeezed’ by accelerated fragments of the atomic nuclei of heavy elements, as is the case in a thermonuclear bomb. It is necessary to develop an atomic press in which the light nuclei are compressed between the accelerated shells of the heavy nuclei and the elastic quantised medium which acts as a wall (anvil) and its strength increases with increase of the effect of acceleration. This factor of the quantised medium, having the property of superhardness under the effect of colossal acceleration, has never been examined in synthesis theory.

On the other hand, I wanted to verify by calculations the extent to which the temperature concept of thermonuclear synthesis is related to nuclear synthesis. In the literature I could not find any calculations linking nuclear forces with temperature. Of course, they can not be there. In order to calculate these forces, it is necessary to have clear information on the temperature not as the parameter on the scale of a thermometer but as an energy factor. However, the current quantum theory also has its shortcomings here. It appears that as the photon energy increases, the recoil of the photon to the atom becomes smaller. The largest recoil is recorded for the low-energy infrared photon.

I paid special attention to this energy paradox because temperature is linked with the temperature oscillations of the atoms and molecules as a result of recoil in emission (re-emission) of the photon. At the beginning, the development of quantum theory also started with the energy paradox expressed by the discrete nature of radiation of the atom and the dependence of the photon energy on its frequency and the fact that it was independent of radiation intensity. This contradicted classic electrodynamics. At the present time, there are such contradictions in the quantum theory between temperature and atom recoil. The current state of the quantum theory does not make it possible to calculate the recil of the simplest atom in emission of a photon. In the case of a gun everything is okay. As the weight of a bullet increases, the recoil becomes stronger. For the atoms this analogy is not suitable and the situation is even reversed. As the photon energy decreases, the atom recoil becomes weaker. It appears that the temperature, being the parameter of oscillations of the atoms, is not connected with the photon energy and, vice versa, temperature increase takes place with a decrease of the photon energy when the photon concentration increases. Evidently, the term ‘thermal photons’ is suitable for this type of photon.

I have managed to solve the problem for thermal photons discovering the two-rotor structure of the photon which is also investigated in this book. Knowing the configuration and strength of the electrical and magnetic fields of the photon, we can calculate the force momentum acting on the charge of the proton nucleus in photon emission. This force is not sufficient for overcoming electrostatic repulsion of two protons in synthesis of new nuclei. If this were possible, the processes of thermonuclear synthesis under the effect of high-energy photon radiation would have been discovered in experiments a long time ago. However, I know of no positive results of such experiments.

Analysis of the two-rotor structure of the photon made it possible to derive a mathematical equation for the atom recoil whose intensity is inversely proportional to the energy of the emitted photon. This paradox of quantum theory is explained by realising that the elastic quantised medium (EQM), whose properties were previously not taken into account, takes part in atom recoil during photon emission. The discovery of the quantum of space-time (quanton) has greatly widened the analytical possibilities of quantum theory where together with the radiation quantum (photon) we can also operate with the quanton. I should also mention that the photon is a secondary formation in the quantised space-time and fully belongs to this quantised space-time, being its integral part, and the quantum is a primary formation, forming the quantised medium, i.e. primary matter.

It should also be mentioned that the thermonuclear synthesis of luminosity of the stars has not been proven. The temperature in the Sun does not exceed 6000°C and nobody has taken measurements of the temperature inside the Sun. The electronic neutrino fluxes do not correspond to the norms of the thermonuclear reaction. However, the electronic neutrino is also generated in the reactions of annihilation of electrons and positrons when the mass of the particles, as the energy of elastic deformation of the elastic quantised medium, is released and transforms to electromagnetic radiation, and a pair of massless charges generates an electronic neutrino i.e., some field bit of information on the existence of the pair of particles: electron and positron. It is most likely that the source of energy of the stars is the electron–positron plasma which is generated in their interior as a result of the deformation of quantised space-time. The thermonuclear concept of the luminosity of the stars cannot explain the formation of new stars from the quantised space-time which is a source of colossal energy. There is no explanation for the reasons for stabilisation of the luminosity of the Sun as hydrogen burns out over a period of billions of years from the moment of creation of biological life on the Earth. It may be that the ratio of hydrogen and helium on the Sun does not change? Traditional science also cannot explain the source of energy of heating of the Earth interior.

At present, there is no scientific concept of formation of heavy elements in the universe, assuming that the heavy nuclei form in the interior of the stars from the nuclei of light elements and are subsequently ejected with protuberances during explosions of stars into the cosmic space forming cosmic dust. It is quite possible that these processes take place but I believe that they are not fundamental. For the stars to generate something, it is necessary to produce stars themselves: more accurately light elements (hydrogen and helium). Where have these elements come from? From the Big Bang? This has not been proven.

The Superunification theory gives answers to these questions. However, I do not intend to answer the main question: ‘who quantised our electrically asymmetric universe?’ The answer to this problem is outside the framework of our knowledge. At the moment. The Big Bang hypothesis of the quantisation of the universe is problematic. However, the Superunification theory gives a clear answer to the question: ‘who lights up the stars’ assuming that the only source of energy in the universe is the quantised space-time as a carrier of the fifth force (superstrong electromagnetic interaction). However, this is a completely different subject.

Thus, the temperature concept of nuclear synthesis is highly vulnerable by criticism and the negative result of the ITER project can be reliably predicted. This is based on the analysis of the nature of nuclear forces as short-range forces between the sign-changing shells of the nucleons taking into account the interaction with the elastic quantised medium. I would like to make some errors in calculations and predictions so that my colleagues in science would not be angry with me. However, the truth is more important, since even a negative result in the ITER project is also important for science like a positive one.

16. Conclusions

The nature of the nuclear forces is one of the most important problems of theoretical physics. It has been assumed that the nuclear forces are the maximum possible forces in nature, characterising the strong fundamental interaction, as one of the four forces known in nature. Attempts to unify the strong interaction with other: electromagnetism and gravitation, have not been successful. It has been shown that this is caused by the fact that on the whole the strong interaction is not a carrier of the maximum possible force and cannot be therefore used as a unifying factor. In order to unify the nuclear forces with gravitation and electromagnetism, and also electroweak interactions, we must have an even greater force, previously not known in science. This is the golden rule of physics that the force can be conquered only by a greater force.

The presence of such a Superforce, as the fifth force, became known after discovery of the quantum of space-time (quanton) and superstrong electromagnetic interaction. In particular, SEI (and not the strong interaction) is the carrier of the Superforce. For comparison: the attraction force of the nucleons, characterising the nuclear forces, is estimated at approximately 0.63 kN (Table 5.1), and the force of interaction between the quantons is of the order of 10^{23} N. The diameter of the nucleon is $\sim 10^{-15}$ m, the diameter of the quanton $\sim 10^{-25}$ m. Even if we not relate the forces to their cross-section, these forces are simply incommensurable. As we penetrate deeper into matter, we face higher and higher concentrations of forces and energy. It becomes clear that the only source of energy in the universe is the superstrong electromagnetic interaction. This is electromagnetic energy. All the known types of energy (chemical, nuclear, electromagnetic, gravitation, etc) are regarded in the final analysis as the manifestation of the superstrong interaction and are represent only method of extracting the energy of this interaction. We live in the electromagnetic universe.

The nuclear forces, acting between the nucleons and the atomic nucleus, must be examined from the unified positions of unification of the fundamental interactions through the superstrong electromagnetic interaction. Here, it must be understood that the mass of the nucleons forms as a result of the spherical deformation of the quantised space-time which is a carrier of the superstrong electromagnetic interaction. It has been established that the only possible method of spherically deforming the elastic quantised medium, ensuring that all the possible properties of the nucleons are utilised, is the presence in the nucleon of the shell assembled from electrical massless charges with sign-changing signs.

This shell is sign-changing and has the property of contracting on the sphere with the effect of forces of electrical attraction between the charges of the nucleon shell. The spherical compression of the sign-changing shell takes place together with the medium inside the shell. However, on the external side of the shell, the elastic quantised medium is subjected to tension. In this case, the quantum density of the medium (quanton concentration) inside the shell increases and outside the shell it decreases. Consequently, the nucleon assumes a mass as the parameter of 'distortion' of the quantised space-time under the effect of spherical deformation. The resistance of the shell to collapse is limited by the pressure of the medium inside the shell which is balanced by the tension of the elastic quantised medium from the external side. In addition, the factor of stability of the nucleons in relation to the collapse of the shell includes the zones of anti-gravitational repulsion between the nuclei of the sign-changing shell whose effect starts to be evident at distances shorter than the classic electron radius of the electron.

Another fundamental property of the sign-changing shells of the nucleons is their capacity to be attracted by the charges with opposite polarity, regardless of the presence or absence of a non-compensated electrical charge. In the proton, the shell contains a non-compensated electrical charge with positive polarity and an odd number of charges – 69 charges. In the neutron, the number of charges in the sign-changing shell is even (70 charges) and these charges are compensated in pairs, so that the neutron is regarded as an electrically neutral particle.

The electrical neutrality of the neutron is evident at distances greater than 10^{-15} m. At shorter distances, not only in the neutron but also in the proton, the electrical field of the sign-changing shell of the nucleons is characterised by specific features of action at short distances of 10^{-16}... 10^{-15} m, comparable with the spacing of the distribution of the charges in the shell. These are short-range fields and forces which enable the forces of electrostatic attraction of the shells to overcome the forces of electrostatic repulsion of the non-compensated charge of the protons in the atomic nucleus. The open zones of anti-gravitational repulsion in the complicated relief of the fields of the nucleon shells prevent the nucleons from coming together closer than 10^{-16} m, thus avoiding the collapse of the nucleons and ensuring stability of the nuclei.

In particular, the sign-changing structure of the nucleon shells, including the zones of electrostatic attraction and anti-gravitational repulsion, has made it possible to formulate a concept of the electrical nature of nuclear forces within the framework of the Superunification theory.

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6
Two-rotor structure of the photon
Photon gyroscopic effect

After introducing in 1905 the radiation quantum referrred to subsequently as the photon, Einstein is justifiably is regarded as one of the founders of quantum theory. However, Einstein could not accept the statistical nature of the wave function which is the basis of the calculation apparatus of modern quantum (wave) mechanics and in his final months assumed that the quantum theory should be deterministic. Only after discovery in 1996 of the space-time quantum (quanton) was it possible to develop a deterministic quantum theory. The classic analysis of the structure of the main elementary particle could be carried out, including the photon, and bypassing the wave function. It was found that the photon is a two-rotor relativistic particle and that its electrical and magnetic rotors exist simultaneously and are situated in the orthogonal polarisation planes. The intersection of the polarisation planes forms the main axis of the photon around which the polarisation waves can rotate. The main axis of the photon is directed in the direction of the speed vector of the movement of the photon in the quantised medium. In this form, the photon represents a wave–particle, some concentrated bunch of the electromagnetic energy of the quantised space-time, flying with the wave speed of light. The electromagnetic field of the photon satisfies the two-rotor Maxwell equation. Calculation parameters of the photon were determined for the first time: the strength of the electrical and magnetic fields in the rotors of the photon, the densities of the electrical and magnetic displacement currents, the currents themselves, and many other parameters which could not previously be calculated. It was found that deceleration of light in an optical medium is caused by the wave trajectory of the photon as a result of the probable capture by the photon of atomic centres of the lattice of the optical medium with the speed vector of the photon in the quantised medium not coinciding with the speed vector in the optical medium.

6.1. Introduction

This study is a continuation of analysis of new fundamental discoveries of the space-time quantum (quanton) and the superstrong electromagnetic interaction (SEI) for examination of the structure and parameters of the photon. Paradoxically, the radiation quantum (photon) was discovered more than 100 years before discovery of the space-time quantum (quanton), regardless of the fact that the photon is a secondary formation in the quantised space-time. In particular, the quantised space-time represents the unified Einstein field which is a carrier of superstrong electromagnetic interaction. New discoveries have been used as a basis for developing the theory of the elastic quantised medium (EQM) and the Superunification theory which combines all the known fundamental interactions [1, 2].

It should be mentioned that Einstein was at the origins of the quantum theory and he introduced the concept of the radiation quantum [3, 4]. Paradoxically, Einstein in particular did not accept the statistical nature of the wave function on which the modern quantum theory is based. This scientific approach was based on the classic perception of the phenomena and events, assuming the quantum theory should be predictable, i.e., deterministyic [5, 6].

Now it can be claimed with confidence that Einstein won this scientific battle. The discovery of the quanton has returned to the quantum theory the classic field as the unified electromagnetic field in the sense that all the quantum processes and events develop on the unified field inside the quantised space-time. The presence of the unified field makes it possible to change greatly the calculation apparatus of quantum theory, making it accessible and predictable. Several fundamental concepts were used to describe the nature and structure of the photon, three of which belong to Einstein:

1. The concept of the unified field which in the theory of the elastic quantised medium was emboddied into the quantised space-time [1, 2].
2. The concept of determinism in quantum theory
3. The concept of the photon as a specific wave-particle
4. Analysis of the Maxwell rotor equations

5. The Planck relationship between the radiation energy of the photon W and its frequency ν:

$$W = \hbar\nu \tag{6.1}$$

where $\hbar = 1.054 \cdot 10^{-34}$ J·s is the Planck constant.

All the previously mentioned fundamental concepts (with the exception of the Maxwell equations) relate to the beginning of the 20th century and have proved to be sufficient for developing the classic theory of the photon. In fact, no further fundamental concepts in the photon theory than those mentioned previously were proposed in the 20th century. The fact that the further development of the photon theory was postponed by almost 100 years is due to principal errors in the unjustified refusal of the light-bearing medium, and not only of Einstein but of the entire theoretical physics of the 20th century. This does not diminish Einstein's achievement in science because every scientist has a right to make an error and only those who do not do anything do not make any errors. The unjustified refusal of the light-bearing medium was the result of the inaccurate interpretation of the experiments carried out by Fizo and Michelson and Morley [1,2].

Paradoxically, it was Einstein who developed throughout all his scientific activities the concept of unification of space and time into a single concept of space-time, trying to combine electromagnetism and gravitation, with this concept used in refusal of the light-bearing medium. If we characterise the physics of the 20th century as a whole, regardless of considerable achievements of mainly the experimental type, a number of paradoxic situations occurred in theoretical physics, with one of them being the rejection of the light-bearing medium. In the final analysis this resulted in a new crisis in quantum theory because regardless of the huge investments into the development of the most powerful particle accelerators and quantum generators, the results of all subsequent investigations did not help physics to understand the structure of elementary particles, including the photon.

To remove the obstacles forming the development of quantum theory it was necessary to return to physics the light-bearing medium as the fundamental property of the quantised space-time. For this purpose, it was necessary to derive analytically the Maxwell equations which had previously been derived by Maxwell in the purely empirical form to provide a mathematical basis for the Faraday laws of electromagnetic induction of the analytical derivation is of the Maxwell equations was based only on the analysis of electromagnetic perturbation of the quantised space-time which is a carrier of the electromagnetic wave. It was proved that like light, the electromagnetic wave cannot propagate in the empty space [1, 2].

In particular, the inaccurate interpretation of the Maxwell rotor equations was used as an additional argument for ignoring the light-bearing medium, assuming inaccurately that the electromagnetic field is an independent substance which does not require a carrier in the form of the light-bearing medium. It was assumed that the rotor of the magnetic field generates the rotor of the electrical field, and vice versa, generating an electromagnetic wave. However, in [2] it was shown that this concept is not confirmed by experiments. The rotors of the magnetic and electrical fields exist simultaneously in the electromagnetic wave. This means that in the electromagnetic wave, in contrast to the laws of electromagnetic induction in electrical circuits, the magnetic field does not generate the electrical field and vice versa. The propagation of the electromagnetic wave in vacuum is due to the quantised space-time being a light-bearing medium [1].

Another paradox of modern physics is the incorrect interpretation of the propagation of light in optical media. This problem was often investigated in [2]. This book is concerned with the complete justification of the wave nature of movement of the photon in the optical medium along a wave-shaped trajectory. The movement of the photon in the optical medium is linked with the light-bearing quantised medium. The optical medium distorts the straight trajectory of the photon in the quantised medium, and prevents the photon from carrying out additional transverse oscillations inside the lattice of the optical medium. Consequently, moving in the quantised medium with the speed of light C_0 but, in this case, along the wave-shaped trajectory, the photon travels the same distance in the optical medium after a longer period of time that if the photon had travelled along a straight line. The effect of reducing the speed of the photon in the optical media takes place. In order to understand the nature of these phenomena, it was necessary to develop the two-rotor structure of the photon and link its parameters with equation (1) where the photon energy remains proportional only to the frequency of its electromagnetic field.

Of all the elementary particles the photon stands separately because it cannot be in the rest state, both absolute or relative. The photon exists only at the speed of light inside the quantised space-time representing a particle–wave and when arrested it disappears without a trace, transferring its energy momentum to the atom (molecule). The speed of the photon in the space-time non-perturbed by gravitation is a constant, $C_0 \approx 3 \cdot 10^8$ m/s. In the quantised space-time perturbed by gravitation the speed of the photon C decreases [1, 2]

$$C = C_0 \sqrt{1 - \frac{\gamma_n R_g}{r}} \tag{6.2}$$

where r is the distance from the centre of the gravitational perturbation to the coordinates in which the speed of light is determined, m; R_g is the gravitational radius of the perturbing mass m, m; g_n is the normalised relativistic factor

$$\gamma_n = \frac{1}{\sqrt{1-\left(1-\frac{R_g^2}{R_S^2}\right)\frac{v^2}{C_0^2}}} \tag{6.3}$$

$$R_g = \frac{Gm}{C_0^2} \tag{6.4}$$

where $G = 6.67 \cdot 10^{-11}$ Nm^2/kg^2 is the gravitational constant; R_S is the radius of the gravitational boundary (radius of the perturbing mass), m; v is the speed of movement of the perturbing mass, m/s.

There is no other equation in physics, with the exception of (6.2), for determining the speed of the photon C. Equation (6.2) is governed by the principle of spherical invariance which postulates that all the solids retain the configuration of their gravitational field, irrespective of the speed of movement of the solid. There is no compression of the gravitational field in the direction of movement. This means that the speed of light on the surface of the Earth remains constant, irrespective of the horizontal orientation of the arms of the Michaelson interferometer. This was also recorded in the experiments carried out by Michaelson and Morley.

On the other hand, the principle of spherical invariance enables the Earth to be regarded as an independent local centre, determining the principle of the relative-absolute dualism when the principle of relativity is manifested as the fundamental property of the quantised space-time. The presence of energy bifurcation on the acceleration curve in transition from a non-inertial system to an inertial reference system, and vice versa, shows that the principle of relativity does not require any further additional experimental verification because it is found in almost all experiments with acceleration of solids (particles) [2].

Previously, it was reported in [2] that the experiments with the exclusion of the light-bearing medium had been formulated incorrectly. For this to be so it would be necessary to exclude the light-bearing medium along the path of the photon. This means that the exclusion of the light-bearing medium from physics was not justified. The exclusion of the hypothetical mechanistic aether with the properties of aether wind was justified because, as shown in the EQM theory, the former does not exist in nature. However, mechanistic aether has no relationship with the quantised space-time as a light-bearing medium.

However, the experiment which confirms that the failure of the light-bearing medium results in the disruption of its light conductivity has been formulated by the nature itself in astrophysics on the surface of a black hole. In fact, for a static black hole at $\gamma_n = 1$, the speed of light C (2) on the surface ($r = R_g$) is equal to 0. This means that the light cannot leave the black hole and penetrate into it, making it invisible. This is explained by the fact that the quantum density of the medium ρ_1 on the surface of the black hole is equal to 0, forming a discontinuity in the light-bearing medium. When falling onto a black hole, the photon slows down to zero and ceases to exist. Thus, the strong gravitational field of the black hole absorbs photons [2].

In particular, the presence of the light-bearing medium is a compulsory condition for the existence of a photon as a particle-wave. The nature and structure of the photon can be investigated only in the conditions of the quantised space-time. Information on the photon currently available is extremely rare and relates to its individual properties, such as: energy $\hbar\nu$(1), spin $1\hbar$, relativistic pulse $p=\hbar\nu/C$, the rest mass is equal to 0. The calculation mathematical apparatus is purely phenomenological and does not make it possible to derive specific calculation parameters of the photon for any wavelength nor clarify its structure [7].

6.2. Electromagnetic nature of the photon and rotor models

To determine the structure of the photon and its specific parameters in the conditions of the Maxwell classic electromagnetic field, it was necessary to analyse the state of the photon in the quantised space-time as its integral part. Since the photon does not have any rest mass and moves constantly with the speed of light C, we can only discuss the particle-wave in the quantised medium. However, this single wave is grouped in such a manner that it represents some wave energy bunch similar to a corpuscule, showing corpuscular-wave properties. For this reason, the photon cannot transfer a free electrical charge, like the electron, nor it can carry a free magnetic charge because of the absence of such in nature. These charges exist only as combined charges in the structure of the quanton and the quantised medium.

At present, the photon as a particle-wave does not cause any doubts as regards its existence, showing the corpuscular and wave properties. However, old stereotypes have not as yet been overcome here. In the photoeffect, the photon is regarded as a sphere. When studying the wave properties of the photon, the photon is regarded as identical with some wave electromagnetic packet, taking into account the classic considerations of the electromagnetic wave. The existing contradictions cannot be eliminated assuming that the photon-sphere in movement in the quantised medium transfers simultaneously the electromagnetic wave, but this wave should of course differ from the classic electromagnetic wave, regardless of the classic base.

To combine the structure of the photon-sphere and its electromagnetic wave field into a single structure, it was necessary to overcome the existing stereotypes and return to the analysis of the light-bearing medium which in the EQM theory is treated as an elastic quantised medium being the carrier of the superstrong electromagnetic interaction.

In [1], special attention was given to the nature of electromagnetism in the quantised medium, with the analytical derivation of the Maxwell equations for the classic electromagnetic waves of the continuous type. The simultaneous existence of the electrical and magnetic components in the electromagnetic wave can be explained only in the EQM theory on the basis of analysis of electromagnetic polarisation of the quantised medium where the displacement of the electrical charges in the quanton results in the simultaneous displacement of the magnetic charges, disrupting the magnetic equilibrium of the quantised medium, and vice versa. This can be expressed by the density of the currents of electrical $\mathbf{j}_e$ and magnetic $\mathbf{j}_g$ displacement of the electrical and magnetic charges in the quantised medium in the form of a vector product [1]

$$\left[\mathbf{C}_0 \mathbf{j}_e\right] = \mathbf{j}_g \qquad (6.5)$$

Equation (6.5) is the generalised unique Maxwell equations for vacuum, establishing the mutual orthogonality of three vectors $\mathbf{C}_0$, $\mathbf{j}_e$ and $\mathbf{j}_g$. The vectors $\mathbf{j}_e$ and $\mathbf{j}_g$ are situated in the plane orthogonal to the speed vector $\mathbf{C}_0$ in the direction of movement of the wave, determining the transverse nature of electromagnetic oscillations. Equation (6.5) can be written in the complex form through the harmonic variation of the vectors (with the dot) of the strength of the electrical $\dot{\mathbf{E}}$ and magnetic $\dot{\mathbf{H}}$ fields in the electromagnetic wave:

$$\varepsilon_0 \left[\mathbf{C}_0 \dot{\mathbf{E}}\right] = -\dot{\mathbf{H}} \qquad (6.6)$$

where $\varepsilon_0 = 8.85 \cdot 10^{-12}$ F/m is an electrical constant.

The rotorless equation (6.6) can be easily transformed to a wave equation, showing that it is not necessary to use rotor equations for the formation of the electromagnetic wave in the quantised medium. However, rotors are present in the electromagnetic wave, and two rotors exist there simultaneously: electrical and magnetic, as required by the Maxwell equations. The two-rotor unified Maxwell equation for the electromagnetic wave, describing the simultaneous presence of the electrical and magnetic components, results from (6.6)

$$\varepsilon_0 C_0 \operatorname{rot} \mathbf{E} = -\operatorname{rot} \mathbf{H} \tag{6.7}$$

The nature of the equations (6.5)...(6.7) is determined by the fact that the electrical and magnetic charges inside a quanton are connected together electrically, ensuring the simultaneous circulation of the electrical and magnetic energies and determining the periodicity of circulation in the form of electromagnetic oscillations in the quantised medium [1].

Figure 6.1 shows the scheme of simultaneous circulation of the vectors **E** and **H** in the form of rotors (6.7) on the sphere of the electromagnetic wave in the orthogonal sections. The source of the spherical electromagnetic wave is situated in the centre 0. Any two orthogonal sections of the sphere of the wave give two diagonal points *a* and *b* with arbitrary coordinates. At the points *a* and *b* the vectors **E** and **H** are orthogonal to each other, and the rotors themselves (6.7) circulate in the orthogonal planes *Z*0*X* and *Y*0*X*, satisfying the equation (6.7). Regardless of the arbitrary coordinates of the diagonal points *a* and *b* defined on the sphere of the wave, the pattern of the electromagnetic field of the spherical wave is described by the scheme in Fig. 6.1 for the arbitrarily rotated figure in space [1].

The two-rotor differential vector equation (6.7) of the electromagnetic field in vacuum, if it is based on the unanimity of electromagnetic phenomena, should describe not only the spherical wave but also the electromagnetic field of the photon. However, by its nature, the spherical classical electromagnetic wave and the electromagnetic field of the photon have properties which differs greatly that it is unnatural to use the results for describing photon radiation.

The intensity of the classic electromagnetic wave is determined by the Pointing vector |**EH**|, which determines the volume density of

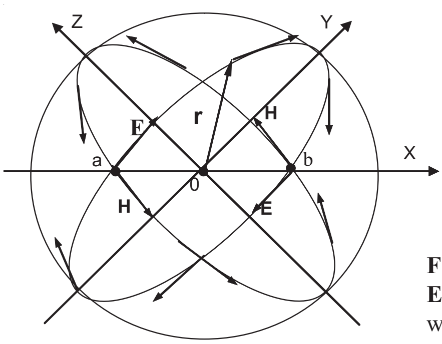

Fig. 6.1. Simultaneous circulation of the vectors **E** and **H** on the sphere of the electromagnetic wave in orthogonal sections.

electromagnetic energy W_v [1]:

$$W_v = \frac{EH}{C_0} \tag{6.8}$$

Equation (6.8) includes the moduli of the actual value of the strength of the electrical **E** and magnetic **H** fields of the electromagnetic wave irrespective of radiation frequency. The density of the volume energy in vacuum resulting from the static fields with the strength of the orthogonal vectors **E** and **H** is the same.

The intensity (radiation energy W) of photon radiation is proportional to its frequency (6.1) or inversely proportional to the wavelength $\lambda = C_0/\nu$:

$$W = \hbar\nu = \hbar\frac{C_0}{\lambda} \tag{6.9}$$

The independence of the intensity on radiation frequency (6.8) and its total dependence on frequency in (6.7) appear to be incompatible assumptions which should not result from the analysis of the unified differential equation (6.7) of the electromagnetic field. However, the initial conditions of irradiation of the spherical wave and photon radiation differ and, correspondingly, analysis of the equation (6.7) yields different results.

It is assumed that a spherical wave identical with that in Fig. 6.1 and described by the two-rotor equation (6.7) has been emitted by a relativistic electron. In fact, the orbital electron of the atom situated inside the gravitational well of the atomic nuclei can also be regarded as a relativistic electron. This problem is not investigated in this book because the theory of radiation of the orbital electron is a very large independent section of the theory of Superunification. It should only be mentioned that the presence of the gravitational well [2] in the atom nucleus explains the constancy of the energy of the electron–nucleus system when the increase of the electrical energy of the system for the case in which the electron and the nucleus come closer together is compensated by a decrease of the gravitational energy of the system. For this reason, the electron does not emit anything even on a greatly elongated orbit [8]. However, as shown by calculations, the orbital electron emits only when it reaches the limiting critical speed and acceleration in the vicinity of the atomic nucleus. In this case, the speed of the electron approaches the speed of light and determines the radiation of the orbital electron as the radiation of a relativistic particle.

It is one thing when the source of electromagnetic radiation is stationary or moves in the range of non-relativistic speeds, and the electromagnetic wave in space forms a classic spherical wave whose front increases and expands on the sphere with increasing distance from the source. It is quite another matter when the radiation source moves at relativistic speeds.

We consider a process in which the relativistic electron forms a two-rotor (6.7) spherical wave similar to that in Fig. 6.1 as a result of the transformation of the mass defect into electromagnetic radiation. The theory of relativity shows unambiguously that such a spherical wave, travelling at the speed of light, cannot expand like the classic spherical wave. This is the key point of the problem. The non-expanding wave electromagnetic sphere, travelling at the speed of light, is a photon in the form of a wave sphere-corpuscule whose diameter is constant. However, this is not a solid sphere but a sphere which includes two rotors (6.7), and represents a bunch of the energy of the electromagnetic polarisation of the quantised medium and the trace of its movement in the quantised medium leaves behind a single wave.

Evidently, there is a very short period of time within which the photon forms and is still capable of expanding in the range of speeds from the speed C inside the gravitational well at the final diameter at the moment of reaching the speed of light C_0. It can be assumed that high energy photons form at a higher rate, for example, in annihilation of the electron and the positron and, consequently, their diameter is smaller.

Thus, after irradiation and the formation of the final diameter at the speed of light, the two-rotor sphere-photon cannot expand any further and its diameter remains constant. It should be mentioned that the photon should be regarded as a particle with the spin equal to unity. This results from the equivalence between electricity and magnetism in the electromagnetic wave and the presence of two rotors at the photon, each of which characterises the particle with half spin and in the total ensures the total spin of the particle.

It is also necessary to take into account the rotation of orthogonal planes of polarisation of the photon in which the two previously mentioned rotors of electrical and magnetic polarisation of the medium are located. This rotation takes place around the axis in the direction of movement of the photon. Therefore, the photon as a two-rotor particle with the rotation of the polarisation planes is similar to a spherical particle-corpuscule. This particle in the quantised medium should also be governed by the principle of spherical invariance in retaining its spherical form and diameter. We consider in greater detail the corpuscular and wave properties of the photon with the two-rotor structure.

Figure 6.2 shows the two-rotor structure of the photon with the rotation of the polarisation planes in the right angled coordinate. The direction of the speed of movement of the photon $\mathbf{C}_0$ coincides with the main axis X. The rotors $\mathbf{E}$ and $\mathbf{H}$ are situated in the orthogonal polarisation planes $Y0X$

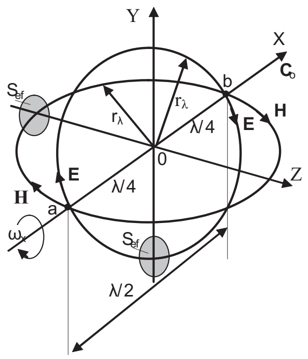

Fig. 6.2. The two-rotor structure of the photon with the rotation of the polarisation planes.

and $Z0X$ and make contact in the vicinity of the diagonal points a and b. The polarisation planes rotate around the main axis X with the cyclic frequency ω_x which is not connected directly with the frequency of circulation of the rotors of the electromagnetic field. Evidently, the flux of the circulation vectors is determined by the effective cross-section of the rotors S_{ef}. This is one of the main new parameters of the photon which has not been examined previously and must be taken into account in further calculations.

Analysis of the quantised structure of the photon in Fig. 6.2 shows that the photon may represent a half-wave two-rotor volume electromagnetic resonator and the circulation of the vectors of the strength of the electrical **E** and magnetic **H** fields of the resonator is determined by the constancy of the electromagnetic energy of the photon. This is achieved by the anti-phase variation of the electrical and magnetic energy of the photon when the increase of the magnetic component results in a decrease of the electrical component, and vice versa. The half-wave resonator is one of the two models of the photon because the all-wave model can be accepted in this case.

It was shown in [1] that all wave electromagnetic processes in the quantised medium are connected with the circulation of the electrical and magnetic energies in the anti-phase and, at the same time, ensure its constancy. This also relates to the photon determining the constancy of its energy at the given frequency. The vectors **E** and **H** are derivatives of the variation of energy, regardless of the decrease or increase of the electrical and magnetic components of the photon energy.

Therefore, with the general energy of the photon constant, the variation of the electrical and magnetic components results in a simultaneous manifestation of the vectors **E** and (–**H**) in the anti-phase, ensuring circulation of the vectors around the rotor in the polarisation planes. In the case of the vectors **E** and **H** the sign of the direction of circulation is important. This sign changes periodically and determines the direction of circulation in the clockwise or anticlockwise direction. The circulation of the vectors **E** and **H** is mutually connected by the two-rotor Maxwell equation (6.7) with both equations determining the density of the fluxes of the electrical $\mathbf{j}_e$ and magnetic $\mathbf{j}_g$ displacement (6.5) in the rotor [1]

$$\begin{cases} \mathbf{j}_e = \mathrm{rot}\,\mathbf{H} = \varepsilon_0 \dfrac{\partial \mathbf{E}}{\partial t} \\ \mathbf{j}_g = \dfrac{1}{\mu_0}\mathrm{rot}\,\mathbf{E} = -\dfrac{\partial \mathbf{H}}{\partial t} \end{cases} \tag{6.10}$$

where $\mu_0 = 1.26 \cdot 10^{-6}$ H/m is a magnetic constant.

The variation of the vectors **E** and **H** with time for the photon which represents a relativistic electromagnetic resonator in the quantised medium should take place in accordance with the harmonic law: sinusoidal or cosinusoidal. Since the primary disruption of electromagnetic equilibrium of the quantised medium is associated with the displacement of the charge in accordance with the sinusoidal law, it is accepted that the variation of the strength of the field is determined by the cosinusoidal function [1]:

$$\begin{cases} \mathbf{E} = \mathbf{E}_a \cos 2\pi\nu t \\ \mathbf{H} = \mathbf{H}_a \cos(-2\pi\nu t) \end{cases} \qquad \mathbf{E} \perp \mathbf{H} \tag{6.11}$$

In (6.11), the vectors **E** and **H** are treated as instantaneous with respect to time, and the vectors $\mathbf{E}_a$ and $\mathbf{H}_a$ represent their amplitude values. Consequently, the first derivative with respect to time of (6.11) is determined by the density of the bias currents $\mathbf{j}_e$ and $\mathbf{j}_g$ which already vary in accordance with the sinusoidal law (T is the oscillation period)

$$\begin{cases} \mathbf{j}_e = \varepsilon_0 \dfrac{\partial \mathbf{E}}{\partial t} = -2\pi\varepsilon_0 \nu \mathbf{E}_a \sin\left(\dfrac{2\pi}{T}t\right) \\ \mathbf{j}_g = -\dfrac{\partial \mathbf{H}}{\partial t} = 2\pi\nu \mathbf{H}_a \sin\left(\dfrac{2\pi}{T}t\right) \end{cases} \qquad \mathbf{j}_e \perp \mathbf{j}_g \tag{6.12}$$

In (6.4) the vectors $\mathbf{j}_e$ and $\mathbf{j}_g$ carry out oscillations in the anti-phase and, therefore, the sign (–) in calculations is retained either in (6.10) or in (6.11). In transition from instantaneous values to actual moduli, equation (6.12) gives

$$\begin{cases} j_e = 2\pi\varepsilon_0 E \cdot \nu \\ j_g = 2\pi H \cdot \nu \end{cases} \tag{6.13}$$

As indicated by (6.13), the densities of the currents in the rotors of the photon are proportional to the strength and frequency of the field. On the other hand, the energy of the photon W (6.19) is proportional only to frequency ν. It is therefore necessary to determine the conditions in which the electromagnetic parameters of the photon in the Maxwell equations ensure that the energy of the photon is proportional only to the frequency of the field. For this purpose, equation (6.8) is integrated

$$W = \int_V W_v dV = \int_V \frac{EH}{C_0} dV \tag{6.14}$$

If the rotor of the photon is regarded as a homogeneous torus ('bagel') with the effective cross-section S_{ef} and the mean length of the line of force ℓ of the tube of the rotor around the circumference, the integral (6.14) can be transformed

$$W = \int_V \frac{EH}{C_0} dV = \frac{1}{C_0} \iint EH d\ell dS = \frac{EH}{C_0} \ell S_{ef} \tag{6.15}$$

Equation (6.15) is equated with (6.9) and we determine the conditions in which the electromagnetic parameters of the photon satisfy the condition of proportionality of the energy to the frequency of the field

$$\frac{EH}{C_0} \ell S_{ef} = \hbar \nu \tag{6.16}$$

$$\frac{EH}{C_0} \frac{\ell S_{ef}}{\nu} = \hbar = \text{const} \tag{6.17}$$

Condition (6.17) determines the electromagnetic parameters of the photon at which the photon energy is proportional to frequency. From equation (6.17) it is now necessary to remove the frequency of the field ν and replace it by the wavelength $\nu = C_0/\lambda$

$$\frac{EH}{C_0} \frac{\ell \lambda S_{ef}}{C_0} = \hbar = \text{const} \tag{6.18}$$

In the condition (6.18) the wavelength λ and the length of the mean line of force ℓ of the tube of the rotor of the photon as linear parameters are connected by the relationship (here k_λ is the coefficient of the wavelength of the photon)

$$k_\lambda = \frac{\lambda}{\ell} \tag{6.19}$$

From (6.19) we replace in (6.18) $\lambda = k_\lambda \ell$:

$$\frac{E\ell H\ell}{C_0^2} k_\lambda S_{ef} = \hbar = \text{const} \qquad (6.20)$$

Equation (6.20) includes the rotor (circular) electrical φ_e and magnetic φ_g potentials (actual values) of the photon

$$\varphi_e = E\ell, \quad \varphi_g = H\ell \qquad (6.21)$$

The electrical φ_e and magnetic φ_g potentials (6.21) determine the difference of the potentials (voltage) circulating in the turn of the photon rotor (the dimension is potential per turn). Substituting (6.21) into (6.20) we obtain a more exact condition in which the photon energy is proportional to the field frequency

$$\frac{\varphi_e \varphi_g}{C_0^2} k_\lambda S_{ef} = \hbar = \text{const} \qquad (6.22)$$

The rotor potentials (6.22) φ_e and φ_g per the turn of the photon rotor, are induction potentials and should not depend on the length of the rotor turn (as in a transformer) and are constants which will be the same for all the photons, emitted by the electron

$$\varphi_e = \text{const}, \quad \varphi_g = \text{const} \qquad (6.23)$$

$$\frac{\varphi_e \varphi_g}{C_0^2} = \text{const} \qquad (6.24)$$

If a turn made from a conductor could be installed in the electrical rotor, the difference of the electrical potentials, equal to the rotor potential φ_e, would be induced at the ends of the turn. The rotor potentials (6.23) are measured: electrical φ_e in volts (V) and magnetic φ_g in amperes (A). The magnetic potential in the SI system is a derivative of the magnetic moment which has the dimension [Am^2 = Dc·m]. In the EQM theory, the magnetic potential is determined by the magnetic charge g whose dimension is [Dc = A·m]. This shows that the dimension of the magnetic potential is [A], as that of electrical current, because the magnetic parameters in the SI system are derivatives of electrical current [1].

Constant (6.24) is included in (6.22). This shows that the product $k_\lambda S_{ef}$ should also be a constant

$$k_\lambda S_{ef} = \text{const} \qquad (6.25).$$

Thus, the condition (6.22) should include only one constant to ensure that the photon energy remains proportional to the frequency of the electromagnetic field. Of the six parameters included in (6.22) only two are known: C_0^2 and $\hbar$. Taking into account the symmetry between electricity and magnetism of the photon, the magnetic parameters can be reduced to electrical ones:

$$\varphi_g = \varepsilon_0 C_0 \varphi_e \tag{6.26}$$

In (6.22) we replace the magnetic potential φ_g and leave only one parameter in the condition (6.22)

$$\frac{\varepsilon_0 \varphi_e^2}{C_0} k_\lambda S_{ef} = \hbar = const \tag{6.27}$$

The new condition (6.27) of proportionality of the photon energy to the field frequency contains three unknown parameters: φ_e, k_λ and S_{ef}, two of which, k_λ and S_{ef}, are related to the photon geometry. Figure 6.2 shows the two-rotor structure of the photon and also that the rotors circulate in two orthogonal polarisation planes. Subsequently, it was assumed that the rotor has the form of a torus ('bagel').

The complicated geometrical form of the proton indicates that the electrical and magnetic fields inside the torus are distributed nonuniformly in the cross-section of the torus. In this case, the conditions of proportionality of the photon energy to the field frequency should be written in the integral form (6.14). However, the functional distribution of the field in the cross-section of the torus inside the rotor is not known. Therefore, it was decided to transfer to the actual values of the electromagnetic parameters of the photon, assuming that the field in the cross-section of the torus inside the rotor is distributed uniformly. In this case, the cross-section of the rotor S_{ef} is calculated, like the effective (actual) cross-section which does not reflect the total cross-section of the torus S_t. The effective cross-section of the rotor S_{ef} and the total cross-section of the torus S_t are different cross-sections which can be connected by the coefficient of the cross-section of the rotor k_s, and k_s<1

$$S_{ef} = k_s S_t \tag{6.28}$$

Naturally, if we know the geometry of the photon rotors and its connection with the wavelength (6.19) and cross-section of the rotors (6.28), we can determine the unknown geometrical parameters k_λ and S_{ef} in the condition (6.27). For this analysis it is necessary to select a photon whose parameters are determined by the distinctive geometry, on the basis of the limiting initial conditions which are available. These known geometrical parameters should be characteristic of the gamma quantum with the energy of 0.511 MeV produced as a result of annihilation of the electron.

When the electron annihilates to a gamma quantum with the maximum radiation energy for electron of 0.511 MeV, the energy, which exceeds this

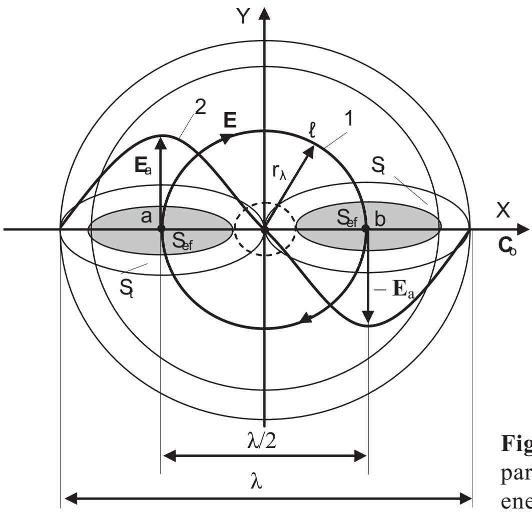

Fig. 6.3. Calculation of the geometrical parameters of a gamma quantum with the energy of 0.511 MeV.

limiting value, cannot be emitted by the electron. Evidently, in the limiting case, the photon rotor for the given gamma quantum should occupy the maximum possible volume of the photon, having the form of a torus in the form of a bagel without any orifice in the centre.

Figure 6.3 shows the calculation diagram of the geometrical parameters of the gamma quantum with the energy of 0.511 MeV for the electrical rotor of the photon at the speed C_0 on the axis X. The torus of the rotor with the section S_t occupies the maximum possible volume of the photon. Previously, all the calculation parameters of the photon were related to the mean length ℓ of the force tube of the rotor with the cross-section S_{ef} represented by a circle 1 with the radius r_λ. It was assumed that the parameters of the strength **E** of the electrical field of the local are uniformly distributed throughout its effective cross-section S_{ef}.

In reality, the photon can leave a wave electromagnetic trace in the quantised medium which is described by the harmonic function (curve 2 in Fig. 6.3) of the wavelength λ for the strength of the field **E**. The harmonic function is given for the moment of time when the circulation of vector **E** in the rotor reaches the amplitude value $\mathbf{E}_a$. As a result of analysis, the calculation scheme can be used to determine the geometrical parameters of the gamma quanta with the energy of 0.511 MeV. It may be seen that the mean length of the force tube of the rotor ℓ is determined by the radius $r_\lambda = \lambda/4$

$$\ell = 2\pi r_\lambda = \frac{\pi}{2}\lambda \tag{6.29}$$

Substituting (6.29) into (6.19) we determine the required coefficient k the wavelength of the photon

$$k_\lambda = \frac{\lambda}{\ell} = \frac{2}{\pi} = 0.64 \tag{6.30}$$

The wavelength λ_0 of the annihilation gamma quantum of the electron, equal to the Compton wavelength of the electron λ_0, is determined from the condition of equivalence of the photon energy and electron mass

$$\hbar\frac{C_0}{\lambda_0} = m_e C_0^2 \tag{6.31}$$

$$\lambda_0 = \frac{\hbar}{m_e C_0} = 3.86\cdot10^{-13}\,\mathrm{m} \tag{6.32}$$

The cross-sectional area S_t of the torus of the rotor is determined from the equality of the diameter d_t of the torus to half the wavelength $d_t = \lambda_0/2$ (Fig. 6.3)

$$S_t = \frac{\pi d_t^2}{4} = \frac{\pi\lambda_0^2}{16} = 2.93\cdot10^{-26}\,\mathrm{m}^2 \tag{6.33}$$

The calculation area of the effective cross-section S_{ef} of the force tube of the rotor is determined from the condition of the equality of electrical fluxes for the homogeneous and inhomogeneous fields, penetrating through the sections S_{ef} and S_t. In Fig. 6.3, the effective cross-section S_{ef} its dark. The flux of the electrical field penetrating the actual effective cross-section S_{ef} is homogeneous and determined by the actual value of the strength of the field **E**. The heterogeneous flux of the electrical field penetrating the maximum cross-section S_t is determined by the harmonic function **E** in the cross-section. If the fluxes are equal, it can be seen that the effective section S_{ef} is $\sqrt{2}$ times smaller than the maximum cross-section S_t, according to the coefficient k_s=1/$\sqrt{2}$ (6.28)

$$S_{ef} = k_s S_t = \frac{S_t}{\sqrt{2}} = \frac{\pi\lambda^2}{16\sqrt{2}} = 2.07\cdot10^{-26}\,\mathrm{m}^2 \tag{6.34}$$

Substituting the geometrical parameters of the photon: coefficient k_λ (6.30) and the cross-section S_{ef} (6.34) of the photon rotor into the condition (6.27) of the proportionality of the photon energy to the field frequency, we determine the last unknown parameter: the rotor electrical potential φ_e

$$\varphi_e = \sqrt{\frac{\pi\hbar C_0}{2\varepsilon_0 S_{ef}}} = 0.521\ \text{MV} \tag{6.35}$$

The determined rotor potential $\varphi_e = 0.521$ MV is a constant for the photons emitted by the electron and is almost identical with the electrical potential 0.511 MV of the electron on its gravitational boundary determined by the classic radius $r_e = 2.82\cdot10^{-15}$ m. The small difference between 0.521 MV (6.35) and 0.511 MV is the error of calculation and can be subsequently removed. Therefore, for calculations in practice, the rotor potential for the photons emitted by the electron is represented by the electrical potential 0.511 MV on the gravitational boundary of the electron

$$\varphi_e = 0.511\ \text{MV} = \text{const} \tag{6.36}$$

From (6.36) we determine the rotor magnetic potential φ_g of the photon

$$\varphi_g = \varepsilon_0 C_0 \varphi_e = 1.36\cdot10^3\ \text{A} \tag{6.37}$$

Consequently, it can be seen that the process of formation of the photon by the electron, as assumed previously, is connected with the gravitational boundary of the electron and its electrical potential is induced on the photon as the rotor potential irrespective of the photon energy. This is the main parameter of the photon which determines the proportionality of its energy to the field frequency.

It was shown in [1] that for a classic electromagnetic wave spherically propagating in the space from the radiation source, the density of volume energy decreases in inverse proportion to the square of the distance irrespective of the field frequency. For the photon, the density of the volume energy is a constant value for every field frequency.

Taking into account the exact value of the rotor potential $\varphi_e = 0.511$ MV (6.36) of the photon, from (6.27) we determine the effective cross-section S_{ef} of the proton of the photon for $k_\lambda = 2/\pi$

$$S_{ef} = \frac{\pi\hbar C_0}{2\varepsilon_0 \varphi_e^2} = 2.15\cdot10^{-26}\ \text{m}^2 \tag{6.38}$$

From (6.38) we determine the calculation parameter d_s of the photon rotor for the effective cross-section S_{ef}

$$d_s = \sqrt{\frac{4S_{ef}}{\pi}} = 1.65\cdot10^{-13}\ \text{m} \tag{6.39}$$

The calculation results presented previously were obtained for the model of a photon rotor in the form of a torus. However, identical results can be obtained regarding the model of the photon rotor in the form of a disc. In addition, the disc model better corresponds to the flat model of the rotor when placed in the polarisation planes. In any case, for calculations it is necessary to determine the value of the effective cross-section S_{ef} (6.38) of the photon rotor and the value of the rotor potential $\varphi_e = 0.521$ MV (6.36), which is the initial value in calculation of new constants of the photon.

Of the eight constants characterising the photon and presented in Table 3.1, only the first two constants were known initially: the Planck constant and the spin. These two constants are sufficient for estimating the strength of the electrical and magnetic fields of the photon. Taking into account the small dimensions of the photon, it is not possible to introduce measuring probes into the region of its rotor electromagnetic fields to measure the strength of the field. For this reason, quantum electrodynamics is restricted to calculations of the energy of the photon, its momentum and frequency. Table 6.1 gives the constants characterising the photon.

Table 6.1. Photon constants

Parameter	Value
1. Planck constant $\hbar$	$\hbar = 1.054 \cdot 10^{-34}$ J·s
2. Spin S	$S = 1\hbar$
3. Rotor electrical potential φ_e	$\varphi_e = 0.511 \cdot 10^6$ V (36)
4. Rotor magnetic potential φ_g	$\varphi_g = 1.36 \cdot 10^3$ A (37)
5. Effective cross section of rotor S_{ef}	$S_{ef} = 2.15 \cdot 10^{-26}\,\text{m}^2$ (38)
6. Calculated rotor diameter d_s	$d_s = 1.65 \cdot 10^{-13}$ m (39)
7. Wavelength coefficient k_λ	$k_\lambda = \lambda / \ell = 2/\pi = 0.64$ (30)
8. Rotor cross section coefficient k_s	$k_s = 1/\sqrt{2} = 0.707$ (34)

Until now, the quantum theory did not have at its disposal methods of estimating the potentials and strength of the electrical and magnetic fields of the photon. The procedures for calculating the electromagnetic parameters of the photon are presented for the first time, regardless of the fact that methods of measuring them in experiment are not yet available.

As an example, we can estimate the specific electromagnetic parameters of the photon in red light for a helium–neon laser with a wavelength of $\lambda = 630$ nm ($0.63 \cdot 10^{-6}$ m) and the frequency $\nu = 0.48 \cdot 10^{15}$ Hz. The electromagnetic parameters of the photon are calculated using the procedure described below and the constants from Table 6.1:

1. We determine the photon energy for the wavelength $\lambda = 630$ nm from (6.9)

$$W = \hbar \nu = \hbar \frac{C_0}{\lambda} = 5.02 \cdot 10^{-20}\ \text{J} = 0.31\ \text{eV} \tag{6.40}$$

2. We determine the mean length ℓ of the lines of force of the tube of the photon rotor by means of the wavelength λ and the coefficient of the wavelength k_λ:

$$\ell = \frac{\lambda}{k_\lambda} = \frac{\pi}{2}\lambda = 0.99 \cdot 10^{-6}\ \text{m} \tag{6.41}$$

3. The actual value of the strength of the electrical field E of the photon rotor is determined by means of the rotor electrical potential vector φ_e = $0.511 \cdot 10^6$ V (6.36) and the mean length ℓ (6.41) of the line of force

$$E = \frac{\varphi_e}{\ell} = \frac{2\varphi_e}{\pi\lambda} = 0.516 \cdot 10^{12}\ \frac{\text{V}}{\text{m}} \tag{6.42}$$

4. The actual value of the strength H of the magnetic field of the photon rotor is determined by means of the rotor magnetic potential φ_g = $1.36 \cdot 10^3$ A (6.37) and the mean length ℓ (6.40) of the line of force from (6.16) and (6.42)

$$H = \frac{\varphi_g}{\ell} = \frac{2\varphi_g}{\pi\lambda} = 1.37 \cdot 10^9\ \frac{\text{A}}{\text{m}} \tag{6.43}$$

$$H = \varepsilon_0 C_0 E = 1.37 \cdot 10^9\ \frac{\text{A}}{\text{m}} \tag{6.44}$$

5. The volume density of electromagnetic energy W_v (6.8) is determined from E (6.42) and H (6.43)

$$W_v = \frac{EH}{C_0} = 2.36 \cdot 10^{12}\ \frac{\text{J}}{\text{m}^3} \tag{6.45}$$

6. We verify the correspondence of the electromagnetic energy (6.15) of the photon, circulating in the rotors, to the energy (6.40)

$$W = \int_V \frac{EH}{C_0}\,dV = \frac{EH}{C_0}\ell S_{ef} = 5.02 \cdot 10^{-20}\ \text{J} \tag{6.46}$$

7. From equation (6.13) we determine the density of the electrical j_e and magnetic j_g bias currents in the photon rotors

$$j_e = 2\pi\varepsilon_o E \cdot \nu = 1.38 \cdot 10^{16}\ \frac{\text{C}}{\text{s}\cdot\text{m}^2} = \left[\frac{\text{A}}{\text{m}^2}\right] \tag{6.47}$$

$$j_g = 2\pi H \cdot \nu = 4.13 \cdot 10^{24} \frac{\text{Dc}}{\text{s} \cdot \text{m}^2} = \left[\frac{\text{A}}{\text{s} \cdot \text{m}}\right]$$
$$j_g = C_0 j_e = 4.14 \cdot 10^{24} \frac{\text{Dc}}{\text{s} \cdot \text{m}^2} \qquad (6.48)$$

8. We determine the values of the electrical I_e and magnetic I_g currents in the photon rotors

$$I_e = j_e S_{ef} = 2.97 \cdot 10^{-10} \frac{\text{C}}{\text{s}} = [\text{A}] \qquad (6.49)$$

$$I_g = j_g S_{ef} = 8.9 \cdot 10^{-2} \frac{\text{Dc}}{\text{s}} = \left[\frac{\text{A} \cdot \text{m}}{\text{s}}\right]$$
$$I_g = C_0 I_e = 8.9 \cdot 10^{-2} \frac{\text{Dc}}{\text{s}} \qquad (6.50)$$

9. We determine the reactive (wave) resistance of the electrical Z_e and magnetic Z_g rotors of the photon

$$Z_e = \frac{\varphi_e}{I_e} = 1.72 \cdot 10^{15} \text{ohm} \qquad (6.51)$$

$$Z_g = \frac{\varphi_g}{I_g} = 1.53 \cdot 10^4 \frac{\text{A} \cdot \text{s}}{\text{Dc}} = \left[\frac{\text{s}}{\text{m}}\right]$$
$$Z_g = \varepsilon_0 Z_e = 1.52 \cdot 10^4 \frac{\text{s}}{\text{m}} \qquad (6.52)$$

10. We determine the reactive powers: electrical Q_e and magnetic Q_g, circulating in the photon rotors:

$$Q_e = I_e \varphi_e = 1.52 \cdot 10^{-4} \text{VA} \qquad (6.53)$$

$$Q_g = \mu_0 I_g \varphi_g = 1.52 \cdot 10^{-4} \text{VA} \qquad (6.54)$$

The calculation equations presented above can be written in the differential, integral and complex forms, increasing the number of parameters which characterise the photon. At the moment, this is not important. It is important to show the physical nature of the processes, taking place in the photon rotors, without overloading the material with calculations.

It has been reliably established that the electromagnetic parameters of the photon can be calculated, confirming the deterministic nature of the quantum theory when investigating the parameters of single particles, as postulated by Einstein. Naturally, in cases in which the quantum theory operates with a large number of particles, the group behaviour of the particles can be evaluated by the statistical methods using the wave function when the physical laws of behaviour of the particles in the group are not known.

The fundamental physical laws include the law of electromagnetic induction represented by the Maxwell equations in which the large number of the quantons behave in an adequate manner resulting in the disruption of electromagnetic equilibrium in the quantised medium which can be described in a deterministic manner from the position of the causality of the phenomenon. The EQM theory operates with the colossal concentration of the particles (quanton), characterised by the quantum density of the medium which reaches the values of the order of 10^{75} particles/m^3.

The highest concentration of the quantons in the medium determines physical laws regarding them as some mean statistical parameters establishing a compromise between chaos and order in the quantised medium. For the physical laws to operate, there should be a specific degree of spontaneous freedom of the behaviour of the particles, characterising some chaos as the possibility of selecting the action or interaction. To ensure that the behaviour of the particles does not extend outside the limits restricting the uncontrolled intensification of spontaneous chaos, it is necessary to have restraining forces determined by physical laws from the position of determinism. In particular, the possibility of equilibrium between chaos, as the freedom of selection, and determinism, as a law restricting chaos, determines the established state of the particles (their stability or instability) in the quantised medium. This also relates to the photon.

Analysing the stable state of the photon for $\lambda = 630$ nm, it is important to mention that regardless of the very small value of the electrical $I_e = 2.97\cdot 10^{-10}$ A (6.49) and magnetic $I_g = 8.9\cdot 10^{-2}$ Dc/s (6.50) currents circulating in the photon rotors, the density of the currents $j_e = 1.30\cdot 10^{16}$ A/m^2 (6.47) and $j_g = 4.14\cdot 10^{24}$ Dc/cm^2 (6.48) and also the strength of the fields $E = 0.516\cdot 10^{12}$ V/m (6.42) and $H = 1.37\cdot 10^9$ A/m (6.43) reach colossal values because of the small dimensions of the photon and high energy concentration in the volume W_v=$2.36\cdot 10^{12}$ J/m^3 (6.45).

Comparing the diameter d_s=$1.65\cdot 10^{-13}$ m (6.39) of the effective cross-section of the rotor S_{ef}, for example, with the wavelength λ= 630 nm ($0.63\cdot 10^{-6}$ m) of the light photon, we determine their ratio

$$\frac{d_s}{\lambda} = 2.6\cdot 10^{-6} \tag{6.55}$$

In particular, in the range of low energy of the photons emitted by the orbital electron in the optical range conditions are created in which the diameter of the effective cross-section S_{ef} of the proton remains incommeasurably small (6.55) with the increase of the wavelength of the photon in comparison with the wavelength λ. This enhances the effect of the rotor potential of 0.511 MV on the fulfilment of the condition (6.27) which determines the law of proportionality of the photon energy to the field frequency.

If the photon rotors is not a torus and has the form of a disc we can estimate the thickness h_λ of the disc for λ = 630 nm, assuming that its radius is equal to half the wavelength $\lambda/2$, and the cross-section of the disc in the direction of the radius is represented by the effective cross-section $S_{ef} = 2.15\cdot10^{-26}$ m^2 (6.38)

$$h_\lambda = \frac{2S_{ef}}{\lambda} = 3.4\cdot10^{-20}\,\text{m} \tag{6.56}$$

The result (6.56) does not contradict the EQM theory because the quanton diameter is of the order of 10^{-25} m and the disk of the rotor contains approximately 10^5 layers of quantons because the quanton is part of the polarised quantised medium. It has been established that the characteristic feature resulting from the increase of the wavelength for photon radiation is the compression of the polarisation plane in the disc model. This also ensures that the photon energy is proportional to the field frequency.

Table 6.2 shows the calculation parameters of the photon at λ= 630 nm. The parameters of the photon for λ = 630 nm, presented in Table 3.2, correspond to the condition of proportionality of its energy to the frequency of the electromagnetic field, and this can be confirmed by means of classic considerations on the basis of analysis of the unified field.

The main difference between the models of the photon with the rotor in the form of a torus or a disc is the photon diameter. For the disc model of the rotor, the diameter of the photon d_λ is determined by the wavelength λ, and the radius r_λ of the mean line of the rotor ℓ is equal to half the wavelength $\lambda/2$

$$\begin{aligned} d_\lambda &= \lambda \\ r_\lambda &= \lambda/2 \end{aligned} \tag{6.57}$$

Table 6.2. Calculation of electromagnetic parameters of the photon, λ = 630 nm

Parameter	Electrical	Magnetic
1. Field strength	$E = 0.516\cdot10^{12}$ V/m (6.42)	$H = 1.37\cdot10^{9}$ A/м (6.43)
2. Current density	$j_e = 1.38\cdot10^{16}$ A/m^2 (6.47)	$j_g = 4.14\cdot10^{24}$ Dc/s·m^2 (6.48)
3. Current intensity	I_e= 2/97$\cdot10^{-10}$ A (6.49)	$I_g = 8.9\cdot10^{-2}$ Dc/s (6.50)
4. Reactive power	$Q_e = 1.52\cdot10^{-4}$ VA (6.53)	$Q_g = 1.52\cdot10^{-4}$ VA (6.54)
5. Wave resistance	$Z_e = 1.72\cdot10^{15}$ ohm (6.51)	$Z_e = 1.52\cdot10^{4}$ s/m (6.52)
6. Thickness of rotor disk	$h_\lambda = 3.4\cdot10^{-20}$ m (6.56)	$h_\lambda = 3.4\cdot10^{-20}$ m (6.56)
7. Formation time	$t_\lambda \approx 10^{-15}$ s (6.59)	$t_\lambda \approx 10^{-15}$ s (6.59)

Diameter (6.57) characterises the wave model. For the model of a light photon with the rotor in the form of a torus when the radius r_λ of the mean line ℓ of the rotor is equal to half the wavelength λ/2 and determines the diameter d_λ of the half-wave model we obtain

$$\begin{aligned} d_\lambda &= \lambda/2 \\ r_\lambda &= \lambda/4 \end{aligned} \tag{6.58}$$

Theoretically, both the wave (6.57) and half-wave (6.58) models of the photon are working models. However, preference is given to the wave model which is more universal, although some properties of the photon are explained by the half-wave model. The wave model explains electromagnetic parameters of the photon both in the region of low energies of the optical range and in the region of high energies of gamma quanta, representing the cross-section of the rotor in the form of a changing ellipse. In the region of low photon energies, the ellipse of the cross-section of the rotor is elongated representing the rotor in the form of flat disks situated in the orthogonal polarisation planes. In the region of high energies, a decrease of the wavelength results in expansion of the ellipse of the rotor cross-section into a circle and the rotor itself in the limiting case transforms into a torus. This is dictated by the conditions of proportionality of the photon energy to the field frequency. The half-wave model of the photon theoretically represents the averaged-out model of the photon which is connected with the mean length ℓ of the rotor and is suitable for simplified calculations.

As already mentioned, the electron forms photon radiation at the speed C slightly lower than the speed of light C_0. This is the range of the speed and time in which the photon can spherically expand. For this reason, the photons with high energy have small diameters because they form at a higher rate. We can estimate the time t_λ, assuming that spherical expansion of the photon from the gravitational boundary of the electron to the diameter determined by the wavelength (6.57) takes place with the mean speed $(C + C_0)/2$, which is very close to the speed of light C_0

$$t_\lambda \approx \frac{\lambda/2}{C_0} \approx \frac{\lambda}{2C_0} = \frac{\hbar}{2W} \tag{6.59}$$

Thus, for the photon with λ = 630 nm (red light) the duration of formation is $t_\lambda \approx 10^{-15}$ s, and for a gamma quantum with $\lambda = 3.86 \cdot 10^{-13}$ m it is $t_\lambda \approx 0.64^{-21}$ s. Equation (6.59) confirms that the rate of the high-energy processes is considerably higher than that of low-energy ones. This also applies to the processes of formation of photons in which the photons with high energies form on the electron many times faster than the low-energy photons.

6.3. Electromagnetic trace of the photon in the quantised medium

After discussing the electrical and magnetic parameters of the two-rotor structure of the photon (Tables 6.1 amd 6.2), it is necessary to show the wave nature of the photon which becomes evident when a flying photon leaves a trace in the quantised medium in the form of an electromagnetic wave. Figure 6.3 shows the possible wave trace of a photon on the X axis as a result of circulation of the vector of the strength **E** in accordance with the harmonic law. However, on the X axis, the vector **E** is transverse in relation to the direction of movement of the photon. This is consistent with the Maxwell equations which regard the electromagnetic wave oscillations as transverse oscillations of the vectors **E** and **H** in the orthogonal planes. However, in addition to the transverse components of circulation of the vectors **E** and **H**, the photon also has its longitudinal components which are not found in the classic electromagnetic wave.

Figure 6.4 shows the scheme of stage by stage circulation of the instantaneous vector of strength **E** of the electrical field in the rotor of a photon flying with the speed of light $\mathbf{C}_0$ in the direction of the X axis. The plane of the electrical polarisation of the photon is represented by the axes XY in the rectangular coordinate system. The positive value of the vector of strength **E** is represented by the direction of its circulation in the clockwise direction. This direction is maintained in the first half period of the oscillations of the time range from 0 to π for the total period 2π. In the second half period of the oscillations, the direction of the circulation of the vector of strength **E** of the field changes to the opposite direction. This anticlockwise direction of rotation is regarded as the negative direction of circulation of the vector of strength **E** in the range of the second half period from to 2π.

We examine individual stages of the variation of the instantaneous strength **E** in any region of the rotor in accordance with the harmonic law (6.11) for the period T in the range from 0 to 2π at the wavelength λ with the photon travelling at the speed of light in the quantised medium. In this case, analysis can be carried out more efficiently when the variation of the strength **E** is determined by the sinusoidal function

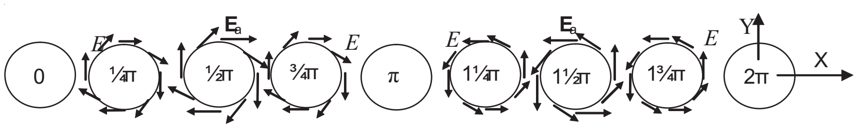

Fig. 6.4. Stages of circulation of the vector of the strength **E** of the electrical field in the photon rotor.

$$\mathbf{E} = \mathbf{E}_a \sin 2\pi\nu t = \mathbf{E}_a \sin\left(\frac{2\pi}{T}t\right) \tag{6.60}$$

The sinusoidal function (6.60) makes it possible to 'fix' the initial observation conditions within the limits of the period T where the moment of time $t = 0$ corresponds to the zero strength of the field $\mathbf{E} = 0$. With unfolding of the period, the value of the vector **E** increases and at time $t = 1/4\ T$ reaches the maximum value $\mathbf{E}_a$ in the stage $1/2\pi$ (the angular phase of oscillations in radians). Subsequently, strength **E** starts to decrease and at time $t = 1/2\ T$ in stage π decreases to 0. Further, the direction of circulation of the instantaneous vector of strength **E** changes to the opposite direction and passes gradually through all stages in accordance with the harmonic law (6.60) synchronously at every point of the proton.

It should be noted that the direction of circulation of the vector of strength **E** in the photon rotor and the direction of the vector **E** in the rectangular coordinate system may differ. The circulation of vector **E** (6.6) determines the actual state of the photon and the projections of the vector **E** of the axes X and Y leave an electromagnetic trace of the photon in the quantised medium which can be recorded by a stationary observer. The projection of **E** on the Y axis gives the transverse component of the vector $\mathbf{E}_y$, and on the X axis it gives its longitudinal components $\mathbf{E}_x$

$$\mathbf{E} = \mathbf{E}_y + \mathbf{E}_x$$
$$E = \sqrt{E_y^2 + E_x^2} \tag{6.61}$$

Identical stages can also be described for the instantaneous vector of the circulation of strength **H** (6.11) of the magnetic field in the photon rotor only in accordance with the sinusoidal law, like the vector **E** (6.60). The vectors **E** and **H** circulate in the anti-phase in the orthogonal polarisation planes $X0Y$ and $X0Z$, and the projections of vector **H** on the axes X and Z are denoted by $\mathbf{H}_x$ (longitudinal) and $\mathbf{H}_z$ (transverse), respectively.

In order to investigate the electromagnetic trace of the photon in the quantised medium and describe it mathematically, it is necessary to turn to the special theory of relativity as the theory of relative measurements. Evidently, the described stages of circulation of the electrical and magnetic fields of the photon rotors are real stages in the quantised medium and can be controlled by the observer moving together with the photon at the speed of light C_0. For a stationary observer, all the longitudinal components $\mathbf{E}_x$ and $\mathbf{H}_x$ of the vectors **E** and **H** become invisible at the photon speed $v = C_0$ [8] because of their relativistic 'shortening'

$$\begin{cases} E_x = (E\cos\alpha_x)\sqrt{1-\dfrac{v^2}{C_0^2}} = 0 \\ H_x = (H\cos\alpha_x)\sqrt{1-\dfrac{v^2}{C_0^2}} = 0 \end{cases} \tag{6.62}$$

Here α_x is the angle of inclination of the vectors **E** and **H** to the X axis.

Angle α_x in (6.62) is identical for the vectors **E** and **H** with the same coordinate x of application to the rotor because in this case the variation of these vectors in the photon rotor takes place simultaneously (synchronously) as regards both direction and magnitude.

Attention should be given to the fact that the assumptions of the special theory of relativity must be applied with considerable care and only in cases in which we understand the physical nature of the processes associated with the application of relative measurements, although hypothetical, but still measurements, and even more so when measurements are actually taken. For example, in the experiments carried out by Michaelson and Morley no relative measurements across and along the direction of movement of the earth could be made because of the spherical invariance on the whole of the measurement system which travelled together with the observers.

It is important not to confuse the actual processes with errors generated by measurements in the relativistic region. The special theory of relativity has two directions: description of the fundamental relationships and measurement theory. An increase of the relativistic mass of the particles is the fundamental assumption of the relativity theory which occurs in nature regardless of the efficiency of the measurement method. The Lorentz shortening in the direction of motion is the result of measurements, determined by the natural error, especially in the relativistic region, with the errors caused by the finite speed of travel of the measurement signal. For this reason, in (6.62) it is not necessary to use the normalised relativistic factor γ_n (6.3).

The photon as a reference system for the speed of light C_0 is a very interesting object for theoretical physicist. The photon has no mass, i.e., it is not capable of spherical deformation of the quantised medium which generates mass. The photon only transfers the two-rotor polarisation of the quantised medium with the speed of light C_0 in the direction of its movement. The polarisation structure of the photon determines the nature of the photon which corresponds only to the dynamics of movement and excludes the rest state. This leads to the wave electromagnetic processes of movement of the photon in the quantised medium whose two-rotor structure makes it possible to localise the wave in a corpuscule, some bunch of the electromagnetic energy of polarisation of the medium without its spherical deformation. This concept of the photon removes all the contradictions determined by the corpuscular–wave dualism in which the classic mechanics excludes the mutual merger of the wave and the particle in a single object.

However, for the two-rotor structure of the photon to be capable of movement in the quantised medium with the speed of light C_0, it is necessary to examine the relationship to the speed of light C_0 as the speed restricting only the wave process in the quantised medium in the direction of movement of the wave along a straight line. Theoretical physics has been looking closely at supraluminal speeds for a long time, analysing the possibility of supraluminal movement by hypothetical particles, i.e., tachions [10]. If the supraluminal tachion is not regarded as a separate independent particle and is treated as the localised part of the photon rotor, the possibility of the existence of such special formations is quite high.

Every localised part of the photon rotor moves in the straight direction along the X axis with the speed of light C_0 (Fig. 6.2). If the polarisation planes of the photon rotate with the cyclic frequency ω_x, then every point of the rotor describes a helical trajectory in the direction of movement. The length of the helical trajectory increases with the increase of the distance along the straight line in the direction of the X axis around which the helical line is described. Correspondingly, the speed C_0 of any point of the rotor along the helical line will be greater than the speed of light C_0 along a straight line

$$C_c = \sqrt{C_0^2 + v_\tau^2} = C_0\sqrt{1 + \frac{v_\tau^2}{C_0^2}} = C_0\sqrt{1 + \frac{(r_x\omega_x)^2}{C_0^2}} > C_0 \tag{6.63}$$

where ν_τ is the tangential component of speed along the helical line, m/s; r_x is the distance of the point to the X axis, m.

Equation (6.63) shows that the speed of light C_0 can be reached only in the presence of supraluminal speeds C_c. This is especially relevant in analysis of the speed C_ψ of flux linkage of the field in the photon rotor. Actually, for the rotor of a photon to retain its circular form and for the photon itself to be spherical in rotation of the polarisation planes, the flux linkage of the rotor should also be maintained when the photon travel at the speed of light C_0. This is possible only if the speed C_ψ of flux linkage of the field in the photon rotor is greater than the speed of light C_0. We can determine the minimum speed C_ψ of flux linkage for example for a half-wave model of a photon, assuming that in displacement of the photon by 0.5λ with the speed of light, the speed C_ψ should ensure the closing of the flux around the circle of the mean line 0.5πλ (Fig. 6.2). This is possible if the speed of flux linkage is at least π times greater than the speed of light, i.e.

$$C_\Psi \geq \pi C_0 \tag{6.64}$$

Flux linkage Ω_E or Ω_H determines the fluxes of the electrical Ψ_E or magnetic Ψ_H fields, respectively, along the entire length ℓ of the homogeneous tube of the photon rotor

$$\begin{cases} \Omega_E = \Psi_E \ell = \ell \int_S EdS = ES\ell = \varphi_e S \\ \Omega_H = \Psi_H \ell = \ell \int_S HdS = HS\ell = \varphi_g S \end{cases} \tag{6.65}$$

It can be assumed that every point of the photon rotor moves in a straight line with the speed of light, polarising the quantised medium by wave perturbation. In this case, the quantons at every point of the rotor link together synchronously, ensuring that the flux linkage (6.65) is maintained. This flux linkage may not formally be connected with the determined speed C_ψ (6.64). However, in this case, the other speed C_ψ of flux linkage should be many times greater than the speed of light because the process of flux linkage in the rotor should take place in the period not shorter than the duration of relaxation of the quanton which is of the order of $T_0 = 2.5 \cdot 10^{-34}$ s [1]. In this case, we can estimate approximately the speed C_ψ of flux linkage for the half wave model of the photon with $\lambda = 0.63 \cdot 10^{-6}$ m (Fig. 6.2)

$$C_\Psi = \frac{2\pi r_\lambda}{T_0} = \frac{\pi\lambda}{T_0} = 8 \cdot 10^{29}\,\mathrm{m/s} = 2.7 \cdot 10^{21} C_0 \tag{6.66}$$

Even higher speeds C_ψ of flux linkage should be found in the classic spherical electromagnetic wave where the radius r_γ of the sphere of the wave increases with the speed of light in moving away from the radiation source, ensuring the formation of electrical and magnetic rotors of the wave (Fig. 6.1). It may be also suggested that these high speeds, such as (6.66) or higher, are the results of only mathematical calculations and the actual situation is linked with the synchronous relaxation of quantons. However, the flux linkage in the rotor is also a reality, and the problem of the speed of flux linkage should be solved because flux linkage ensures the stability of the rotors in the electromagnetic wave. It is possible that the speed C_ψ of flux linkage in the rotor is rather a energy information problem in which the information according to which the process has started travels through all the quantons in the photon rotor with the speed (6.66).

It is sufficient to break up rotors at the photon and the photon is immediately destructed transferring its energy to, for example, an atom in photon absorption. Naturally, the process of transfer of energy from the photon to the atom takes place through an orbital electron when the breaking of the photon rotors increases the strength of the electrical and magnetic fields of the electron–nucleus system, ejecting the electron to a higher orbit. This means that the electron must be moved away from the nucleus of the atom to the region of the quantised medium which does not restrict the electron mass, as in the vicinity of the nucleus with the relativistic electron. Consequently, the electron can restore its mass to the initial condition which was reduced as a result of the mass defect during emission of the photon. In this case, the electron–nucleus system operates as a receiving resonance antenna on the microscopic level. For this reason, the absorption spectra of the atoms differ from the radiation spectra, because they are produced by different mechanisms.

Therefore, to ensure stability of the photon, it is necessary to ensure the stability of the rotors by circulation of the vectors **E** and **H** as a result of the exchange of electrical and magnetic energies between the rotors of the quantised medium through the diagonal points *a* and *b* (Fig. 6.2). In particular, as a result of reactive (without losses) electromagnetic exchange of the photon energy with the quantised medium, the medium retains the electromagnetic wave trace.

The presence of diagonal points *a* and *b* and, more accurately, local regions of energy exchange in the photon rotors, gives the specific physical meaning to the speed C_ψ of flux linkage (6.66). In a general case in which it is necessary to determine the speed, it is essential to specify the initial coordinates from which counting is started in the propagation of the process to determine its initial speed. For the speed of flux linkage C_ψ (6.66), the initial coordinates are the diagonal points *a* and *b* of the photon rotors. These points indicate the start of dynamics of the process linking together the electrical and magnetic components of the photon through its rotors into a general electromagnetic field.

The EQM theory and the Superunification theory present the most powerful analytical apparatus of theoretical physics enabling investigations to be extended to the level of the diameter of the quantum of the order of 10^{-25} m, into the zones of the local regions of energy exchange in the photon rotors, indicated by the diagonal points *a* and *b* in Fig. 6.2 and 6.3. The state of the quanton as a result of its electromagnetic polarisation was analysed in [1] when deriving Maxwell equations. It was established that the electrical energy of the quanton can increase only as a result of reducing its magnetic energy ensuring the energy balance of the quanton and, at the same time, determining the action of the laws of electromagnetic induction in vacuum. Electricity can interact with magnetism only through a quanton, or vice versa.

Now, by analogy with [1], it is necessary to examine the mechanism linking together the electrical and magnetic rotors of the photon leading to wave energy exchange with the quantised medium. For this purpose, it is sufficient to analyse the processes, linking together two lines of force: electrical and magnetic in the photon rotors, which in the EQM theory are represented by a string of quantons closed around a ring.

Figure 6.5 shows the diagram of connection of the electrical and magnetic rotors of the photon through the quantons at the diagonal zones (points) a and b. In this case, the rotors of the vectors **E** and **H** consist of a set of quantons are oriented with the electrical axis in the direction of vector **E** and with the magnetic axis in the direction of vector **H**, forming strings of tensions closed around a circle. The mean statistical angle of orientation of the axes of the quantons and the displacement of the charges inside the quanton from the equilibrium state are determined the direction and magnitude of the vectors **E** and **H** in the rotors [1]. In order to avoid complicating the scheme, Fig. 6.5 shows only the connecting quantons in the diagonal points a and b of intersection of the rotors. The quantons are denoted in the projection on the plane by four monopole charges: two electrical ones (e^+ and e^-) and two magnetic ones (g^+ and g^-) connected into the electrical and magnetic dipoles, whose axes are always orthogonal.

It is pleasing to see that every electromagnetic process analysed using quantons as test particles shows its nature to the observer without any contradictions, explaining the reasons for the very phenomenon. In this case, this relates to the formation and behaviour of the rotors at the speed of light which form electromagnetic fields and the structure of the photon. In the electrodynamics, the state of fields is analysed by the method of test

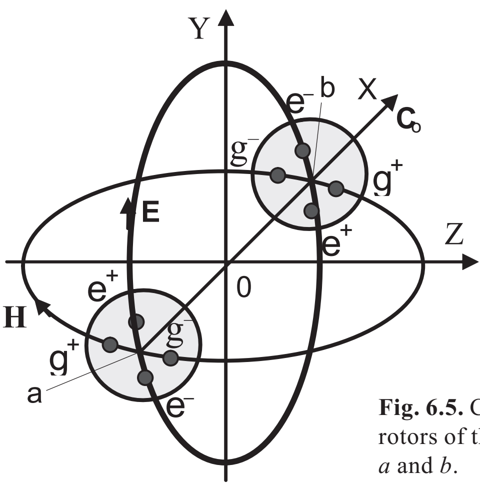

Fig. 6.5. Connection of the electrical and magnetic rotors of the photon through quantons at the points *a* and *b*.

particles-charges. The EQM theory offers for the first time a method in which the test particle is represented by a quanton, with the distinguishing feature being that the quanton combines in itself the orthogonal system of fields.

This approach in mathematics has resulted in the development of a very powerful theory of the functions of the complex variable limited at the present time to the calculations of plane-parallel orthogonal fields. However, the mathematical theory offers new calculation methods, whereas the physical theory is directed to explaining the nature of the phenomenon. In the past physics was referred to as natural philosophy for good reason. Analysing the electromagnetic fields by the method of the test quanton, we can understand the nature of the phenomenon and in cases in which it is necessary to carry out calculations there are no significant difficulties because the calculations are based on the explained physical model. However, the quanton is not only the test particle for analysis but it is also the particle representing the real quantum of the space-time.

Only through the quanton which combines electricity and magnetism, can we link the circulation of electrical and magnetic energies in the photon rotors by synchronous interaction. It should be mentioned that the strength of electrical **E** and magnetic **H** fields of the electromagnetic wave is determined by the displacement of the electrical and magnetic charges inside the quanton by the values Δx and Δy, respectively [1]. For a photon, the displacement of the charges in the rotors should be investigated along the circular line ℓ of the string (the lines of force of the proton), denoting displacement as $\mathbf{\Delta\ell}$ (here $\mathbf{1}_\ell$ is the unit vector of circulation around the circumference ℓ of the proton):

$$\mathbf{E} = \frac{2ek_3\mathbf{1}_\ell}{\varepsilon_0 L_{q0}^3}\Delta\ell \tag{6.67}$$

$$\mathbf{H} = \frac{2gk_3\mathbf{1}_\ell}{L_{q0}^3}(-\Delta\ell) \tag{6.68}$$

here $L_{q0} = 0.74\cdot10^{-25}$ m is the quanton diameter, $k_3 = 1.44$ is the filling factor [1].

For the connecting quantons in the zones *a* and *b* in Fig. 6.5, the vectors **E** (6.67) and **H** (6.68) are initially orthogonal with respect to the condition of their application to the quanton. The positive displacement of the electrical charges $\Delta\ell$ is associated with the tensioning of the electrical axis of the quanton, whereas the negative displacement $(-\Delta\ell)$ determines the anti-phase compression of the magnetic axis. We can determine the displacement of the charges in the photon rotors, for example, for λ= 637 nm, because the parameters of the field E = 0.516·10^{12} V/m and H = 1.37·10^{9} A/m are available (Table 6.2)

$$\Delta\ell = \frac{\varepsilon_0 L_{q0}^3}{2ek_3} E = 4.01 \cdot 10^{-57}\,\text{m} \tag{6.69}$$

$$-\Delta\ell = \frac{L_{q0}^3}{2gk_3} H = 4.01 \cdot 10^{-57}\,\text{m} \tag{6.70}$$

As indicated by (6.69) and (6.70), the EQM theory gives the same displacement of electrical and magnetic charges of the quantons in the rotors of the photon, determining the synchronous displacement of the charges in the anti-phase. The displacement of the charges of the order of 10^{-57} m for λ = 637 nm is extremely small in relation to the diameter of the quanton of the order of 10^{-25} m. Regardless of such a small displacement of the charges, the disruption of the electrical and magnetic equilibrium of the quantised medium in the photon rotors is determined by the relatively high parameters of the strength of the fields E = 0.516·10^{12} V/m and H = 1.37·10^{9} A/m (Table 6.2). This again stresses that the quantised medium is characterised by colossal elasticity resulting in the relatively high speed C_0 ~3·10^{8} m/s of propagation of the wave processes in this medium.

Previously, it was shown that the rotors of the electrical and magnetic fields of the photon are situated in the orthogonal polarisation planes and the intersection of these planes determines the direction of movement of the photon represented by the vector of speed C_0 on the X axis (Fig. 6.2). This is determined by the fact that initially the electromagnetic field of the photon forms as a spherical wave but this takes place at speed C very close to the speed of light C_0. Therefore, in the photon there is a short time period (6.59) essential for expanding the photon to the finite size, determined by the wavelength. Reaching the speed of light, the photon cannot expand any further, fixing its wave (half-wave) diameter and stabilising the frequency of circulation of the electrical and magnetic energies in the photon rotors.

Circulation of the electrical and magnetic energies in the rotors of the photon and synchronisation of circulation take place as a result of the work of connecting quantons in the zones a and b (Fig. 6.5). In fact, the displacement $\boldsymbol{\Delta\ell}$ (6.69) of the electrical charges in the connecting quanton in the zone a along the chain consisting of photons causes displacement by $\Delta\ell$ of the charges in all quantons of the circular string of the electrical rotors. This displacement of the electrical charges determines the strength **E** (6.67) of circulation of the electrical field in the photon rotor, leading to flux linkage (6.65) of the quantons of the rotor.

Displacement **Δℓ** (6.69) of the electrical charges in the connecting quanton (zone *a*) is connected synchronously with the displacement (–**Δℓ**) (6.70) in the anti-phase of the magnetic charges of the quanton. As shown in [1], this is determined by the law of energy conservation which also holds for the quanton as a carrier of the electromagnetic wave. The displacement of the magnetic charges determines the strength **H** (6.68) of circulation of the magnetic field in the photon rotor synchronously with the circulation of vector **E**. Identical processes take place in the second connecting quanton in the zone *b*. In fact, the two-rotor structure of the quanton represents a microscopic electromagnetic oscillatory circuit moving in the quantised medium with the speed of light.

Thus, the interaction between electricity and magnetism inside the photon, resulting in the circulation of the field and of electromagnetic energy in the photon rotors, takes place through the connecting quantons in the zones *a* and *b*. Therefore, we examine in greater detail the processes of circulation of electrical and magnetic energy in the electrical and magnetic rotors of the photon as in an oscillatory circuit. For this purpose, the total energy $\hbar\nu$ of the photon is represented by its electrical W_e and magnetic W_g components which are equivalent to each other:

$$W = \hbar\nu = W_e + W_g = \frac{1}{2}\int_V \varepsilon_0 E^2 dV + \frac{1}{2}\int_V \mu_0 H^2 dV \tag{6.71}$$

It should be mentioned that the equivalence of electricity and magnetism in the electromagnetic wave, not disregarding the photon, is determined by the ratio E/H as an exact constant, regardless of the values of E and H, and determines the wave resistance of the quantised medium of 377 ohm

$$\frac{E}{H} = \frac{1}{\varepsilon_0 C_0} = \mu_0 C_0 = 377\frac{\text{V}}{\text{A}} = 377 \text{ ohm} \tag{6.72}$$

For a proton with a homogeneous cross-section and constant volume $V = S_{ef}\ell$ with the mean length ℓ (6.41) of the lines of force in the rotor taken into account, the expression (6.71) is simplified

$$V = S_{ef}\ell = \frac{\pi}{2}S_{ef}\lambda \tag{6.73}$$

$$W = \hbar\nu = \frac{1}{2}\varepsilon_0 E^2 V + \frac{1}{2}\mu_0 H^2 V \tag{6.74}$$

Equation (6.74) determines the balance of electrical and magnetic energies for the actual values of the strength E and H. In transition to instantaneous values represented by the cosine function (6.12), the instantaneous value of energy W_{in} of the photon changes in the proton with the doubled cyclic frequency 2ω, where ω = 2πν

$$W_{in} = \frac{1}{4}\varepsilon_0 V E_a^2 [1+\cos(2\omega t)] + \frac{1}{4}\mu_0 V H_a^2 [1+\cos(-2\omega t)] \quad (6.75)$$

Equation (6.75) includes the components of the energy which characterise its specific level W_{const} in relation to which the variable component of energy W_{var} in the photon rotors circulates

$$W_{const} = \frac{1}{4}\varepsilon_0 V E_a^2 + \frac{1}{4}\mu_0 V H_a^2 \quad (6.76)$$

$$W_{\text{var}} = \frac{1}{4}\varepsilon_0 V E_a^2 \cos(2\omega t) - \frac{1}{4}\mu_0 V H_a^2 \cos(2\omega t) \quad (6.77)$$

Equations (6.76) and (6.77) can be reduced to the form (6.74), replacing the amplitude values E_a and H_a by the actual values $E_a = \sqrt{2}\cdot E$ and $H_a = \sqrt{2}\cdot H$ and taking into account that for the actual values cos(2ω*t*) = 1, as in the case of the effect of the static field is

$$W_{\text{const}} = \frac{1}{2}\varepsilon_0 V E^2 + \frac{1}{2}\mu_0 V H^2 = \hbar\nu \quad (6.78)$$

$$W_{\text{var}} = \frac{1}{2}\varepsilon_0 V E^2 - \frac{1}{2}\mu_0 V H^2 = \frac{1}{2}\hbar\nu - \frac{1}{2}\hbar\nu = 0 \quad (6.79)$$

Equation (6.79) can be derived as a mean quadratic equation, integrating the square (6.77) in the interval of the period, separating the results by the period and calculating the square root. Further, we write the actual value of energy as the sum of (6.78) and (6.79)

$$W = W_{\text{const}} + W_{\text{var}} = \hbar\nu + \left(\frac{1}{2}\varepsilon_0 V E^2 - \frac{1}{2}\mu_0 V H^2\right) = \hbar\nu \quad (6.80)$$

As indicated by (6.80), the energy of the photon, determined as a result of renormalisation of energy is equivalent to the photon energy (6.74). However, the physical meaning of energy (6.8) differs completely from that of energy (6.74). The form of the equation (6.74) reflects the classic approach to the problem of photon energy assuming that the energy, transferred by the photon, is accumulated only in the photon rotors. However, in the classic approach, when rejecting the light-bearing quantised medium, expression (6.74) does not reflect the circulation of the energy when the electrical energy of the photon should be completely converted to its magnetic energy, and vice versa. It may easily be shown that this is possible only if there is a phase shift of π/2 between the vectors **E** and **H**. In fact, there is no phase shift in the electromagnetic wave. The vectors **E** and (–**H**) can exist only simultaneously and in the anti-phase. This shows convincingly that the classic approach contains contradictions which are eliminated by the equation (6.80).

In particular, expression (6.74) does not reflect the fact that the energy in the photon rotors circulates in the anti-phase in relation to the sign of the energy. This may be explained as follows. If the energy in the electrical rotors is positive, then at this moment the energy in the magnetic rotor is negative. Conversely, at the moment when the energy in the electrical rotor is negative, the sign of the energy in the magnetic rotor changes to positive. The sign of the energy determines its direction: positive value of the energy is associated with extraction of the energy from the quantised medium, the negative value with the absorption by the quantised medium. This is reflected in (6.77) and (6.80).

The equations (6.77) and (6.80) reflect the actual position of the photon, and the wave displacement of the photon in the quantised medium with the speed of light is possible only as a result of the exchange of electromagnetic energy of the photon with the quantised medium. The photon cannot exist without the light-bearing medium. For the classic equation (6.74) to be valid, the equation should realise the concept of circulation of the energy between the electrical and magnetic rotors of the photon. However, as shown by analysis, there is no such mechanism of circulation of energy in nature. The photon energy can circulate only as a result of exchange of energy with the quantised medium in accordance with (6.77) and (6.80), when the positive energy of the electrical rotor is connected with the extraction of the energy from the quantised medium, whereas the negative energy of the magnetic rotor is directed to transfer to the quantised medium, and vice verse. The photon is capable of leaving a wave electromagnetic trace in the quantised medium (showing the wave properties) only as a result of energy exchange with the quantised medium.

Actually, in the formation of the photon as a result of the mass defect of the orbital electron energy $\hbar\nu$ being a constant is immediately released into the quantised medium because the mass defect is a constant value with time. However, this energy can be transferred in space only as a result of a wave process. Therefore, the energy of the mass defect as the energy of the elastic deformation of the medium is released and causes a wave process to take place leading to the formation of two rotors. The energy is divided equally between these rotors (6.74) and each half circulates in the rotors of the photon in accordance with (6.77). However, expression (6.74) does not take into account the sign of the energy, like equation (6.80).

Equation (6.74) was written on the basis of the formal energy balance. In more detailed analysis by taking into account the sign of the argument ($-2\omega t$) in (6.75) which considers the anti-phase circulation of energy it is possible to determine more accurately the energy balance (6.80) of the photon in the quantised medium. The energy balance of the photon (6.80) determines the continuous exchange of energy with the quantised medium. The amount of energy, directed from the quantised medium to one of the rotors of the photon, is equivalent to the amount of energy ejected by another rotor into the quantised medium, maintaining the initial energy $\hbar\nu = \Delta m_e C_0^2$ of the photon constant.

On the level of the quantons this is reflected in the fact that when the electrical charges in the electrical rotor inside the quantons travel away from each other, the magnetic charges in the magnetic rotor inside the quanton come closer together, and vice versa. The movement of the charges away from each other in the quantons is equivalent to a decrease of their internal energy and an increase of the external energy in the medium in the photon rotor, and vice versa. In movement of the photon, the rotor runs on the quantised medium resulting in its polarisation. At the same time, the quanton leaves the medium, releasing polarisation energy. This is possible only in the case of continuous exchange of energy between the rotors of the photon and the quantised medium leading to the wave transfer of the photon in the medium with the speed of light.

As already mentioned, as a result of relativistic shortening of the longitudinal components $\mathbf{E}_x$ and $\mathbf{H}_x$ (6.62) of the electromagnetic wave recorded by a stationary observer, it is important to examine oscillations of all the transverse components of the instantaneous vectors of the strength $\mathbf{E}_y$ and $\mathbf{H}_z$ (6.61) along the axes Y and Z, respectively, where α_x is the angle of inclination of the vectors $\mathbf{E}$ and $\mathbf{H}$ to the X axis

$$\begin{cases} \mathbf{E}_y = \mathbf{E}\cos\alpha_x \\ \mathbf{H}_z = -\mathbf{H}\cos\alpha_x \end{cases} \quad \mathbf{E}_y \perp \mathbf{H}_z \tag{6.81}$$

System (6.81) links the application of the vectors $\mathbf{E}$ and $\mathbf{H}$ on the photon rotor with the same coordinate x.

Figure 6.6 shows the transverse projections of the instantaneous vector of strength $\mathbf{E}_y$ of circulation of the rotors of the electrical field of the photon on the Y axis (a), and shown separately inside the rotor (b). The maximum value of the transverse components of the strength vector is obtained at the diametral points a and b, and change to the zero state in the centre of the photon on the Y axis, changing in accordance with the law (6.81). The

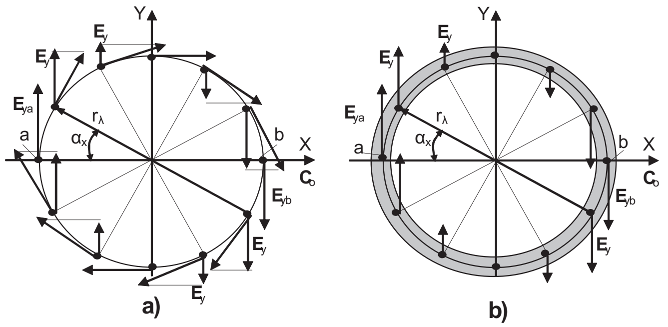

Fig. 6.6. Construction of transverse projections on the Y axis of the instantaneous vector of strength E_y of circulation of the rotor of the electrical field of the photon (a) and definition of transverse projections inside the cross-section of the rotor (b).

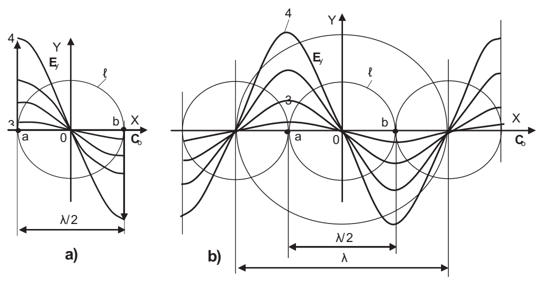

Fig. 6.7. Variation of the transverse component E_y inside the photon in the half wave (a) and wave (b) models.

identical pattern of the fields may also be visualised for the vector of circulation of the instantaneous values of the transverse component of the strength $\mathbf{H}_z$ (6.81) of the magnetic field of the photon rotor, taking into account the orthogonality of the vectors $\mathbf{H}_z$ and $\mathbf{E}_y$.

Figure 6.7 shows the graphs of the variation of the transverse component of the strength $\mathbf{E}_y$ of the electrical field inside the photon for the half- wave (a) and wave (b) models. Similar graphs can also be constructed for the variation of the transverse component of the strength $\mathbf{H}_z$ (6.81) of the magnetic field inside the photon rotor. The half-wave model (a) can be characterised, as already mentioned, only by a specific stage in the development of the wave model (b). These graphs show that the half-wave model does not satisfy the wave equation of the photon in the total volume when the wave should be described as changing with both time and in space. Therefore, prior to further analysis, it is necessary to show how the wave equation of the photon is derived.

6.4. The wave equation of the photon

In [1], a relatively simple method of derivation of the wave equation of classic electromagnetic wave on the basis of analysis of the displacement of the electrical and magnetic charges inside quantons in the passage of the electromagnetic wave through the quantised medium has already been described. The method can also be used for deriving the wave equation of the photon. However, in the EQM theory, it is possible to propose a new method of deriving the wave equation of the photon. For this purpose, we compare the equations (6.81) and (6.11), presenting (6.81) in the following form:

$$\begin{cases} \mathbf{E} = \mathbf{E}_a \cos\left(\frac{2\pi}{T}t\right) \\ \mathbf{H} = \mathbf{H}_a \cos\left(-\frac{2\pi}{T}t\right) \end{cases} \qquad \mathbf{E} \perp \mathbf{H} \tag{6.82}$$

The equation (6.82) reflects the variation of the vectors **E** and **H** with time t in accordance with the cosine law, and the increase of these vectors with time is indicated by individual stages in the graphs 1, 2, 3, 4 (Fig. 6.7). The graphs 1, 2, 3, 4 reflect the distribution in space of the transverse components of the strength $\mathbf{E}_y$ and $\mathbf{H}_y$ also in accordance with the cosine law (6.81). For this purpose, the argument α_x of function (6.81) is expressed through the linear parameters of the photon, linking the angle α_x with wavelength λ and the coordinate x through the appropriate increments, where ℓ is the length of the mean line of the photon rotor with a radius r_λ:

$$d\alpha_x = \frac{d\ell}{r_\lambda} = 2\pi\frac{d\ell}{\ell} \tag{6.83}$$

In equation (6.83), the relationship between the small angle $d\alpha_x$ and the variation $d\ell$ is connected with the fact that in the range of small angles $\sin(d\alpha_x) \approx d\alpha_x$, and we obtain $d\ell = r_\lambda \sin(d\alpha_x) \approx r_\lambda d\alpha_x$ (Fig. 6.7). Evidently, the angle α_x with the photon travelling the distance equal to the wavelength λ should carry out the complete rotation 2π. Consequently, for the amplitude of the transverse components $\mathbf{E}_{ay}$ and $\mathbf{H}_{az}$ the variation of the coordinates dx in the direction of movement of the wave and the increment $d\ell$ can be connected by the proportion:

$$\frac{dx}{\lambda} = \frac{d\ell}{\ell} \tag{6.84}$$

Substituting (6.84) into (6.83) and integration gives

$$\alpha_x = 2\pi \frac{x}{\lambda} \tag{6.85}$$

Thus, the wave properties of the photon should satisfy the condition (6.85), with the value of x varying from 0 to λ. We substitute (6.85) into (6.81) and obtain the linear distribution of the transverse component of the strength $\mathbf{E}_y$ and $\mathbf{H}_y$ of the fields along the wavelength in the form of a cosine function through the transverse amplitudes $\mathbf{E}_{ay}$ and $\mathbf{H}_{az}$

$$\begin{cases} \mathbf{E}_y = \mathbf{E}_{ay} \cos\left(\frac{2\pi}{\lambda} x\right) \\ \mathbf{H}_z = -\mathbf{H}_{az} \cos\left(\frac{2\pi}{\lambda} x\right) \end{cases} \quad \mathbf{E}_y \perp \mathbf{H}_z \tag{6.86}$$

Equation (6.86) determines the linear distribution of the transverse component of the strength of the field $\mathbf{E}_y$ and $\mathbf{H}_z$ along the wavelength. Equation (6.82), which describes the time distribution of the vectors $\mathbf{E}$ and $\mathbf{H}$ will also hold for the transverse components of the strength of the field $\mathbf{E}_y$ and $\mathbf{H}_z$

$$\begin{cases} \mathbf{E}_y = \mathbf{E}_{ay} \cos\left(\frac{2\pi}{T} t\right) \\ \mathbf{H}_z = -\mathbf{H}_{az} \cos\left(\frac{2\pi}{T} t\right) \end{cases} \quad \mathbf{E}_y \perp \mathbf{H}_z \tag{6.87}$$

The equations (6.86) and (6.87) link the variation of the transverse components of the strength of the field $\mathbf{E}_y$ and $\mathbf{H}_y$ in time t and in space along the wavelength λ. To connect the components $\mathbf{E}_y$ and $\mathbf{H}_y$ by a wave equation, we determine the partial derivatives with respect to time t from (6.86) and along the length x from (6.87)

$$\begin{cases} \frac{\partial \mathbf{E}_y}{\partial x} = -\frac{2\pi}{\lambda} \mathbf{E}_{ay} \sin\left(\frac{2\pi}{\lambda} x\right) \\ \frac{\partial \mathbf{H}_z}{\partial x} = \frac{2\pi}{\lambda} \mathbf{H}_{az} \sin\left(\frac{2\pi}{\lambda} x\right) \end{cases} \quad \mathbf{E}_y \perp \mathbf{H}_z \tag{6.88}$$

$$\begin{cases} \frac{\partial \mathbf{E}_y}{\partial t} = -\frac{2\pi}{T} \mathbf{E}_{ay} \sin\left(\frac{2\pi}{T} t\right) \\ \frac{\partial \mathbf{H}_z}{\partial t} = \frac{2\pi}{T} \mathbf{H}_{az} \sin\left(\frac{2\pi}{T} t\right) \end{cases} \quad \mathbf{E}_y \perp \mathbf{H}_z \tag{6.89}$$

Taking into account that the wavelength λ and the period T are connected, and also that the distance x and time t are connected for the wave front together through the speed of light ($\lambda = C_0 T$ and $x = C_0 t$), the linear equation (6.18) will be reduced to the temporary form

$$\begin{cases} C_0 \dfrac{\partial \mathbf{E}_y}{\partial x} = -\dfrac{2\pi}{T}\mathbf{E}_{ay}\sin\left(\dfrac{2\pi}{T}t\right) \\ C_0 \dfrac{\partial \mathbf{H}_z}{\partial x} = \dfrac{2\pi}{T}\mathbf{H}_{az}\sin\left(\dfrac{2\pi}{T}t\right) \end{cases} \quad \mathbf{E}_y \perp \mathbf{H}_z \tag{6.90}$$

We equate the left-hand part of (6.89) and (6.19) because their right-hand parts are equal, and obtain the wave equation of the photon

$$\begin{cases} \dfrac{\partial \mathbf{E}_y}{\partial t} = C_0 \dfrac{\partial \mathbf{E}_y}{\partial x} \\ \dfrac{\partial \mathbf{H}_z}{\partial t} = C_0 \dfrac{\partial \mathbf{H}_z}{\partial x} \end{cases} \quad \mathbf{E}_y \perp \mathbf{H}_z \tag{6.91}$$

Increasing the order of partial derivatives, we reduce the wave equation (6.91) of the photon to the differential equation of the second order in partial derivatives in the classic form:

$$\begin{cases} \dfrac{\partial^2 \mathbf{E}_y}{\partial t^2} = C_0^2 \dfrac{\partial^2 \mathbf{E}_y}{\partial x^2} \\ \dfrac{\partial^2 \mathbf{H}_z}{\partial t^2} = C_0^2 \dfrac{\partial^2 \mathbf{H}_z}{\partial x^2} \end{cases} \quad \mathbf{E}_y \perp \mathbf{H}_z \tag{6.92}$$

At the same time, the wave equation (6.92) of the electromagnetic wave of the photon differs from the classic equation by the fact that it contains only transverse components of the strength of the field $\mathbf{E}_y$ and $\mathbf{H}_z$. The longitudinal components $\mathbf{E}_x$ and $\mathbf{H}_x$ (6.62) of the field remain unobserved because of their relativistic shortening. The longitudinal components of the electromagnetic field are not found in the classic electromagnetic wave.

Because of the relativistic shortening of the longitudinal components of the field these differences between the wave equations (6.91) and (6.92) of the photon cause differences in comparison with the Maxwell equations (6.10) to which the strength (6.61) of the transverse components $\mathbf{E}_y$ and $\mathbf{H}_z$ of the field corresponds only at the diagonal points a and b of the photon rotor. In this case, the longitudinal component $\mathbf{E}_x = 0$ and $\mathbf{H}_x = 0$ is not found in the rotor and there is only the transverse component $\mathbf{E}_y$ and $\mathbf{H}_y$, which determines the density of current in the Maxwell equations

$$\begin{cases} \mathbf{E} = \mathbf{E}_y \\ \mathbf{H} = \mathbf{H}_z \end{cases} \text{at the points } a \text{ and } b \tag{6.93}$$

Since the longitudinal components of the electromagnetic wave of the photon are also found in reality, the wave equations can also be written through the longitudinal components which replace the transverse components in (6.91) and (6.92). On the whole, the differential equations (6.91) and (6.92) do not change if the transverse components are replaced by their total vectors **E** and **H** in (6.82).

As a result of analysis of the half-wave model of the photon (Fig. 6.7a) we obtain the wave equations (6.91) and (6.92) of the photon which enable the problem of the structure of the photon to be finally solved. Thus, in order to form the wave front of the photon with time and in space the wave process should be organised at least within the limits of the entire period. The half-wave model does not correspond to these conditions, showing the truncation of the leading and trailing fronts of the waves, as shown in Fig. 6.7a.

The wave front can be restored fully only in the wave model (Fig. 6.7b). For this purpose, three half-wave models are combined on the *X* axis and in the centre we obtain a wave model with the integral wave front, as shown in Fig. 6.3. In order to form the integral wave front, the latter should include the entire region inside the photon rotor along the entire wavelength λ. As already mentioned, this condition is satisfied by disc rotors with an ellipsoidal cross-section which in the case of the low-energy photons in the optical range is extended into a narrow band with the thickness of the order of 10^{-20} m (6.56).

Consequently, we can determine the sinusoidal distribution of the strength **E** and **H** of the field of the rotor in the cross-section of the photon when moving away from its centre 0 to the distance *x* when the transfer of the start of counting from the point *a* by 1/4λ of the cosine function (6.86) along the *X* axis to point 0 transforms the cosine to the sine

$$\begin{cases} \mathbf{E} = \mathbf{E}_a \sin\left(\dfrac{2\pi}{\lambda} r\right) \\ \mathbf{H} = -\mathbf{H}_a \sin\left(\dfrac{2\pi}{\lambda} r\right) \end{cases} \quad \mathbf{E} \perp \mathbf{H} \tag{6.94}$$

Equation (6.94) presents the total vectors **E** and **H** and not their transverse components $\mathbf{E}_y$ and $\mathbf{H}_y$ (6.86). This is associated with the fact that, as already mentioned, the transverse components $\mathbf{E}_y$ and $\mathbf{H}_y$ along the *X* axis are equivalent to the total vectors **E** and **H** of the photon rotor. Taking into account the spherical symmetry of the photon, the actual (without relativistic shortening) distribution of the strength of the field in the photon rotors is determined by the sinusoidal function (6.94) in the appropriate polarisation planes (in the planes of the photon rotors).

In classic electrodynamics it is accepted that the strength of a circular field, for example in the magnetic rotor of linear current, weakens when moving away from the centre of the rotor. For a photon, there is no strength in the centre of the rotor and the strength increases in accordance with the sinusoidal law (6.94), reaching the maximum value at $r = 1/4\lambda$ for the mean radius of the photon r_λ. With further movement away from the centre of the photon, the strength of the field in the rotor decreases to 0 at $r = 1/2\lambda$. Actually, in rotation of the polarisation planes the photon represents a spherical bunch of the energy of the electromagnetic field of polarisation of the quantised medium in the volume of the wave front at the wavelength λ. The photon energy is localised in the volume of the space restricted by the wavelength and the wave front.

Thus, analysing the electromagnetic field of the total wave model of the photon (Fig. 6.7b) it has been established that for a stationary observer the field of the photon is described by the equation (6.87) and the wave equations (6.91) and (6.92). The wave electromagnetic trace is shown graphically in Fig. 6.8. This trace is left by the wave front of the photon moving in space with the speed of light C_0 and the amplitude of the transverse components $\mathbf{E}_{ay}$ and $\mathbf{H}_{az}$. It may be seen that the observed relativistic electromagnetic trace of the photon in the quantised medium does not differ from the classic electromagnetic wave with the transverse oscillations of the vectors of the strength of the electrical and magnetic fields.

Analysis also shows that the half-wave model of the photon, selected for average calculations, was used in the final analysis for justifying the wave model of the photon. The averaged-out parameters of the half-wave model correspond to the actual parameters of the wave model of the photon. Actually, the distribution of the strength of the field according to the sinusoidal law (6.94) makes it possible to determine the actual parameters of the field **E** and **H** in the range from 0 to $1/2\lambda$. These parameters characterise the RMS values (effective values corresponding to the uniform fields)

$$\begin{cases} E = \sqrt{\dfrac{1}{\lambda/2}\displaystyle\int_0^{\lambda/2} E_a^2 \sin^2\left(\dfrac{2\pi}{\lambda}r\right)dr} = \dfrac{E_a}{\sqrt{2}} \\ H = \sqrt{\dfrac{1}{\lambda/2}\displaystyle\int_0^{\lambda/2} H_a^2 \sin^2\left(\dfrac{2\pi}{\lambda}r\right)dr} = \dfrac{H_a}{\sqrt{2}} \end{cases} \tag{6.95}$$

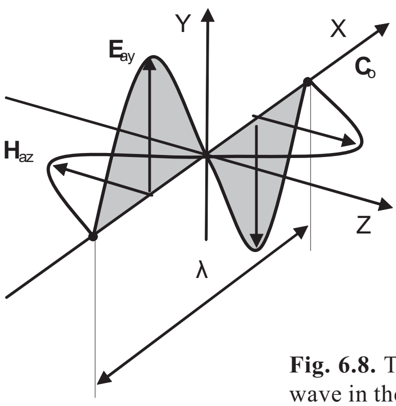

Fig. 6.8. The observed electromagnetic trace of the photon wave in the quantised medium.

Initially, the half-wave model was based on the conclusions (6.95) which treated this model as an averaged-out model, characterised by the RMS parameters of the photon. Averaging was based on the fully substantiated assumptions in which the nonuniform field of the photon rotor is replaced by a uniform field in the cross-section and is equivalent to the nonuniform field as regards efficiently. For transition to the averaged-out model, it is fully justified to use the condition (6.95) which take into account the sinusoidal distribution of the field in the cross-section of the photon rotor. This also relates to the determination of the effective cross-section of the rotor of the photon S_{ef} (6.34).

6.5. Total two-rotor structure of the photon

Now, when the main parameters of the photon are available, it is necessary to improve the accuracy of the configuration of the fields of the photon. This is very important when investigating the interaction of a photon with material media, including optical media. In particular, the interaction of photon fields with local fields of atomic structures on matter determines the slowing down of light C in the matter in comparison with the speed of light C_0 in vacuum (quantised medium). Until now, the reasons for these phenomena were unknown in quantum electrodynamics, like the reasons for the partial carrying away of the light by the moving medium, because analysis of the reasons for these phenomena cannot be carried out without participation of the quantised medium as the light-bearing medium [12].

To construct the total configuration of the electromagnetic field of the photon we use the method of the test quanton and investigate the possible orientation of the magnetic axes in the electrical rotor and orientation of the electrical axes of the quanton in the magnetic field of the photon. In this case, the rotor field of the photon in the polarisation plane should generate a radial field in the same plane. The mechanism of this phenomenon will be investigated later and, at the moment, the radial electrical field is denoted by rad**E**, the magnetic field as rad**H**. We also describe the operation in which the rotor rot**H** of the magnetic field of the photon induces the radial electrical field rad**E**, and the electrical rotor rotE induces the radial magnetic field rad**H**

$$\begin{cases} \mathrm{rad}\,\mathbf{H} = -\varepsilon_0 C_0 \,\mathrm{rot}\,\mathbf{E} \\ \mathrm{rad}\,\mathbf{E} = -\mu_0 C_0 \,\mathrm{rot}\,\mathbf{H} \end{cases} \tag{6.96}$$

In classic electrodynamics, rotor **E** is represented by the partial derivative of the strength **H** of the magnetic field with time, and rotor **H** is the partial derivatives of the strength **E** of the electrical field with time [1]. The theory of the photon as a particle having the complete symmetry between electricity and magnetism enables the possibilities of these functions can be expanded, replacing in rot**E** of the electrical parameters by excellent magnetic parameters, and in rot**H** the magnetic parameters by equivalent electrical parameters

$$\begin{cases} \mathrm{rot}\,\mathbf{E} = -\mu_0 \dfrac{\partial \mathbf{H}}{\partial t} = \dfrac{1}{C_0}\dfrac{\partial \mathbf{E}}{\partial t} \\[2ex] \mathrm{rot}\,\mathbf{H} = -\varepsilon_0 \dfrac{\partial \mathbf{E}}{\partial t} = \dfrac{1}{C_0}\dfrac{\partial \mathbf{H}}{\partial t} \end{cases} \tag{6.97}$$

Replacing rot**E** and rot**H** in (6.96) from (6.97) we obtain

$$\begin{cases} \mathrm{rad}\,\mathbf{H} = -\varepsilon_0 \dfrac{\partial \mathbf{E}}{\partial t} \\[2ex] \mathrm{rad}\,\mathbf{E} = -\mu_0 \dfrac{\partial \mathbf{H}}{\partial t} \end{cases} \tag{6.98}$$

Equation (6.98) indicates that the variation of the electrical field **E** with time inside the electrical rotor of the photon results in the interaction of the radial magnetic field **H** in the electrical rotors and, vice versa, the change of the magnetic field **H** with time inside the magnetic rotor results in the induction of the radial electrical field **E** in the magnetic field of the photon. The electrical and magnetic parameters of the radial and rotor fields are connected by the differential relationships (6.97), establishing the equivalence between the electricity and magnetism in the rotors of the photon:

$$\mathbf{H} = \varepsilon_0 C_0 \mathbf{E}, \quad \mathbf{H} \perp \mathbf{E} \tag{6.99}$$

Equation (6.99) is a solution of the system (6.98) which was previously described by the equivalence condition (6.96). The equation (6.19) can be used to determine the strength of the radial electrical and magnetic fields in the photon rotors on the basis of the strength of the fields circulating in the rotors of the appropriate vectors.

Figure 6.9 shows the mechanism of formation of radial fields $\mathbf{E}_{\text{rad}}$ and $\mathbf{H}_{\text{rad}}$ of the rotors of the photon which in contrast to the rotor fields are denoted by the index ($_{\text{rad}}$). The full image of the field is difficult to describe graphically in the three-dimensional image and, therefore, we only show its individual elements for the part of the rotor in the form of a closed string consisting of quantons. The quantons are denoted by their projections and orthogonal electrical and magnetic axes connecting into pairs in dipoles electrical and magnetic charges inside the quanton.

On the *Y* axis inside the electrical rotor **E** we specify the quanton 1 whose electrical axis in the limiting case is oriented, to simplify considerations, completely in the direction of the strength vector **E**. A second quanton 2, which belongs to the second rotor string consisting of quantons, is placed below quanton 1. The electrical axis of the quanton 2 is also oriented in the direction of circulation of the vector **E** of the photon rotor. Evidently, the magnetic charges of the quantons 1 and 2, capable of tapping, unfold??? the magnetic axes in the radial direction, forming a radial magnetic field with the strength $\mathbf{H}_{\text{rad}}$. Thus, the circular vector of the electrical field **E**, circulating in the rotor, generates in the same rotor the radial magnetic field $\mathbf{H}_{\text{rad}}$ in accordance with (6.99) which is slightly weaker in comparison with (6.99) because of its secondary induction nature. This weakening of the induced radial field $\mathbf{H}_{\text{rad}}$ is taken into account by the attenuation coefficient k_{at} which will be determined later:

$$\mathbf{H}_{rad} = k_{at}\varepsilon_0 C_0 \mathbf{E}, \quad \mathbf{H}_{rad} \perp \mathbf{E} \tag{6.100}$$

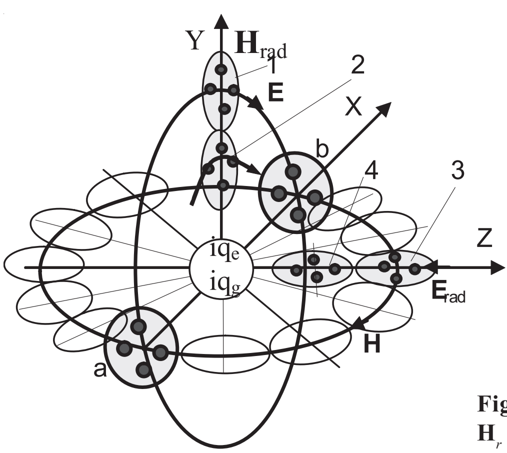

Fig. 6.9. Formation of radial fields $\mathbf{E}_r$ and $\mathbf{H}_r$ in the photon rotors.

The identical pattern may also be observed in the magnetic rotor **H** of the photon where the coupling of the magnetic charges in the quantons 3 and 4 induces in the plane of the rotor the radial electrical field $\mathbf{E}_{rad}$ in accordance with (6.19) and taking into account the attenuation coefficient k_{at}

$$\mathbf{E}_{rad} = k_{at}\,\mu_0 C_0 \mathbf{H}, \quad \mathbf{E}_{rad} \perp \mathbf{H} \tag{6.101}$$

The expressions (6.100) and (6.101) do not correspond to the previously presented equations (6.96)...(6.19) because of the presence of the attenuation coefficient k_{at}. The point is that the equations (6.96)...(6.99) describe the field in the disc of the photon rotor consisting of only a single layer of quantons; in this case, nothing interferes with interaction in the rotor. However, in reality, as shown previously, the photon rotor is a multilayer formation consisting of a large number of quantons. For example, for a photon with $\lambda = 630$ nm, the number of layers consisting of quantons in the disc of the rotor is of the order of 10^5 layers at the mean thickness h_λ of the disk of the rotor of the order of 10^{-20} m (6.56)

$$h_\lambda = \frac{2S_{ef}}{\lambda} = 3.4 \cdot 10^{-20}\,\text{m} \tag{6.102}$$

It was shown in [1] that the strength of the field in the quantised medium is an average parameter as a result of random deformation and orientation polarisation of a large number of quantons which together determine the disruption of the electrical and magnetic equilibrium of the quantised medium. Therefore, investigating the multilayer photon rotor, it may be assumed that the fields in every individual layer of the rotor satisfy the equations (6.96)...(6.99). However, if the density of the layers is high, the interaction between the layers results in a weakening of the radial field $\mathbf{E}_{rad}$ (6.102) and $\mathbf{H}_{rad}$ (6.100) which is taken into account by introducing the attenuation factor k_{at}. Because of the random nature of orientation of the quantons in the rotors, it is almost impossible to create conditions in which the charges in the quantons of the adjacent layers do not disrupt the required orientation of the quantons in every individual layer.

In any case, the flux Φ_τ of the electrical field of the electrical rotor of the photon, penetrating through the quantons in the tangential direction in the cross-section of the rotor, should be equivalent to the flux Φ_{rad} of the field in the radial direction and governed by the condition of equivalence between electricity and magnetism in the photon rotors

$$\Phi_\tau = \frac{1}{C_0}\Phi_{rad} \tag{6.103}$$

Taking into account the equivalence conditions (6.103), we can determine the value of the attenuation factor k_{at} in (6.100) and (6.101), taking into account the averaged-out parameters of the photon. For this purpose, it is necessary to determine the tangential Φ_τ and radial $\Phi_{\rm rad}$ fluxes of the fields inside the photon rotor on the level of the mean lines of force at the distance λ/4 from the photon centre. Consequently, the tangential flux in the electrical rotor of the photon is determined by the averaged value of the strength **E** and the effective cross-section $S_{ef} = 2.15\cdot10^{-26}$ m^2 (6.38)

$$\Phi_\tau = \int_S \varepsilon_0 \mathbf{E} dS = \varepsilon_0 \mathbf{E} S_{ef} \tag{6.104}$$

To determine the radial flux, equivalent to the flux (6.104), it is necessary to determine the area $S_{\rm rad}$ which the radial flux penetrates at a distance of λ/4 from the photon centre. Consequently, the area $S_{\rm rad}$ has the form of a narrow ring with the thickness h_λ (6.102) and with the length of circumference determined by the radius equal to λ/4

$$S_{rad} = \frac{1}{2}\pi h_\lambda \lambda = \pi S_{ef} \tag{6.105}$$

Taking into account (6.100) and (6.105), we determine the radial flux of the magnetic field in the electrical rotor of the photon

$$\Phi_{rad} = \int_S \mathbf{H}_{rad} dS = \mathbf{H}_{rad} S_{rad} = \mathbf{H}_{rad} \pi S_{ef} = \pi k_{at} \varepsilon_0 C_0 \mathbf{E} S_{ef} \tag{6.106}$$

Substituting (6.106) and (6.104) into the condition (6.103) we determine the attenuation factor k_{at}

$$k_{at} = \frac{1}{\pi} \tag{6.107}$$

Taking into account (6.107), we write the radial components $\mathbf{E}_{rad}$ (6.101) and $\mathbf{H}_{rad}$ (6.100) of the strength of the field in the photon rotors

$$\mathbf{E}_{rad} = \frac{\mu_0}{\pi} C_0 \mathbf{H}, \quad \mathbf{E}_{rad} \perp \mathbf{H} \tag{6.108}$$

$$\mathbf{H}_{rad} = \frac{\varepsilon_0}{\pi} C_0 \mathbf{E}, \quad \mathbf{H}_{rad} \perp \mathbf{E} \tag{6.109}$$

If we consider a set of quantons in the magnetic rotor, then in accordance with (6.108) their magnetic axes should be oriented in the direction of the rotor of the electrical axes in the direction of radius from the photon centre. Evidently, the radial electrical component $\mathbf{E}_{\rm rad}$ (6.108) of the magnetic photon can be taken into account by placing an imaginary electrical charge iq_e in the rotor centre. Identical considerations relate to the electrical rotor where the radial magnetic component $\mathbf{H}_{rad}$ (6.109) of the electrical rotor of the photon can be taken into account by placing an imaginary magnetic charge iq_g in the photon centre. The imaginary unity i indicates that the photon charges are imaginary and do not exist in reality.

The introduction of the imaginary charges iq_e and iq_g which change with time and the frequency of the photon field makes it possible to analyse the trajectory of the photon in the presence of external perturbing fields, for example, in optical media. The values of the imaginary charges iq_e and iq_g of the photon can be estimated by the strength of the fluxes of the field penetrating the cross-section S_{rad} (6.105) of the photon in the radial direction on the level of the mean line of the photon rotor taking into account (6.108) and (6.109)

$$\begin{cases} iq_e = \int_S \varepsilon_0 E_{rad} dS = \varepsilon_0 E_{rad} S_{rad} = \varepsilon_0 \frac{\mu_0}{\pi} C_0 H \pi S_{ef} = \frac{HS_{ef}}{C_0} \\ iq_g = \int_S H_{rad} dS = H_{rad} S_{rad} = \frac{\varepsilon_0}{\pi} C_0 E \pi S_{ef} = \frac{ES_{ef}}{\mu_0 C_0} \end{cases} \quad (6.110)$$

It should be mentioned that the values of the imaginary charges (6.110) correspond to the mean line of the photon rotors and are maximum for every wavelength of the photon. Taking into account the mean values of E (6.42) and H (6.43), we determine the maximum values of the imaginary charges iq_e and iq_g (6.110) of the photon through its constants (Table 6.1) for any wavelength λ:

$$\begin{cases} iq_e = \frac{HS_{ef}}{C_0} = \frac{2\varphi_g}{\pi C_0 \lambda} S_{ef} = \frac{2\varepsilon_0 \varphi_e S_{ef}}{\pi\lambda} \\ iq_g = \frac{ES_{ef}}{\mu_0 C_0} = \frac{2\varphi_e}{\pi \mu_0 C_0 \lambda} S_{ef} = \frac{2\varphi_g S_{ef}}{\pi\lambda} \end{cases} \quad (6.111)$$

From (6.111) we obtain a relationship between the imaginary charges iq_e and iq_g of the photon rotors

$$iq_g = C_0 iq_e \quad (6.112)$$

Expression (6.112) confirms the accuracy of calculations because it corresponds to the relationship between the magnetic g and electrical e charges: $g = C_0 e$ [1].

Equation (6.111) makes it possible to determine the imaginary charges iq_e and iq_g of the photon for any wavelength λ through electrical or magnetic constants. In particular, for λ = 630 nm we determine the values of the imaginary charges iq_e and iq_g through the constants in Table 1

$$\begin{cases} iq_e = \dfrac{2\varepsilon_0\varphi_e S_{ef}}{\pi\lambda} = 10^{-25}\,\text{C} \\ iq_g = \dfrac{2\varphi_g S_{ef}}{\pi\lambda} = 3\cdot 10^{-17}\,\text{Dc} \end{cases} \tag{6.113}$$

In the limiting case, in annihilation of the electron to radiation with the photon energy of 0.511 MeV, the wavelength of the gamma quantum, equal to the Compton wavelength of the electron, is $\lambda_0 = 3.86\cdot 10^{-13}$m (6.32). Consequently, it is possible to determine the limiting iq_{emax} and iq_{max} imaginary charges of the photon with the energy of 0.511 MeV, emitted by the electron at the moment of its annihilation

$$\begin{cases} iq_{e\max} = \dfrac{2\varepsilon_0\varphi_e S_{ef}}{\pi\lambda_0} = e = 1.6\cdot 10^{-19}\,\text{C} \\ iq_{g\max} = \dfrac{2\varphi_g S_{ef}}{\pi\lambda_0} = g = 4.8\cdot 10^{-11}\,\text{Dc} \end{cases} \tag{6.114}$$

As indicated by (6.114), the theory shows complete agreement for the imaginary charges of the photon at electron annihilation when the imaginary charges correspond in magnitude completely to the actual electrical charge $e = 1.6\cdot 10^{-19}$ C of the electron and its imaginary magnetic charge $g = 4.8\cdot 10^{-11}$ Dc [1]. In fact, equation (6.114) is also a verification equation and confirms that the parameters of the photon are linked directly with the parameters of the radiating electron.

When writing the equations (6.97)–(6.99) it was noted that they differ from the classic equations because they regard the photon as a relativistic particle when the electrical and magnetic rotors show flux linkage in the binding zones *a* and *b*. If in the region of the microworld of the elementary particles in Fig. 6.2 (dimensions 10^{-15} m) the rotors are still connected by the points *a* and *b*, then in transition to the region of the ultra microworld of the quantons (dimensions 10^{-25} m) the points *a* and *b* increase and transform to the zones *a* and *b*, including a large number of quantons. Naturally, the equations (6.108) and (6.109) determine the radial components of the field as components acting (effective) in any region of the photon rotor, with the exception of the zones *a* and *b*. For this reason, the application of the imaginary charges for estimating the radial fields of the photon rotors does not relate to the zones *a* and *b* in which the radial field is disrupted.

In a general case, for a photon with wavelength λ, the imaginary charges iq_e and iq_g can be written by means of the elementary electrical *e* and magnetic g charges taking (6.114) into account

$$\begin{cases} iq_e = e\dfrac{\lambda_0}{\lambda} \\ iq_g = g\dfrac{\lambda_0}{\lambda} \end{cases} \tag{6.115}$$

As indicated by (6.115), the imaginary charges iq_e and iq_g of the low-energy photon, emitted by an orbital electron, are given by the electrical e and imaginary magnetic g charges of the electron, and also by the ratio of the Compton wavelength of the electron λ_0 to the wavelength λ of the photon emitted by them. The imaginary charges iq_e and iq_g of the low-energy photon are always smaller in values than the elementary charges e and g. This is the case in which the imaginary charges iq_e and iq_g can have any fractional values of the integer elementary charges e and g.

The importance of the equations (6.111)...(6.115) is clear when it is necessary to estimate the force effect on the photon from the side of the external electrical, magnetic in electromagnetic fields. In this case, the complicated interaction of the rotor and radial fields of the photon with the external fields which can be calculated using the most complicated integral equations or numerical summation in computer processing, is replaced by a simpler interaction with the imaginary charges of the photon in accordance with the principle of superposition of the field. Naturally, this method greatly simplifies the calculation procedure and provides clear information on the physical processes.

The introduction of the imaginary photon charges is of special importance when evaluating the interaction of the photons with matter in the processes of reflection, refraction, penetration and scattering of the photons, regardless of the fact that these processes have been studied quite sufficiently. The slowing down of the photons in the optical media and their carrying away by the moving medium can be explained quite simply by the interaction of the photon fields with the fields of the structure of optical media. In this case, the replacement of the photon fields by the imaginary charges explains the wave trajectories of the photon in optical media when the path in the matter along the wave trajectory with the speed C_0 between the nuclei of the atoms of the structure of matter is treated as the path along a straight line with a lower phase speed C_p [2].

The movement of the photon in the optical media along the wave trajectory is determined by the harmonic (cosine or sine) nature of variation of the charges with time. In fact, the initial parameters in the evaluation of the charges (6.111) are the acting parameters of the rotors **E** and **H** which in transition to amplitude values change in accordance with the cosine law (6.82) with time. Correspondingly, in transition to the instantaneous parameters of the imaginary charges (6.115), it is necessary to transfer to their amplitudes, multiply by $\sqrt{2}$ and by adding the time function of the cosine

$$\begin{cases} iq_e = e\dfrac{\lambda_0\sqrt{2}}{\lambda}\cos\left(\dfrac{2\pi}{T}t\right) \\ iq_g = g\dfrac{\lambda_0\sqrt{2}}{\lambda}\cos\left(-\dfrac{2\pi}{T}t\right) \end{cases} \tag{6.116}$$

On the other hand, the imaginary charges iq_e and iq_g are characterised by a non-classic distribution in movement away from the photon centre. The distribution is also described by the cosine distribution (6.86) in relation to the distance r (Fig. 6.7). To describe the distribution of the photon charge in relation to the distance, the origin of the coordinates should be transferred from the point (a) in Fig. 6.7 to the centre 0, i.e., the origin of the coordinates should be moved by 1/4λ. In this case, the cosine function changes to the sine function, determining the distribution of the charge in movement away from the centre of the photon

$$\begin{cases} iq_e = iq_e\sin\left(\dfrac{2\pi}{\lambda}r\right) \\ iq_g = iq_g\sin\left(\dfrac{2\pi}{\lambda}r\right) \end{cases}, \quad r \le \frac{\lambda}{2} \tag{6.117}$$

Since the origin of the coordinates has been transferred by a quarter of the wavelength 1/4λ, and correspondingly, by 1/4T, the distribution of the imaginary charge with time (6.115) can also be described by the sine function. Consequently, combining (6.116) and (6.117), we write the generalise function of distribution of the imaginary charges iq_e and iq_g of the photon in time and space connected with the centre of the photon

$$\begin{cases} iq_e = e\dfrac{\lambda_0\sqrt{2}}{\lambda}\sin\left(\dfrac{2\pi}{T}t\right)\sin\left(\dfrac{2\pi}{\lambda}r\right) \\ iq_g = -g\dfrac{\lambda_0\sqrt{2}}{\lambda}\sin\left(\dfrac{2\pi}{T}t\right)\sin\left(\dfrac{2\pi}{\lambda}r\right) \end{cases}, \quad r \le \frac{\lambda}{2} \tag{6.118}$$

Evidently, in quantum electrodynamics, the distribution of the central charge in time is described by such a complicated function (6.118), firstly when the action of the charges is localised in the region $r \le \lambda/2$. Evidently, the imaginary charges of the photon are not point charges and have finite dimensions, restricted by the classic radius of the electron r_e.

The harmonic variation of the imaginary charges of the photon in time with the frequency of the electromagnetic field explains why it is not possible to deflect the trajectory of the photon in the static electrical and magnetic fields, although in reality in a static field this trajectory is described by a harmonic function with a very small deflection amplitude. However, these are already problems of the control of the photon trajectory which are outside the framework of these investigations, like the investigations of the organisation and synchronisation of wave packets from a large number of photons which determine coherent radiation.

Figure 6.10 shows the two-rotor full-wave structure of a low-energy photon emitted by an orbital electron when the photon diameter is equal to the wavelength of its electromagnetic field. Naturally, this structure of the photon combines the results of the previously mentioned investigations and satisfies the conditions of proportionality of photon energy to the frequency of the electromagnetic field.

The low-energy photon, emitted by the electron, has a two-rotor structure consisting of electrical and magnetic rotors. The radial cross-section of the low-energy rotors has the form of an ellipse elongated into a narrow strip because of the very small thickness h_λ (6.56) of the rotor in comparison with the wavelength. The electrical and magnetic fields of the rotors of the photon are situated in the orthogonal polarisation planes and have the common intersection line in the direction of the speed vector $\mathbf{C}_0$ on the X axis. This photon axis is referred to as the main axis. In addition, the polarisation planes of the photon can rotate around the main axis X with the cyclic frequency ω defining the photon as a spherical particle with the diameter equal to wavelength.

In the electrical rotor, the vector of the tangential strength $\mathbf{E}$ of the electrical field circulates around the circumference, changing with time and in space in accordance with the cosine law and functions (6.87) and

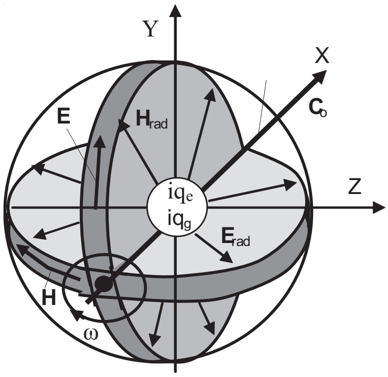

Fig. 6.10. The two-rotor structure of the low-energy photon emitted by the orbital electron.

(6.86). In addition, the tangential vector of the strength **E** of the electrical field induces the radial vector of the strength of the magnetic field $\mathbf{H}_{rad}$ (6.109) which is a function of vector **E**. The radial magnetic field $\mathbf{H}_{rad}$ can also be taken into account by introducing the imaginary magnetic charge iq_g (6.118) which is situated in the photon centre but its effect extends only to the electrical rotor. Naturally, the energy of the electrical rotor should be divided equally between its electrical and magnetic components. However, on the whole, this does not change the energy balance (6.78) of the photon because the energy in the magnetic rotor is also divided into halves between the magnetic and electrical components.

In the magnetic rotor, the vector of tangential strength **H** of the magnetic field circulates around the circumference changing with time and in space in accordance with the cosine law and functions (6.87) and (6.86). In addition to this, the tangential vector of strength **H** of the magnetic field induces the radial vector of the strength of the electrical field $\mathbf{E}_{rad}$ (6.108), which is a function of vector **H**. The radial electrical field $\mathbf{E}_{rad}$ can also be taken into account by introducing the imaginary electrical charge iq_e (6.118) which is situated in the photon centre but its effect extends only to the magnetic rotor.

In movement in the quantised medium, the photon with the structure shown in Fig. 6.10 leaves an electromagnetic trace which does not differ from the classic electromagnetic wave with transverse oscillations of the vectors of the strength of the electrical and magnetic fields (Fig. 6.8).

Thus, the investigations have made it possible to determine the structure of the low-energy photon (Fig. 6.8) and obtain its calculated parameters which satisfy the conditions of proportionality of the photon energy to the frequency of the electromagnetic field of the photon. This removes for the photon all the contradictions determined by the corpuscular–wave dualism, with the structure of the photon treated as a corpuscule in the form of a bunch of localised energy whose movement is determined by the wave transfer of energy of the electromagnetic polarisation of the quantised medium with the speed of light C_0.

6.6. Reasons for the deceleration of light in the optical medium

It is well known that all the optical matter media show the deceleration of the speed of light in comparison with vacuum, i.e., with the quantised medium. Current views on this problem contain only misunderstandings and alogisms where one claim of the absence of the light-bearing properties of the space does not correspond to experimental observations, although the propagation of light in space is detected literally all the time.

Nobody has shown that the light-bearing (luminiferous) medium is not required for the propagation of the electromagnetic wave because in these experiments it would be necessary to exclude the space-time from the experiments, i.e., get rid of the quantised medium. This is required by an experimental procedure in which exclusion of one of the factors has no effect nor influences the result. In this case, a disputable factor is the light-bearing medium, i.e., vacuum space. Here only the exclusion of the light-bearing medium from the experiment, as a disputable factor, can prove that the light-bearing medium is not required for light propagation. This is not realistic. It appears that the theoreticians do not have the experimental procedure and the experimentators do not have the astuteness of the mind of theoreticians.

In [2] it was shown that the imaginary deceleration of light in an optical medium is determined by the wave trajectory of movement of a photon with the speed of light C_0 inside the optical medium. The speed of light C_0 is determined by the parameters of the quantised medium as a light-bearing medium, and the speed of light C_0 is not connected to any extent with the optical medium which is an integral part of the quantised space-time. The optical medium causes perturbation of the straight movement of the photon and transverse vibrational deviations of the photon from the straight line movement. These transverse deviations are taken into account by the refractive index of the optical medium n_0:

$$n_0 = \frac{C_0}{C_{p0}} > 1 \tag{6.119}$$

where C_{p0} is the phase speed of the photon in the optical medium, m/s.

Phase speed C_{p0} determines the apparent speed of the photon in the optical medium along the straight line ℓ_x in the direction of, for example, the X axis during time t_0:

$$C_{p0} = \frac{\ell_x}{t_0} = \frac{C_0}{n_0} \tag{6.120}$$

In fact, as a result of movement of the photon in the optical medium along the perturbed wave trajectory during time t_0, the photon travels distance ℓ_0 in the quantised medium with the speed C_0

$$C_0 = \frac{\ell_0}{t_0} \tag{6.121}$$

Solving jointly (6.121) and (6.120), we determine the true length ℓ_0 of the path of the photon in the optical medium

$$\ell_0 = n_0 \ell_x \tag{6.122}$$

For example, for a pipe 1 m long with water with the refractive index n_0 = 1.33, the length of the path of the photon ℓ_0 (6.122) in the quantised medium inside the water is 1.33 m.

Equation (6.122) determines the linear dependence of the trajectory of the photon which in the first approximation should have the form of a broken periodic line determining the wave trajectory of the photon in the optical medium. However, this does not mean that the wave trajectory of the photon should in fact be represented by a broken line. It can already be assumed that the transverse deviations of the photon from the straight trajectory are extremely small. For this reason, the geometrical optics could not record transverse deviations of the photon inside the optical medium and should record only the external refractive index n_0 (6.119).

In order to continue investigations of the movement of the photon in optical media, it is necessary to verify another version of the possible deceleration of light, associated with gravitational deceleration in the vicinity of the atomic nucleus in accordance with (6.2). In the EQM theory, the speed of light C is a variable quantity and depends in a general case on the value of the gravitational potential C^2 of the quantised medium. In the conditions of non-relativistic speeds of movement of the optical medium at γ_n = 1 from (6.2) we obtain the deceleration of the speed of light C in comparison with C_0 in the vicinity of the mass m_0 of the atomic nucleus of the lattice of the optical medium at the distance r

$$C = C_0\sqrt{1-\frac{\varphi_n}{C_0^2}} = C_0\sqrt{1-\frac{Gm_0}{C_0^2 \cdot r}} \tag{6.123}$$

Equation (6.123) shows that in the absence of a gravitational perturbation, when the Newton potential is equal to 0, i.e., $\varphi_n = 0$, the speed of light is equal to the speed in the non-perturbed quantised medium, i.e., $C = C_0$. In the presence of a gravitational perturbation of the quantised medium, the speed of light decreases in accordance with (6.123). We introduce the coefficient of gravitational deceleration n_G of the speed of light in a gravitation-perturbed quantised medium, transforming (6.123)

$$n_G = \frac{C_0}{C} = \frac{1}{\sqrt{1-\frac{\varphi_n}{C_0^2}}} \tag{6.124}$$

From (6.124) we remove the Newton perturbing potential φ_n as a function of the coefficient of the gravitational deceleration of the speed of light n_G

$$\varphi_n = C_0^2 - C^2 = C_0^2\left(1 - \frac{C^2}{C_0^2}\right) = C_0^2\left(1 - \frac{1}{n_G^2}\right) \tag{6.125}$$

The equations (6.123)–(6.125) determine the relationship of the deceleration of light in the vicinity of the gravitational mass with the Newton perturbation potential φ_n. Consequently, it is possible to explain the decrease of the speed of light as a result of the gravitational perturbation of the quantised medium inside the optical medium in the vicinity of the atomic nuclei of the molecular lattice.

We examine an example in which the optical medium is represented by water (Fizo's experiment). Liquid water is regarded as some randomly oriented tetrahedral molecular network whose nodes contain oxygen atoms O, connected together by two hydrogen atoms H_2. Interatomic spacing O–H is ~0.1 nm, = 10^{-10}m. Further, we determine the gravitational perturbation potential φ_n in the middle $r \sim 0.5 \cdot 10^{-10}$ m between the atoms O–H through the masses of the oxygen nuclei $m_O \sim 2.7 \cdot 10^{-26}$ kg and hydrogen nuclei $m_H \sim 1.67 \cdot 10^{-27}$ kg

$$\varphi_n = G\frac{(m_O + m_H)}{r} \approx 0.4 \cdot 10^{-25}\,\mathrm{m}^2/\mathrm{s}^2 \tag{6.126}$$

If the perturbing gravitational potential φ_n (6.126) is substituted into (6.123) and (6.124), it may easily be shown that it cannot have any significant effect on the deceleration of light in water because its value is extremely small. Even if the calculations are carried out using the gravitational potential on the surface of the atomic nuclei, it is still is incommensurably smaller in order to observe a noticeable deceleration of light.

We can determine the value of the required gravitational potential whose effect on the quantised medium is equivalent to the deceleration of light by water. In this case, coefficient n_0 (6.119) should be compared with the coefficient n_G (6.124) of the deceleration of light by the gravitational field:

$$n_0 = n_G, \qquad \frac{C_0}{C_{p0}} = \frac{C_0}{C} \tag{6.127}$$

Equation (6.127) determines the condition of equivalence of the speed of light in the optical medium perturbed by a strong gravitational field

$$C_{p0} = C \tag{6.128}$$

To determine the gravitational potential having a strong effect on the light equivalent to the deceleration of light by water, in (6.125) n_G is substituted by the coefficient $n_0 = 1.33$ of the deceleration of light by water

$$\varphi_n = C_0^2\left(1-\frac{1}{n_0^2}\right) = 0.43\cdot C_0^2 = 3.9\cdot 10^{16}\,\mathrm{m}^2/\mathrm{s}^2 \qquad (6.129)$$

The value of the required gravitational potential (6.129) is comparable with the gravitational Newton potential C_0^2 on the surface of a black hole [2]. For the gravitational fields to have any effect on the deceleration of light equivalent to the effect of water, as shown by calculations, the gravitational Newton potential (6.129) must be close to the gravitational potential $9\cdot 10^{16}$ m^2/s^2 (or J/kg) of a black hole. This condition cannot be fulfilled in the case of optical media. Thus, the results of calculations reject completely the assumption on the reasons for gravitational deceleration of light in optical media.

Light can be regarded as an electromagnetic wave in the optical medium with the parameters for water $\varepsilon = 81$. In this case, the speed of light in water should correspond to the refractive index $\sqrt{\varepsilon} = 9$. This value differs greatly from the actual refractive index $n_0 = 1.33$ of light by water. This is so even if we accept the Lorentz hypothesis on the possible reemission of the photon by the optical medium which requires time and is a factor of reduction of the speed in the optical medium. Nevertheless, the difference in comparison with the experiments remains too large to be the reason for the deceleration of light.

Thus, a brief analysis of the possible reasons for the deceleration of light in optical media shows that the only possible reason is the periodic refraction of light inside the lattice of the optical medium which causes transverse deviations of the photon trajectory from the straight line, ensuring movement of the photon along a wave trajectory.

6.7. Probable capture of atomic centres of the lattice of the optical medium by a photon

Thus, the only working concept remains a concept of the movement of light in the optical medium along a wave trajectory which in the final analysis determines the refractive (deceleration) index n_0 (6.119). There are all the conditions for claiming this which result from the structure of the photon or, more accurately, its configuration of the electromagnetic field whose radial components can be represented on the basis of the equivalent effect by the imaginary charges iq_e and iq_g (6.115).

By their nature, the imaginary charges iq_e and iq_g (6.115) of the photon are variable charges in time (6.116) because they are formed by the variable field of the photon. In a general case, any optical medium (solid, liquid, gaseous) can be represented by a molecular network (cell), irrespective of the configuration of the cells, with the nodes of the cells containing atomic nuclei with the electrical charge of positive polarity. Consequently, the interaction of the variable imaginary charge of the photon with the electrical charge of positive polarity of the atomic nucleus generates variable forces, resulting in transverse oscillations of the trajectory of the photon. Taking into account that the radial electrical field of the photon and its imaginary charge are situated in the polarisation plane, the same plane will be characterised by transverse oscillations of the photon in relation to the straight line determining the wave trajectory of the movement of the photon in the optical medium. In this case, it is also necessary to take into account the rotation of the polarisation plane of the photon.

This complicated (both with respect to configuration and space and with variation with time) interaction of the fields of the moving photon with??? the speed of light inside a molecular network of the optical medium cannot as yet been determined directly. The replacement of the photon field by imaginary charges with equivalent effects greatly simplifies not only the calculations but also the physical understanding of the processes of interaction of the photon with a molecular network consisting of the atomic nuclei in the nodes.

As reported, the O–H atomic spacing for the tetrahedral molecular network of water is ~0.1 nm = 10^{-10} m. The diameter of the optical photon of, for example, a helium–neon laser is equal to its wavelength $\lambda = 0.63 \cdot 10^{-6}$ m (red light). It appears that the optical photon of red light is four orders of magnitude larger than the cell of the molecular network of water. However, it can be assumed that the calculation dimensions of the imaginary photon charges do not exceed the classic radius of the electron $r_e = 2.8 \cdot 10^{-15}$ m. This means that the calculation diameter of the imaginary charge of the photon is five orders of magnitude smaller than the cell of the molecular network of water.

If we use the classic approach to the movement of the photon in the optical medium, then the photon during its movement in water should capture by its volume a large number of atoms, forming the structure of water. We estimate the number N_a of the atoms which appear inside the volume V_v of the photon with the radius equal to the wavelength of, for example, red light with $\lambda = 0.63 \cdot 10^{-6}$ m, calculating the volume of the atom V_a occupied in the shell of the molecular network of the water of the medium through the mean atomic radius $r_a = 0.1$ nm

$$N_a \approx \frac{V_v}{V_a} = \frac{\frac{1}{6}\pi\lambda^3}{r_a^3} = 1.3 \cdot 10^{11}\,\frac{\text{atoms}}{\text{photon}} \tag{6.130}$$

Taking into account that the electrical charge of the atom nucleus is compensated by the charges of the orbital electrons, it would appear that the molecular network (lattice) of the optical medium should not have any significant effect on the imaginary charge and trajectory of the photon. In fact, such a large number of the atoms per photon of the order of 10^{11} (6.130) creates inside the photon a uniform concentration of the atoms throughout the volume of the photon, and the electrical field of the nuclei of these atoms is fully compensated by the orbital electrons and should have no effect on the imaginary electrical charge of the photon.

However, these considerations would be valid if the imaginary electrical charge of the photon had a spherical symmetry, i.e., its electrical field would operate in the volume of the sphere as, for example, the electrical charge of the electron with the spherical symmetry. However, the effect of the imaginary electrical charge of the optical photon is located in the volume V_r of a very narrow region of the photon rotor determining one of the polarisation planes. The volume V_r of the rotor of the optical photon, as shown previously, is incomparably smaller than the entire volume of the photon V_v, i.e., $V_r \ll V_v$. Therefore, the interaction of the photon with the molecular network (lattice) of the optical medium should not be determined by calculating the entire spherical volume of the photon V_v and it should be determined only by calculating the volume of its rotor V_r.

In order to solve the problem of interaction of the photon with the molecular network (lattice) of the optical medium, it is necessary to transfer to probability calculation methods. It is evident that from the entire variety of the atomic nuclei, the photon should interact on the wavelength only with a single atomic nucleus, synchronising the effect of transverse forces and oscillations with a period of the electromagnetic field at the wavelength. The interaction of the imaginary electrical charge of the photon iq_e with the charge q_n of the atomic nucleus in the periodic sequence ensures the wave trajectory of the photon in the optical medium only in this case. For this, the probability p_{n1} of capture of photons of the entire 1 atomic nucleus should be equal to 1 at the wavelength λ

$$p_{n1} = 1\frac{\text{nuclei}}{\lambda} \tag{6.131}$$

The condition (6.131) determines the non-classic probabilistic approach to the quantum phenomena in the optical media when the wave processes during movement of the photon relate not only to its electromagnetic field but also the trajectory of motion along a wavy line. This means that the trajectory of the photon itself has the form of a wave. This wave should be characterised as the wave of a geometrical type, describing the movement of the photon in the optical medium. Therefore, the condition (6.131) is referred to as the wave condition for the photon in the optical medium.

It is now necessary to verify the extent to which the parameters of the photon in movement of the optical medium satisfy the wave condition (6.131). Taking into account that atomic nuclei, like the atoms themselves, with their number N_a (6.130) inside the photon are uniformly distributed throughout its volume V_v, we can estimate the number n_n of the atomic nuclei of the molecular network (lattice) per volume of the rotor of the photon V_r

$$n_n = \rho_n V_r = N_a \frac{V_r}{V_v} \tag{6.132}$$

As indicated by (6.132), the distribution of the atomic nuclei inside the photon is proportional to the volume of its compound part. Volume V_r of the rotor of the optical photon is determined on the basis of the diameter of the photons equal to its wavelength λ and thickness $h_\lambda = 2S_{ef}/\lambda$ (6.56) of the photon rotor (Fig. 6.8)

$$V_r = \frac{1}{4}\pi\lambda^2 h_\lambda = \frac{1}{2}\pi\lambda S_{ef} \tag{6.133}$$

The volume of the rotor (6.133) is determined for the full-wave model of the photon. Substituting (6.132) into (6.131), and taking into account (6.130), we determine the number n_n (6.132) of the atomic nuclei inside the rotor specifically for the photon of red light with $\lambda = 630$ nm and the rotor thickness $h_\lambda = 3.4\cdot 10^{-20}$ m (6.56)

$$n_n = N_a \frac{V_r}{V_v} = N_a \frac{\frac{1}{4}\pi\lambda^2 h_\lambda}{\frac{1}{6}\pi\lambda^3} = \frac{3}{2} N_a \frac{h_\lambda}{\lambda} = 0.01 \frac{\text{nuclei}}{\text{photon}} \tag{6.134}$$

Comparing the huge number of the atoms $N_a \approx 1.3\cdot 10^{11}$ (6.130) in the volume of the photon energy and the incomplete number of the atomic nuclei $n_n = 0.01$ (6.134) included in the photon rotor, we face a paradoxic situation in which the structure of the photon, which has the unique properties of the rotors, is not capable of including even one atomic nucleus in the composition of the rotor. On the other hand, such fractional parameters as $n_n = 0.01$ (6.134), which is considerably smaller than 1, cannot determine the number of nuclei in the photon rotor and should be regarded as the probability p_n of the atomic nucleus of the molecular network of water entering the photon rotor at the wavelength λ

$$p_n = n_n = N_a \frac{V_r}{V_v} = 0.01 \frac{\text{nuclei}}{\lambda} \tag{6.135}$$

Using equation (6.135) we can estimate the length x_0 of the free path of the photon inside the optical medium to collision of the photon rotor with the atomic nucleus of the molecular network

$$x_0 = \frac{\lambda}{p_n} = 100\lambda \tag{6.136}$$

The free path of the red light photon in water is of the order of 100 λ. It turns out that the photon in interaction with the optical medium does not satisfy the wave condition $p_{n1} = 1$ (6.131). The additional conditions are necessary for the photon to be able capture one atomic nucleus at 1 λ wavelength of the free path in the optical medium.

This additional condition is the rotation of the photon in the optical medium or, more accurately, the rotation of its polarisation planes, i.e., rotors around the main axis X (Fig. 6.10). We can estimate the cyclic frequency ω of rotation (angular speed) of the photon and the angle α_ω through which it is necessary to rotate the polarisation planes of the photon to ensure that the photon at 1λ wavelength captures by its field one atom nucleus of the molecular network (lattice) of the optical medium. For this purpose, the probability parameter $n_n = 0.01$ in (6.135) must be increased to the probability $p_{n1} = 1$ (6.131) of the wave condition, determining the required volume V_ω of the photon so that in rotation around the X axis through the angle α_ω the photon rotor could capture one nucleus

$$p_{n1} = N_a \frac{V_\omega}{V_v} = 1 \frac{\text{nuclei}}{\lambda} \tag{6.137}$$

From (6.137) we determine the volume V_ω defined by the photon rotor in rotation of the photon around the main axis X for $p_{n1} = 1$ taking (6.130) into account

$$V_\omega = \frac{V_v}{N_a} = V_a = r_a^3 \tag{6.138}$$

The volume V_ω (6.138) forms as a result of rotation of the plane of the photon rotor through the angle α_ω

$$V_\omega = \frac{\pi\lambda^3}{6} \frac{\alpha_\omega}{2\pi} = r_a^3 \tag{6.139}$$

From (6.139) we determine the angle α_ω of rotation of the photon around the main axis X during the period T to ensure capture of one nucleus by the photon, and determine the specific value of the angle α_ω for r_a = 0.1 nm and the red light photon with λ = 630 nm

$$\alpha_\omega = \frac{12r_a^3}{\lambda^3 k_3} = 0.48 \cdot 10^{-10}\,\text{rad} \tag{6.140}$$

The rotation of the polarisation planes of the photon through the angle α_ω to ensure that the photon can capture one atomic nucleus of the network of the optical medium should take place during the period T at the wavelength λ. Consequently, we can determine the angular speed of rotation of the photon around the main axis X, for example, for λ = 630 nm

$$\omega = \frac{\alpha_\omega}{T} = \frac{\alpha_\omega}{\lambda} C_0 = 2.3 \cdot 10^4 \frac{\text{rad}}{\text{s}} = 3.66 \cdot 10^3 \text{s}^{-1} \tag{6.141}$$

For the red light photon with λ= 630 nm to capture only one atomic nucleus in a water optical medium, the photon should rotate with a frequency of 3660 rev/s (6.141).

Thus, the calculation show that the unique structure of the photon enables synchronous capture of a single atomic nucleus in rotation of the photon around the main axis in the direction of movement at the wavelength 1λ. This satisfies the wave equation (6.131) which determines the movement of the photon along the wave trajectory inside the optical medium.

For the photon to capture by its field an atomic nucleus at the wavelength 1λ, the photon should rotate in the optical medium with the angular speed ω (6.141). The reasons for the rotation of the polarisation planes of the photon have not as yet been examined. However, when discussing the capture of the atomic nucleus by the photon, this event should be regarded as reciprocal when the atomic nucleus also takes part in photon capture. This is expressed in the fact that the interaction of the nucleus and the photon is determined not only by the force of attraction and repulsion of the electrical charges of the nucleus and the imaginary electrical charge of the photon but also by the interaction of the electrical dipole moment of the photon rotor determined by the polarisation of the quantised medium inside the rotor by the radial electrical field.

The dipole electrical moment $\mathbf{P}_e$ of the photon rotor can be estimated by the polarisation of the quantised medium by the radial electrical field $\mathbf{E}_{rad}$:

$$\mathbf{P}_e = \int_V \varepsilon_0 \mathbf{E}_{rad} dV = 0 \tag{6.142}$$

If we integrate (6.142) over the entire volume of the photon rotor, then because of the symmetric nature of the radial vector of the strength $\mathbf{E}_{rad}$ directed to all sides in the rotor plane, the electrical dipole moment of the rotor is equal to 0. However, it will be equal to 0 if the integral (6.142) is taken from half of the photon rotor volume dissected by the X axis

$$\mathbf{P}_e = \int_{0.5V} \varepsilon_0 \mathbf{E}_{rad}\, dV \neq 0 \tag{6.143}$$

Figure 6.11 shows schematically the effect of the electrical field $\mathbf{E}_n$ of the charge of the atomic nucleus $+q_n$ on the imaginary electrical charge iq_e and the dipole moment $\mathbf{P}_e$ (6.143) on half the photon rotor. The photon is shown in projection on a plane which is normal to the X axis and the direction of movement. The dipole moment $\mathbf{P}_e$ of the rotor is situated in the plane $Z0X$ of the photon rotor, to the right and left of the X axis. In total, two dipole moments compensate each other (6.142). However, when the photon rotor starts to interact with the electrical charge of the atomic nucleus $+q_n$, its electrical field $\mathbf{E}_n$, penetrating the nearest half of the photon rotor, influences the dipole moment $\mathbf{P}_e$ and generates the mechanical moment $\mathbf{M}_e$, which additionally twists of the photon to the complete capture of the nucleus $+q_n$ by the rotor (Fig. 6.11). In this case, half of the photon rotor is regarded as an electrical dipole with the moment $\mathbf{P}_e$, which in the external electrical field $\mathbf{E}_n$ of the nucleus tries to rotate with its axis along the lines of force of the external field of the charge, determining the mechanical moment $\mathbf{M}_e$.

However, the electrical field $\mathbf{E}_n$ of the nucleus which has not as yet been trapped by the rotor cannot influence the imaginary electrical charge iq_e of the photon because the effect of the charge iq_e is situated only in the plane of the rotor. The second factor, ensuring additional rotation of the photon around the main axis, is the formation of the transverse Lorentz force in interaction of the magnetic rotor with the charge of the nucleus of the atom of the lattice. This factor requires additional analysis and is not investigated in this book.

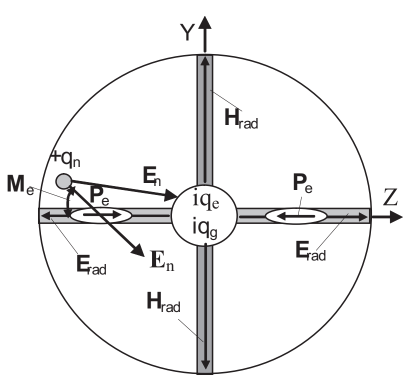

Fig. 6.11. The effect of the electrical field $\mathbf{E}_n$ of the charge of the atomic nucleus $+q_n$ on the imaginary electrical charge iq_e and the dipole momentum $\mathbf{P}_e$ of the photon rotor.

It is important to note that the capture by the photon rotor of the nearest atomic nucleus starts with the formation of the mechanical moment $\mathbf{M}_e$ which additionally twists the photon to the complete capture of the nucleus $+q_n$ by the photon rotor. This is followed by the start of interaction of the charges $+q_n$ and iq_e which in the first half period of the alternating fields of the photon result in attraction of the charges and subsequently during the second half period in the repulsion of the charges. Taking into account that the electromagnetic mass of the atomic nucleus is considerably greater than the electromagnetic mass of the photon, only the photon can be deflected in the transverse direction. Transverse deflections of the photon are of the alternating type and determine in the final analysis its wave trajectory in consecutive capture of the atomic nuclei of the optical medium by the photon.

Probability calculations showed that the rotor of the photon in twisting through the angle α_ω (6.140) can capture during a period only one atomic nucleus of the molecular network (lattice) in the optical medium. The process is then cyclically repeated and determines the capture of the next atomic nucleus. Consequently, the trajectory of the photon in the direction of the X axis shows additional wave transverse deflections.

We can calculate the moments and forces acting on the photon inside the optical medium on the side of the molecular network and obtain the wave equation of movement of the photon in every specific case. However, this problem is outside the given subject taking into account the large volume of computing operations. In addition, the reason for this phenomenon of wave movement of the photon, determined by the periodic capture by the photon of the atomic nucleus in the optical medium has been studied sufficiently in order to understand the gist of the problem and continue further investigations.

In fact, the process of twisting of the photon around the X axis can be not only of the rotational character, determining the angular speed ω (6.141) of rotation, but may also oscillate in relation to the X axis where the angular oscillations in transfer from nucleus to nucleus are characterised by the variation of the sign of the angle $\pm\alpha_\omega$ (6.140). In this case, the cyclic angular rotation of the polarisation plane of the photon is not observed.

In the previously described probability calculations of the capture of the atomic nucleus by the photon we did not consider the effect of orbital electrons. In contrast to the atomic nuclei which can be regarded as static sites of the molecular network, the orbital electrons rotate around the atomic nucleus along complicated trajectories, forming an electronic cloud. We examine the probability model of capture of an orbital electron by a photon.

Figure 6.12 shows the calculation scheme of the probability capture of the orbital electron of the atom by the radial electrical field of the photon $\mathbf{E}_{rad}$. The term capture is used allegorically in this case because in fact no capture takes place and only the possibility of interaction of orbital electrons with the radial electrical field of the photon is estimated. The electronic cloud of the atom is represented by a spherical formation with the atomic radius r_a and the number of electrons Z_e in the volume V_a of the atom. The centre of the atom contains a nucleus with the charge $+q_n$ which is compensated by charges of the orbital electrons

$$q_n = eZ_e \qquad (6.144)$$

The photon is shown in the projection of orthogonal rotors in the direction of movement along the X axis. The radial electrical field with the strength $\mathbf{E}_{rad}$ penetrates the atom through the centre and fully captures its nucleus. The effect of the imaginary electrical charge iq_e of the photon applies only in the plane of the photon rotor. The situation described evaluates the probability of capture of the atom nucleus by the photon rotor as equal to 1. Consequently, the interaction of the charges of the nucleus with the imaginary electrical charge of the photon is complete and determines the force of deflection of the photon in the direction towards the atom nucleus.

However, the interaction of the imaginary electrical charge of the photon with the charges of the orbital electrons is incomplete because the rotors of the photon penetrates only through a narrow region of the nucleus in which the probability density ρ_{e1} (or the density of probability [12]) of the electrons is evaluated by the partial derivative of the probability p_{e1} of the capture of the electron by the proton only in the part of the volume of the rotor of the photon V_e which penetrates through the atom without affecting the entire volume of the photon rotor

$$\rho_{e1} = \frac{\partial p_{e1}}{\partial V_e} \qquad (6.145)$$

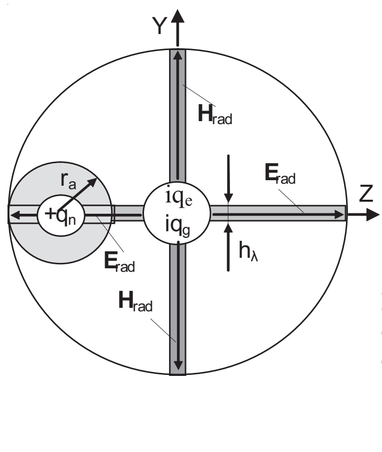

Fig. 6.12. Calculation of the probability of capture of the orbital electron by the radial $\mathbf{E}_{rad}$ electrical field of the photon.

The introduction into (6.145) of the partial derivatives with respect to the volume was intentional in order to distinguish the part of the volume of the photon rotor penetrating the electronic cloud. It is noteworthy that the probability density ρ_{el} (6.145) of the electrons in the volume V_e of the part of the rotor is numerically equal to their concentration g_n in the volume of the atom V_a, even when the particles of the volume are distributed nonuniformly, and their concentration is determined as a function of the coordinates (x, y, z)

$$\frac{\partial p_{e1}}{\partial V_e} = \rho_z(x, y, z) \tag{6.146}$$

The equation (6.146) can be solved if we know the distribution of the particles in the volume or the distribution of the probability density ρ_{e1} of the particles in the volume. If the instantaneous distribution of the electrons in the volume of the electronic cloud is not known, it can be assumed that the distribution of the electrons in every very narrow spherically symmetric (in relation to the centre of the atom) volume is uniform. Taking into account that the angular speed of rotation of the photon is very low (6.141) and the speed of the orbital electrons may reach relativistic speeds, the effect of rotation of the photon on the calculated probability of capture of the orbital electron can be ignored. If the rotor of the photon penetrates diametrically the electronic cloud or, more accurately, its layers with the uniform concentration of the electron, it can be assumed that the mean concentration of the electrons ρ_n in the volume of the rotor is represented by their averaged volume density

$$\rho_z = \frac{Z_e}{V_a} \tag{6.147}$$

Consequently, taking into account (6.147), equation (6.146) can be presented in the following form

$$\frac{\partial p_{e1}}{\partial V_e} = \frac{Z_e}{V_a} \tag{6.148}$$

We divide the variables in (6.148). Integration is carried out in the conditions of the partial derivative, disregarding the volume V_a, and we determine the probability ρ_{el} of capture of the orbital electron by the photon at the wavelength 1λ:

$$\int \partial p_{e1} = \frac{Z_e}{V_a} \int \partial V_e$$

$$p_{e1} = Z_e \frac{V_e}{V_a} \le 1 \tag{6.149}$$

Probability p_{e1} (6.149) of capture of a single orbital electron by a photon from the total number Z_e of the orbital electrons imposes restrictions on volume V_e

$$V_e \leq \frac{V_a}{Z_e} \tag{6.150}$$

We determine the probability p_{el} (6.149) of capture of a single orbital electron by a photon with the optical medium represented by water with, as mentioned previously, the tetrahedral molecular network O–H. The oxygen atom may have a stronger effect on the photon than the hydrogen atom because the former has a large electrical charge of the nucleus. Thus, the number of the orbital electrons for the oxygen atom is $Z_e = 8$, and the atomic radius $r_a = 0.1$ nm.

Since the electronic cloud is spherically symmetric, the problem is simplified and it can be assumed that the electrons are uniformly distributed in every very narrow spherical region of the electronic cloud. Consequently, the nonuniform distribution of the electrons, especially in the given case, can be regarded as a uniform distribution in the volume of the atom with the atomic radius r_a and we can determine the average concentration ρ_n (6.147) of the electrons in the oxygen atom (for $Z_e = 8$ and $r_a = 0.1$ nm)

$$\rho_z = \frac{Z_e}{V_a} = \frac{Z_e}{\frac{4}{3}\pi r_a^3} = 1.91 \cdot 10^{10} \frac{\text{electrons}}{\text{m}^3} \tag{6.151}$$

Using the equation (6.149) we can determine the probability p_{e1} of at least one orbital electron of the oxygen atom being in the region of the flat photon rotor at the wavelength 1λ, for example for a red light photon with $\lambda = 630$ nm and the thickness of the rotor $h_\lambda = 3.4 \cdot 10^{-20}$ m (6.56)

$$p_{e1} = Z_e \frac{V_e}{V_a} = Z_e \frac{\pi r_a^2 h_\lambda}{\frac{4}{3}\pi r_a^3} = Z_e \frac{3h_\lambda}{4r_a} = Z_e \frac{3S_{ef}}{2r_a\lambda} = 2 \cdot 10^{-9}$$

$$p_{e1} = Z_e \frac{V_e}{V_a} = \rho_z V_e = \rho_z \pi r_a^2 h_\lambda = 2 \cdot 10^{-9} \frac{\text{electrons}}{\lambda} \tag{6.152}$$

Thus, the probability p_{v1} of capture of an orbital electron at wavelength 1λ by the radial $\mathbf{E}_{rad}$ electrical field of the photon (or the imaginary electrical charge) is estimated by a very low value of the order of 10^{-9} (6.152) (Fig. 6.4), regardless of the very high concentration ρ_n (6.147) of the electrons in the electronic cloud. Consequently, we can ignore the effect of orbital electrons on the trajectory of movement of the photon in the optical medium and this means that in interaction of the photon with the molecular network (lattice) of the optical medium it is necessary to take into account only interaction of the atomic nuclei with positive polarity, distributed in the nodes of the network (lattice), with the electrical charges q_n.

Attention should be given to the fact that the function of probability density of the electrons p_{e1} (6.146) in the orbital cloud of the atom is directly linked with the wave function of the electron through the probability amplitude $\psi|(x, y, z, t)|^2$ [34]

$$\frac{\partial p_{e1}}{\partial V_e} = \left|\Psi(x, y, z, t)\right|^2 \tag{6.153}$$

Consequently, integration of (6.153) over the entire volume of the atom V_a determines the normalisation conditions for a single orbital electron

$$p_{e1} = \frac{1}{Z_e} \int_V \left|\Psi(x, y, z, t)\right|^2 dV = 1 \tag{6.154}$$

In fact, when solving the probability problem of interaction of the photon with orbital electrons, it was not necessary to use the wave function of the electron. The photon itself is described by the classic wave equation (6.92) which completely satisfies the Maxwell conditions and the two-rotor structure of the photon. In particular, the wave equation of the photon determines the nature of its electromagnetic field which varies with time, including the radial electrical component. The specific features of interaction of this component with the electrical charges of the atomic nuclei in the optical medium create additional transverse wave oscillations of the photon during its movement in the direction of the X axis.

Analysing the current state of the theory of the photon in quantum electrodynamics [7], it is important to note the restrictions in the phenomenological model and the absence of any relationship with the structure of the photon because the two-rotor relativistic model of the photon was not available. This complicates physical interpretation of the phenomenological theory which is not capable of solving the previously described tasks; this can be carried out in a simple manner in the theory of Superunification. The completness of the quantum theory is essential only under the conditions of the effect of superstrong electromagnetic interaction (SEI) on the physical processes. In the present case, this interaction is determined by the presence of the quantised medium, i.e., the light-bearing medium.

The previously mentioned probability calculations enable us to evaluate the state of the photon in the optical medium:

1. The photon has unique properties of a self-setting system in movement in the optical medium. Self-setting of the photon is expressed in the fact that the photon captures only one atomic nucleus of the molecular network (lattice) of the optical medium at the wavelength 1λ, satisfying the wave condition $p_{n1} = 1$ (6.131), which determines the movement of the photon along a wavy trajectory.
2. The probability p_{e1}~10^{-9} (6.152) of capture of the orbital electron of the atom of the optical medium by the photon is expressed by a very small value. Consequently, we can ignore the effect of orbital electrons on the trajectory of movement of the photon in the optical medium. It is necessary to take into account only the interaction of the photon with the atomic nuclei.

The conclusions obtained for the results of probability calculations describe quite accurately the state of the photon in the optical medium and clarify the reasons for its wavy movement with longitudinal oscillations in relation to the direction of movement along a straight line. It would appear that the optical medium is crammed with the atomic nuclei and orbital electrons has the form of a high density network (lattice) and the photon cannot penetrate through this network without colliding with the orbital electron or atomic nucleus.

However, the probability calculations show that because of the specific features of the electromagnetic field of the photon rotors or, more accurately, the radial electrical field situated in a very narrow plane of the rotor, the probability p_{e1}~10^{-1} (6.140) of capture of the orbital electron by the photon almost completely excludes such a capture. If the photon satisfies the wave condition $p_{n1} = 1$ (6.131), the photon can capture one atomic nucleus at wavelength 1λ.

When discussing the peculiarities of the quantum theory which, it appears, is not governed by classic analysis, it is necessary to ask the question: do we know thoroughly the structure of the photon and elementary particles? The structure of the photon was not known prior to the development of the EQM theory and Superunification theory and attempts to explain the non-classic behaviour of the photon proved to be incorrect. Everything has its reason. It is necessary to find it.

In this respect, the photon behaves fully predictably because of the unique parameters of the two-rotor structure and the presence of radial fields in the rotors. Consequently, the photon can select the particles with which it should interact and with which it should not interact. However, this does not mean that the photon has a brain and selectively interacts inside the optical medium only with the essential particles, as a self-setting system.

In fact, this is the role of the specific features of the two-rotor electromagnetic field of the photon which is characterised by selective properties with respect to the nuclei of the atoms and orbital electrons.

6.8. Vector diagram of the complex speed of the photon in the optical medium

Taking into account the results, for further investigations of the complicated trajectory of the photon in the optical medium we express the refractive index n_0 (6.122) of the light as the ratio of the length of the trajectory of the photon along the straight line ℓ_x to the length of the wave trajectory ℓ_0, which characterises the deceleration of light inside the optical medium

$$n_0 = \frac{\ell_0}{\ell_x} = \frac{C_0}{C_{p0}} \tag{6.155}$$

Figure 6.13 shows the vector diagram of the absolute speed C_0 of the light and its phase speed C_{p0} in accordance with (6.155) for a stationary optical medium. The absolute speed of the photon C_0 in the optical medium is the vector sum of the phase speed C_{p0}, with the longitudinal component along the X axis and the transverse component C_{z0} along the Z axis

$$\mathrm{C}_0 = \mathrm{C}_{p0} + \mathrm{C}_{z0} \tag{6.156}$$

The modulus of absolute speed C_0 (6.156)

$$C_0 = \sqrt{C_{p0}^2 + C_{z0}^2} \tag{6.157}$$

The tangent of the angle β_0 and the angle β_0 taking (6.157) and (6.155) into account

$$\operatorname{tg}\beta_0 = \frac{C_{z0}}{C_{p0}} = \frac{\sqrt{C_0^2 - C_{p0}^2}}{C_{p0}} = \sqrt{\frac{C_0^2}{C_{p0}^2} - 1} = \sqrt{n_0^2 - 1} \tag{6.158}$$

$$\beta_0 = \operatorname{arctg}\sqrt{n_0^2 - 1} \tag{6.159}$$

From (6.158) we determine the transverse speed of the photon C_{z0}

$$C_{z0} = C_{p0}\sqrt{n_0^2 - 1} = C_0\frac{\sqrt{n_0^2 - 1}}{n_0} = C_0\sqrt{1 - \frac{1}{n_0^2}} \tag{6.160}$$

The modulus of the vector of absolute speed C_0 is a constant in the local region of space because it is determined by the parameters of the quantised medium as the light-bearing medium inside the optical medium

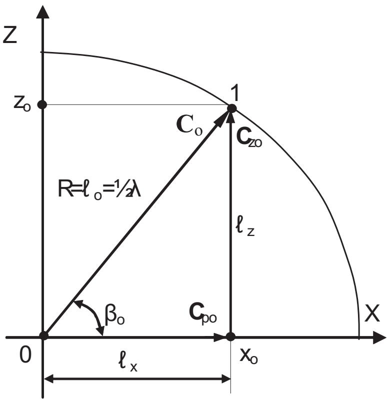

Fig. 6.13. Vector diagram of the absolute speed of light C_0 and its phase speed C_p in the optical medium.

$$C_0 = \text{const} \tag{6.161}$$

The vector diagram of speeds in Fig. 6.13 can be imaged on a complex plane, representing the longitudinal phase speed C_{p0} as the actual component and the speed C_{z0} as the apparent transverse component of the complex speed υ whose modulus C_0 is (6.157), where i is the imaginary unity

$$\upsilon = C_0 \cos\beta_0 + iC_0 \sin\beta_0 = C_0 \exp(i\beta_0) \tag{6.162}$$

Thus, analysis of the refractive index n_0 (6.155) shows that the phase speed C_{p0}, as the longitudinal component of the absolute speed of light C_0, is determined by the difference of the vectors: the absolute vector of speed C_0 and the transverse vector of speed C_{z0}

$$\mathrm{C}_{p0} = \mathrm{C}_0 - \mathrm{C}_{z0} \tag{6.163}$$

In particular, the presence of the transverse component C_{z0} determines the movement of the photon in the optical medium along a wavy trajectory. However, this is not yet indicated by the vector diagram in Fig. 6.14 which determines the linear–broken trajectory of the photon in the form of a triangular periodic function. This function links the linear parameters of the absolute path length ℓ_0 of the photon in the quantised medium with its longitudinal ℓ_x and transverse ℓ_z components

$$\ell_0^2 = \ell_x^2 + \ell_z^2 \tag{6.164}$$

$$\ell_0 = \sqrt{\ell_x^2 + \ell_z^2} \tag{6.165}$$

Using the path components ℓ_x and ℓ_z, we determine the tangent of the angle β_0

$$\operatorname{tg}\beta_0 = \frac{\ell_z}{\ell_x} = \sqrt{n_0^2 - 1} \tag{6.166}$$

From (6.166) we determine the transverse ℓ_z component of the photon path

$$\ell_z = \ell_x \sqrt{n_0^2 - 1} = \ell_0 \sqrt{1 - \frac{1}{n_0^2}} \tag{6.167}$$

Figure 6.14 shows the idealised linear–broken trajectory of the photon in the optical medium in the form of a periodic triangular function. The photon is represented by a circle in projection with the diameter equal to the wavelength λ. The centre of the photon contains the imaginary variable electrical charge iq_e.

The linear–broken trajectory of the photon is determined by the condition of periodic capture of the positively charged atomic nucleus with the charge $+q_n$ of the molecular network (lattice) of the optical medium. The photon starts capture of the atomic nucleus by the imaginary charge iq_e when it is situated at the distance $1/2\lambda$ from the charge $+q_{n1}$ of the nucleus. After $1/2\lambda$ when the imaginary charge iq_e comes closer to the charge $+q_{n1}$ of the nucleus, the current variable charge iq_e changes polarity and the photon starts to be repulsed from the charge of the nucleus $+q_{n1}$. After the next $1/2\lambda$, the imaginary charge iq_e again changes polarity and starts capture of the next atomic nucleus 2 with the charge $+q_{n2}$, repeating the linear–broken trajectory at the period T.

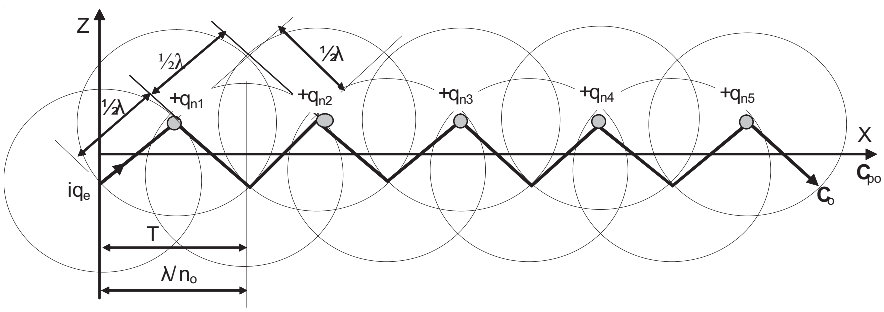

Fig. 6.14. The idealised linear–broken trajectory of the photon in the form of the triangular function in the optical medium in the conditions of periodic capture of the positively charged atomic nucleus of the molecular network.

The process is then periodically repeated and the photon at every wavelength λ gradually captures nuclei with the charges $+q_{n3}$, $+q_{n4}$, $+q_{n5}$, and so on. In the direction of the X axis and in the period T the photon travels the distance λ/n_0 which is shorter than the distance λ in movement along the linear–broken trajectory. However, the movement of the photon along the linear–

broken trajectory in the optical medium in the form of a periodic triangular function does not reflect the actual trajectory of the photon, although it makes it possible derive a number of important relationships between the parameters of the photon trajectory.

Figure 6.14 shows the section for the period T of the linear–broken trajectory of the photon in the form of a triangular function in the optical medium. Analysis of the section makes it possible to determine the main parameters of the triangular function when the linear parameters of the path ℓ_0, ℓ_x, ℓ_z are connected with the wavelength λ and the speed of the photon C_0 (C_{p0} and C_{z0}) through the period T

$$\ell_0 = \frac{1}{2}\lambda = \frac{1}{2}C_0 T \tag{6.168}$$

$$\ell_x = \frac{\ell_0}{n_0} = \frac{1}{2}\frac{\lambda}{n_0} = \frac{1}{2}C_{p0}T = \frac{1}{2}\frac{C_0 T}{n_0} \tag{6.169}$$

$$\ell_z = \ell_0\sqrt{1-\frac{1}{n_0^2}} = \frac{\lambda}{2}\sqrt{1-\frac{1}{n_0^2}} = \frac{C_0 T}{2}\sqrt{1-\frac{1}{n_0^2}} \tag{6.170}$$

From (6.170) we determine the amplitude ℓ_a of the triangular periodic function with ($\ell_a = 0.5\ell_z$)

$$\ell_a = \frac{1}{2}\ell_z = \frac{\ell_0}{2}\sqrt{1-\frac{1}{n_0^2}} = \frac{\lambda}{4}\sqrt{1-\frac{1}{n_0^2}} = \frac{C_0 T}{4}\sqrt{1-\frac{1}{n_0^2}} \tag{6.171}$$

Thus, if we start with the vector diagram (Fig. 6.13) of the photon, then its movement in the optical medium should be determined by the linear–broken triangular trajectory (Fig. 6.14 and 6.15). It would appear that this behaviour of the photon is fully understandable because it does not have any gravitational mass. On the other hand, the movement of the photon in the optical medium is a wave periodic process which should be harmonised to some extent, taking into account that this possibility is offered by the form of writing the complex speed (6.162) of the photon in the optical medium.

6.9. Wave trajectory of the photon in the optical medium

The photon is a unique particle with no gravitational mass. This complicates search for the equation of dynamics of the photon in the classic form in which the acceleration of the particle is determined by the force of the effect and mass of the particle. It would appear that the absence of mass in the photon would enable us to regard the photon as an inertialess particle.

In this case, moving along the linear-broken triangular trajectory (Fig. 6.14), the photon in the areas of breaks in the trajectory should be subjected to colossal acceleration with a sharp change of the direction of movement. However, this contradicts the constancy of the speed C_0 (6.161) of the photon in the quantised medium which can be fulfilled only if the trajectory of the photon has smoother transitions in contrast to the broken curve.

In fact, the speed of the photon C_0 is determined by the first derivative along the path ℓ_0 with respect to time t and is a constant quantity (6.161)

$$\frac{d\ell_0}{dt} = C_0 = \text{const} \tag{6.172}$$

We determine the acceleration of the photon as the second derivative along the path and the first derivative with respect to speed

$$\frac{d^2\ell_0}{dt^2} = \frac{dC_0}{dt} = 0 \tag{6.173}$$

The condition (6.172) of the constancy of the photon speed determines the new condition (6.173) according to which the photon cannot be accelerated. This means that the photon should move along a straight line. This is accurate from the viewpoint of classic mechanics, but the photon does not have a mass and is a relativistic wave particle travelling at the speed of light C_0 in the quantised medium. Consequently, it can be assumed that the classic equations (6.172) and (6.173) hold only for the modulus of the photon speed C_0. Taking into account that the photon speed C_0 is a vector whose direction

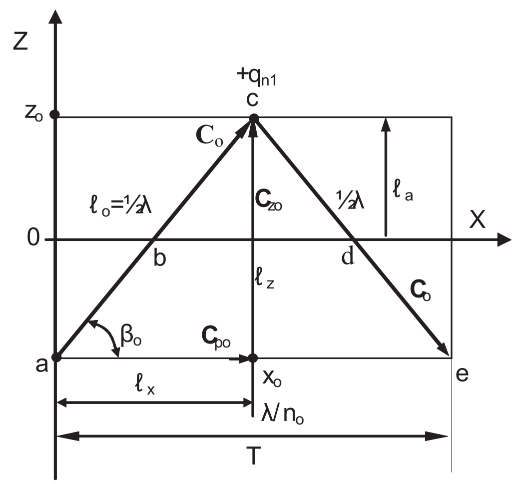

Fig. 6.15. Section of the period T of the linear–broken trajectory of the photon in the form of the triangular function in the optical medium.

can change, ensuring the constancy of the modulus of the speed of light C_0 (6.172), the equation of trajectory of movement of the photon in the optical medium can become a wave equation.

For the photon to move by wavy motion in the optical medium it is necessary to select the periodic function which would satisfy the condition of periodicity of the triangular function (Fig. 6.14) and the condition of constancy of the modulus of the speed of light C_0 (6.172). Therefore, it is rational to present the triangular periodic function $f(x)$ in the form of a Fourier series, with the expansion formula of the series known in electrodynamics [13]

$$f(x) = -\frac{8}{\pi^2}\ell_a\left[\cos\left(2\pi n_0\frac{x}{\lambda}\right) - \frac{1}{9}\left(3\cdot 2\pi n_0\frac{x}{\lambda}\right) + \frac{1}{25}\left(5\cdot 2\pi n_0\frac{x}{\lambda}\right) - \ldots\right] \quad (6.174)$$

Function $f(x)$ (6.173) is connected with the initial conditions in Fig. 6.14. Since the triangular periodic function $f(x)$ (6.174) is symmetric in relation to the X axis, it is represented by even harmonics. Naturally, in this case it is interesting to consider the first harmonics $f_1(x)$ whose wavelength and, appropriately, the frequency coincides with the wavelength λ and frequency of the electromagnetic field of the photon

$$f_1(x) = -\frac{8}{\pi^2}\ell_a\cos\left(2\pi n_0\frac{x}{\lambda}\right) \quad (6.175)$$

Into (6.175) we substitute the value of the amplitude ℓ_a (6.171)

$$f_1(x) = -\frac{2}{\pi^2}\lambda\sqrt{1-\frac{1}{n_0^2}}\cos\left(2\pi n_0\frac{x}{\lambda}\right) \quad (6.176)$$

Function $f_1(x)$ (6.176) can describe the wave trajectory of the photon on the condition that the path of the photon along the arc of the wave trajectory is equal to the path along a straight line ℓ_0 (Fig. 6.15). In this case, the parameters of the wave trajectory determine the equivalent refraction index n_0 (6.155) of the optical medium, as in the case of movement of the photon along a triangular trajectory. For this purpose, we determine the length of the arc $\ell_{1\lambda}$ of the cosine function $f_1(x)$ (6.176) by the well-known integral in the range from 0 to 1/2 λ/n_0

$$\ell_{1\lambda} = \int_0^{\lambda/2n_o}\sqrt{1+\left(\frac{df_1(x)}{dx}\right)^2}\,dx \quad (6.177)$$

Integral (6.177) includes the first derivative $f_1'(x)$ from $f_1(x)$ (6.176)

$$f_1'(x) = \frac{df_1(x)}{dx} = \frac{4}{\pi}\sqrt{n_0^2 - 1} \cdot \sin\left(2\pi n_0 \frac{x}{\lambda}\right) \tag{6.178}$$

If we substitute (6.178) into (6.177), the given integral still has no analytical solution. Therefore, it is rational to carry out numerical integration, dividing the arc of the cosine function $f_1(x)$ (6.176) into sections which can be replaced by straight lines. The summation of these lines gives the approximate value of the required length of the arc $\ell_{1\lambda}$.

For numerical solution of the integral (6.177) it is necessary to define specific conditions, continuing analysis of the behaviour of the photon, for example, of a red light with $\lambda = 630$ nm during its movement in a water medium with the refractive index $n_0 = 1.33$. Substituting these parameters into (6.171) we determine the amplitude ℓ_a of the triangular periodic function

$$\ell_a = \frac{\lambda}{4}\sqrt{1 - \frac{1}{n_0^2}} = 1.04 \cdot 10^{-5}\,\text{m} \tag{6.179}$$

The required length $\ell_{1\lambda}$ (6.177) of the first harmonics should be compared with the length ℓ_0 (6.168) of the side of the triangle of the triangular function, if the photon moves along the linear–broken trajectory in the optical medium

$$\ell_0 = \frac{1}{2}\lambda = 3.15 \cdot 10^{-5}\,\text{m} \tag{6.180}$$

Further, we determine the amplitude ℓ_{a1} of the first harmonics from (6.176)

$$\ell_{a1} = \frac{2}{\pi^2}\lambda\sqrt{1 - \frac{1}{n_0^2}} = 0.843 \cdot 10^{-5}\,\text{m} \tag{6.181}$$

The ratio of the amplitudes ℓ_{a1} (6.181) and ℓ_a (6.179) is equal to $8/\pi^2$

$$\frac{\ell_{a1}}{\ell_a} = \frac{8}{\pi^2} = 0.81 \tag{6.182}$$

Substituting the numerical value of the amplitude ℓ_{a1} (6.181) into (6.176), we consider the first harmonics in the range $x = 1/2\lambda/n_0$ (6.177)

$$f_1(x) = -\ell_{a1}\cos\left(2\pi n_0 \frac{x}{\lambda}\right) = -0.843 \cdot 10^{-5}\cos\left(2\pi n_0 \frac{x}{\lambda}\right) \tag{6.183}$$

$$x = 0 \ldots \frac{\lambda}{2n_0} \approx 0 \ldots 2.4 \cdot 10^{-5}\,\text{m} \tag{6.184}$$

The interval along the axis X (6.184) is divided into 20 equal intervals Δx

$$\Delta x = \frac{\lambda}{40 n_0} \approx 0.12 \cdot 10^{-5}\,\text{m} \tag{6.185}$$

Table 6.3 gives the results of calculations of the values of the first harmonics $f_1(x)$ (6.183) on the Z axis with the intervals Δx (6.185).

Figure 6.16 shows the curve 1 (a_1–b–c_1) of the trajectory of the first harmonics $f_1(x)$ (6.183) of a red light photon with λ= 630 nm in movement in water with n_0 = 1.33. Curve 2 determines the possible trajectory of the photon in the section of the straight line (a–b–c) for the triangular periodic function (Fig. 6.14 and 6.15).

It is convenient to calculate the half $1/2\ell_{1\lambda}$ of the required arc length $\ell_{1\lambda}$ (6.177) of the curve 1 of the first harmonics $f_1(x)$ as the sum of its ten individual sections $\boldsymbol{\Delta}\ell_{1\lambda}$ in equal 10 intervals $\boldsymbol{\Delta}x$ (6.185) for the intervals from 11 to 20 in the range 1, 2... 2, $4\cdot10^{-5}$m (or 90... 180°)

$$\tfrac{1}{2}\ell_{1\lambda} = \sum_{11}^{20}\Delta\ell_{1\lambda} = \sum_{11}^{20}\frac{\Delta x}{\cos\beta} \tag{6.186}$$

The angle β in (6.186) is the angle of inclination of the tangent to the curve 1 of the function $f_1(x)$ to the X axis (6.183). Angle β is determined from the first derivative $f_1'(x)$ (6.178) which determines the tangent of angle β at every point of the interval on the curve 1

$$\operatorname{tg}\beta = f_1'(x) = \frac{4}{\pi}\sqrt{n_0^2-1}\cdot\sin\left(2\pi n_0\frac{x}{\lambda}\right) = 1.12\sin\left(2\pi n_0\frac{x}{\lambda}\right) \tag{6.187}$$

Table 6.4 gives the results of calculations of angle β and individual sections $\boldsymbol{\Delta}\ell_{1\lambda}$ of the curve 1 of the function $f_1(x)$ (6.183) in accordance with (6.186) in the range 1, 2... 2, $4\cdot10^{-5}$m (90...180°) for the intervals from 11 to 20.

The results of the calculations are used to determine the sum $1/2\ell_{1\lambda}$ (6.186) of the individual sections $\Delta\ell_{1\lambda}$ from the lower line of Table 6.4

$$\tfrac{1}{2}\ell_{1\lambda} = \sum_{11}^{20}\Delta\ell_{1\lambda} = 1.547\cdot10^{-5}\,\text{m} \tag{6.188}$$

From (6.188) we determine the required length of the arc $\ell_{1\lambda}$ (6.177)

Table 6.3. Values of the first harmonics $f_1(x)$ (6.183)

Interval	1	2	3	4	5	6	7	8	9	10
x, 10^{-5}	0	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08
Degree	0	9	18	27	36	45	54	63	72	81
$f_1(x)$, 10^{-5} m	–0.84	–0.83	–0.80	–0.75	–0.68	–0.59	–0.49	–0.38	–0.26	-0.13

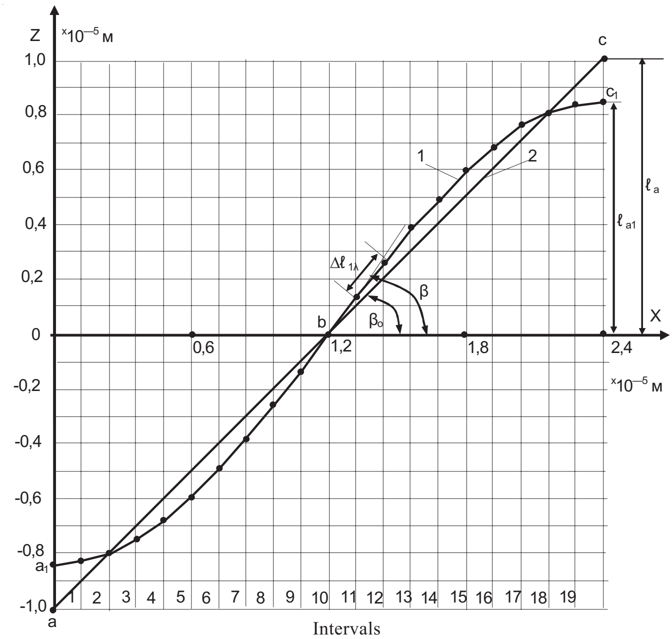

Fig. 6.16. Curve 1 of the trajectory of the first harmonics of the red light photon with λ = 630 nm in movement in water with n_0 = 1.33.

Table 6.4. Results of calculations of angle β and individual sections $\boldsymbol{\Delta\ell_{1\lambda}}$ of the curve 1 of the function $f_1(x)$ (6.183)

Interval	11	12	13	14	15	16	17	18	19	20
x, 10^{-5} m	1.2	1.32	1.44	1.56	1.68	1.80	1.92	2.04	2.16	2.28
Degree	90	99	108	107	126	135	144	153	162	171
tg β	1.12	1.106	1.065	0.998	0.906	0.792	0.658	0.508	0.346	0.175
β, degree	48.2	47.9	46.8	44.9	42.2	38.4	33.4	27.0	19.1	9.94
$\Delta\ell_{1\lambda}$, 10^{-5} m	0.180	0.179	0.175	0.170	0.162	0.153	0.144	0.135	0.127	0.122

$$\ell_{1\lambda} = 2\sum_{11}^{20}\Delta\ell_{1\lambda} \approx 3.09\cdot10^{-5}\,\text{m} \qquad (6.189)$$

The sought arc length $\ell_{1\lambda} \approx 3.09\cdot10^{-5}$ m (6.189) differs from the straight line $\ell_0 = 0.5\lambda = 3.15\cdot10^{-5}$ m (6.180) by only 1.9%. This is a fully acceptable result, taking into account the errors of the methods of approximate numerical calculations. More accurate results can be obtained by dividing the investigated function into a considerably larger number of intervals. To obtain complete agreement between $\ell_{1\lambda}$ and ℓ_0, the amplitude ℓ_{a1} (6.181) of the first harmonics should be slightly corrected.

Thus, the calculations show that for the optical photon, the arc length $\ell_{1\lambda}$ (6.180) of the first harmonics of the cosine function of its trajectory can be justifiably regarded as half length of the electromagnetic wave λ

$$\ell_{1\lambda} = \tfrac{1}{2}\lambda \qquad (6.190)$$

The simple relationship (6.190) changes in principle the current views regarding the movement of light in optical media. In fact, two waves permanently bonded together propagate in the optical medium:

1. The electromagnetic wave travels with the speed of light C_0 in the quantised medium whose carrier is the light-bearing medium.

2. The geometrical wave which propagates in the optical medium with the phase speed C_{p0} lower than the speed of light C_0 and which is synchronised with the electromagnetic wave, determining the wave trajectory of the photon in the optical medium.

The equation (6.190) describes the cosine trajectory of the photon in the form of the first harmonics $f_1(x)$ (6.176) of the triangular periodic function $f(x)$ (6.174), and the trajectory of the geometrical wave of the photon can be justifiably referred to as the wave trajectory.

Figure 6.17 ensures the wave trajectory of the photon in the optical medium. It should be mentioned that in movement of the photon with the period T is the ionisation plane of the photon rotate through the angle α_ω (6.140) which cannot be imaged in a flat projection.

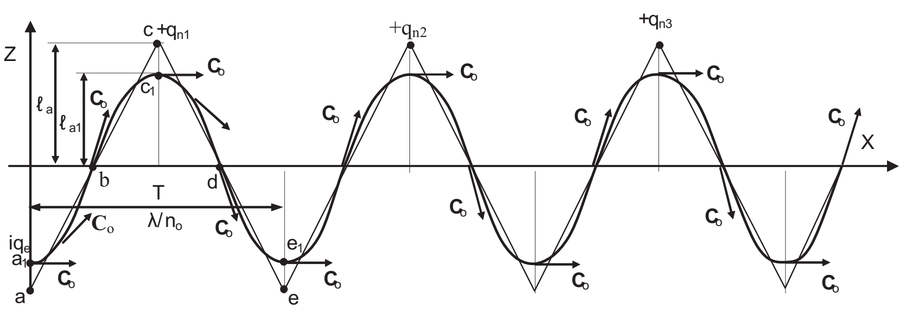

Fig. 6.17. Wave trajectory of the photon in the optical medium.

6.10. Forces acting on the photon in the optical medium

Let us consider the movement of the photon with the imaginary charge iq_e, starting at the moment when the photon is located at point (a_1) of the wave trajectory and starts capture of the atomic nucleus with the charge $+q_{n1}$ which is situated at the tip of the triangle at the point (c) (Fig. 6.16 and 6.17). We determine the maximum distance r_{max} of the start of capture of the nucleus by the photon as the distance between the charges iq_e and $+q_{n1}$ of the straight line ($a_1 - c$)

$$r_{max} = \sqrt{(\ell_a + \ell_{a1})^2 + \left(\frac{\lambda}{2n_0}\right)^2} = \sqrt{\ell_a^2 + 2\ell_a \ell_{a1} + \ell_{a1}^2 + \frac{\lambda^2}{4n_0^2}} \qquad (6.191)$$

Into (6.191) we substitute the amplitude ℓ_a (6.179) and ℓ_{a1} (6.181)

$$r_{max} = \lambda\sqrt{\left(\frac{1}{16} + \frac{1}{\pi^2} + \frac{4}{\pi^4}\right)\left(1 - \frac{1}{n_0^2}\right) + \frac{1}{4n_0^2}} \approx \frac{\lambda}{n_0}\sqrt{0.21n_0^2 + 0.04}$$

$$r_{max} \approx \frac{\lambda}{n_0}\sqrt{0.21n_0^2 + 0.04} \approx 0.46\lambda < 0.5\lambda \qquad (6.192)$$

Equation (6.192) shows that capture of the atomic nucleus by the photon starts at distance r_{max} (6.192) smaller than half the wavelength, i.e., $r_{max} < 0.5\lambda$. This is a very important moment, taking into account the fact that the effect of the imaginary electrical charge iq_e (6.118) of the photon operates at distances shorter than half the wavelength, i.e. $r \le 0.5\lambda$

$$iq_e = (-e)\sqrt{2}\frac{\lambda_e}{\lambda}\sin\left(\frac{2\pi}{T}t\right)\sin\left(\frac{2\pi}{\lambda}r\right), \quad r \le 0.5\lambda \qquad (6.193)$$

In (6.193) the initial conditions are linked to Fig. 6.17. Therefore, the charge ($-e$) in (6.193) has the minus sign. This ensures mutual attraction of the charges iq_e and $+q_{n1}$ during the first half period.

Regardless of the fact that at the moment of time $t = 0$ the imaginary charge iq_e (6.193) is situated at the point (a_1) and its effect is still equal to 0, at $t > 0$ the charge iq_e starts to increase rapidly and is ready for capturing of the atomic nucleus because $r_{max} \approx 0.46\lambda < 0.5\lambda$ (6.192). In accordance with (6.193), the maximum effect iq_{emax} of the charge iq_e (6.193) is observed at the point (b) at $t = \frac{1}{4}T$ and $r = \frac{1}{4}\lambda$

$$iq_{e\max} = (-e)\sqrt{2}\frac{\lambda_e}{\lambda} \qquad (6.194)$$

Further, the effect of the imaginary charge iq_e starts to weaken and at the point (c_1) it reaches zero. This corresponds to time $t = \frac{1}{2}T$ and the maximum distance r_{min} between the charges iq_e and $+q_{n1}$

$$r_{min} = \ell_a - \ell_{a1} = \lambda\left(\frac{1}{4} - \frac{2}{\pi^2}\right)\sqrt{1 - \frac{1}{n_0^2}} \approx 0.05\lambda\sqrt{1 - \frac{1}{n_0^2}} > 0 \qquad (6.195)$$

When the photon passes through the point (c_1) of the trajectory at the time $t > ½T$, then in accordance with (6.193) the polarity of the imaginary charge iq_e (6.193) changes from negative to positive and the photon starts to be repulsed from the charge $+q_{n1}$ of the atomic nucleus. At point (d) the repulsion reaches the maximum value and also the value of the charge iq_{emax} (6.194), although it has the positive sign.

At the point (e_1) for $t = T$, the value of the charge iq_e (6.193) is equal to 0. At $t > T$ the second period starts with the capture of the atomic nucleus with the charge $+q_{n2}$, cyclically repeating the first period and determining the movement of the photon along the wave trajectory in all consecutive periods with capture of the atomic nucleus.

Of special interest is the determination of the force $\mathbf{F}_\text{v}$ of the interaction of the charges iq_e and $+q_{n1}$. It should be mentioned immediately that the interaction of the charge of the atomic nucleus $+q_n$ (6.144) with the imaginary charge iq_e (6.190) is not governed by the Coulomb law. This does not violate the fundamental laws in the area of the microworld of the elementary particles and it is the specific feature of interaction with the radial electrical field $\mathbf{E}_{rad}$ of the photon which is not spherical and is situated in the narrow plane of the rotor. The Coulomb law holds for spherical fields where the force of interaction between the charges decreases in inverse proportion to the distance.

To determine the force $\mathbf{F}_\text{v}$ of the interaction between the imaginary electrical charge of the photon and the charge of the atomic nucleus, it should be mentioned that the imaginary charge iq_e (6.193) is a variable charge with the change of both the magnitude and the sign with the frequency of the electromagnetic field of the photon. In addition, the effect of the charges is restricted by the photon diameter, i.e., does not extend to distances greater than ½λ from the centre of the photon. On approaching the charge iq_e its maximum value is obtained at a distance of ¼λ. At the distances ½λ and 0 from the photon centre the charge becomes equal to 0. The classic charges do not behave in this manner, as permitted by the specific features of the imaginary charge of the photon which takes into account the functional parameters of the radial electrical field $\mathbf{E}_{rad}$.

The special features of the imaginary photon charge differ from those of the field of the classic spherical electrical charge. The imaginary photon charge takes into account the functional parameters of the nonspherical radial electrical field $\mathbf{E}_{rad}$.

Since the functional dependence of the imaginary electrical charge iq_e (6.193) of the photon in time and in space is known, we can determine immediately the functional dependences of the radial electrical field $\mathbf{E}_{rad}$. For this purpose, we use the function $f(S)$ of the imaginary charge of the

iq_{er} (6.193) on the circular surface S of the rotor at the distance r from the centre of the photon in which the radial electrical field $\mathbf{E}_{rad}$ operates

$$\mathbf{E}_{rad} = \frac{1}{\varepsilon_0} \frac{iq_{er}}{\int f(S)dS} \tag{6.196}$$

In fact, the strength of any electrical field, including $\mathbf{E}_{rad}$ (6.196), is determined by the surface density of charges. For example, in the electron, the radial electrical field has spherical symmetry and is uniformly distributed on the sphere $S = 4\pi r^2$, determining the strength $E_e = e/4\pi\varepsilon_0 r^2$ of the electron field. In the photon, the radial electrical field of the rotor does not have spherical symmetry but the strength of its radial field is determined by the expression (6.196). The circular surface S of the photon rotor is determined as the function of r and thickness h_λ(6.56) of the rotor

$$S = 2\pi r h_\lambda \tag{6.197}$$

Taking into account (6.197), from (6.193) we immediately determine the distribution of the strength $\mathbf{E}_{\mathrm{rad}}$ of the radial electrical field of the photon in time and in space

$$\mathbf{E}_{rad} = \frac{iq_e}{\varepsilon_0 S} = \frac{e}{2\pi\varepsilon_0 r h_\lambda} \frac{\lambda_e \sqrt{2}}{\lambda} \sin\left(\frac{2\pi}{T} t\right) \sin\left(\frac{2\pi}{\lambda} r\right) \cdot \mathbf{1}_r, \quad r \le \frac{\lambda}{2} \tag{6.198}$$

Equation (6.119) can be derived by analysing the distribution of the strength of the radial electrical field of the photon in time and in space. However, an interesting feature of (6.198) is that it is connected with the imaginary charge of the photon and determined by the elementary electrical charge e.

Knowing the function of strength $\mathbf{E}_{rad}$ (6.198) we can determine the force $\mathbf{F}_\mathrm{v}$, acting on the photon from the side of the electrical charge of the nucleus of the atom of the molecular network (lattice) of the optical medium, captured by the radial electrical field $\mathbf{E}_{rad}$ of the electrical charge $+q_n$

$$\mathbf{F}_\mathrm{v} = q_n \mathbf{E}_{rad} = \frac{eq_n}{2\pi\varepsilon_0 r h_\lambda} \frac{\lambda_e \sqrt{2}}{\lambda} \sin\left(\frac{2\pi}{T} t\right) \left| \sin\left(\frac{2\pi}{\lambda} r\right) \right| \cdot \mathbf{1}_r, \quad r \le \frac{\lambda}{2} \tag{6.199}$$

The function of the force $\mathbf{F}_\mathrm{v}$ (6.199) is alternating only with respect to time t (or wavelength λ) and not with respect to the distance r between the charges iq_e and $+q_n$. Therefore, in equation (6.199) the functional dependence of the force $\mathbf{F}_\mathrm{v}$ on distance r between the charges is described by the modulus $|\sin(2\pi r/\lambda)|$. The distance r is determined by the radius-vector $\mathbf{r}$ which coincides with the direction of the unit vector $\mathbf{1}_r$ in (6.199). The function of the distance $r(x)$ between the charges iq_e and $+q_n$ is determined by the longitudinal x_r and transverse z_r components of the radius-vector **r**

$$r = \sqrt{x_r^2 + z_r^2} \tag{6.200}$$

$$x_r = \frac{\lambda}{2n_0} - x \tag{6.201}$$

The transverse component z_r is determined from $f_1(x)$ (6.175) and the amplitude ℓ_a (6.173)

$$z_r = \ell_a + f_1(x) = \frac{\lambda}{4}\sqrt{1 - \frac{1}{n_0^2}}\left[1 + \frac{8}{\pi^2}\cos\left(2\pi n_0 \frac{x}{\lambda}\right)\right] \tag{6.202}$$

Substituting (6.201) and (6.202) into (6.200), we obtain the function $r(x)$

$$r(x) = \sqrt{\frac{1}{n_0^2}\left(\frac{1}{2}\lambda - x\right)^2 + \frac{\lambda^2}{16}\left(1 - \frac{1}{n_0^2}\right)\left[1 + \frac{8}{\pi^2}\cos\left(2\pi n_0 \frac{x}{\lambda}\right)\right]^2} \tag{6.203}$$

From (6.202) and (6.201) we determine the tangent of the angle of inclination α_r of the force vector $\mathbf{F}_v$ (6.199) of the X axis and the angle α_r itself as the function of x

$$\operatorname{tg}\alpha_r = \frac{z_r}{x_r} = \frac{\frac{\lambda}{4}\sqrt{1 - \frac{1}{n_0^2}}\left[1 + \frac{8}{\pi^2}\cos\left(2\pi n_0 \frac{x}{\lambda}\right)\right]}{\frac{\lambda}{2n_0} - x} \tag{6.204}$$

$$\alpha_r = \operatorname{arctg}\frac{\frac{\lambda}{4}\sqrt{1 - \frac{1}{n_0^2}}\left[1 + \frac{8}{\pi^2}\cos\left(2\pi n_0 \frac{x}{\lambda}\right)\right]}{\frac{\lambda}{2n_0} - x} \tag{6.205}$$

Knowing the angle α_r (6.205), we express the longitudinal $\mathbf{F}_{vx}$ and transverse $\mathbf{F}_{vz}$ components of the force $\mathbf{F}_v$ (6.199) (where $\mathbf{1}_x$ and $\mathbf{1}_z$ are the unit vectors on the axes X and Z, respectively)

$$\mathbf{F}_{vx} = F_v \cos\alpha_r \cdot \mathbf{1}_x \tag{6.206}$$

$$\mathbf{F}_{vz} = F_v \sin\alpha_r \cdot \mathbf{1}_z \tag{6.207}$$

To determine the components $\mathbf{F}_{vx}$ and $\mathbf{F}_{vz}$ of the force $\mathbf{F}_v$, it is necessary to determine in (6.199) the function of time t with respect to x, i.e. $t\,(x)$. If the movement of the photon were determined by the linear–broken trajectory of the described triangular periodic function $f(x)$ (6.174), time t would be a linear function of x (Fig. 6.14)

$$t(x) = \frac{\ell_0}{C_0} = \frac{x}{C_{p0}} = \frac{n_0}{C_0} x \tag{6.208}$$

In fact, as shown previously, the photon moves along a wave-shaped trajectory described by the first harmonics $f_1(x)$ (6.176) of the periodic function in accordance with the cosine law. This non-linear function, derivative with respect to time t in the section of length $\ell_{1\lambda}$ (6.177) determines the absolute speed of the photon C_0

$$C_0 = \frac{d\ell_{1\lambda}}{dt} \tag{6.209}$$

The element of length $d\ell_{1\lambda}$ (6.209) of the curvilinear trajectory of the photon is expressed through the longitudinal x and transverse z components

$$d\ell_{1\lambda} = \sqrt{dx^2 + dz^2} = \sqrt{1 + \left(\frac{dz}{dx}\right)^2}\, dx \tag{6.210}$$

We substitute (6.210) into (6.209) and after dividing the variables we can write the integral for time t as the function of x

$$t = \frac{1}{C_0} \int \sqrt{1 + \left(\frac{dz}{dx}\right)^2}\, dx \tag{6.211}$$

Equation (6.211) includes the first derivative $f_1'(x)$ (6.178) of the function $f_1(x)$ (6.176) of the cosine trajectory of the photon, determining the tangent of the angle of inclination β of the tangen to the X axis

$$\frac{dz}{dx} = \frac{df_1(x)}{dx} = \mathrm{tg}\,\beta = \frac{4}{\pi}\sqrt{n_0^2 - 1} \cdot \sin\left(2\pi n_0 \frac{x}{\lambda}\right) \tag{6.212}$$

$$\beta = \mathrm{arctg}\left[\frac{4}{\pi}\sqrt{n_0^2 - 1} \cdot \sin\left(2\pi n_0 \frac{x}{\lambda}\right)\right] \tag{6.213}$$

Even if we substitute (6.212) into (6.211), the resultant integral, as mentioned, does not have any analytical solution. The numerical solution of the identical integrals (6.177) shows that the length of the arc $\ell_{1\lambda}$ (6.190) of the first harmonics of the cosine function of the trajectory of the photon within the integration range $x = \lambda/2n_0$ is equal to half the length of the electromagnetic wave λ

$$\ell_{1\lambda} = \tfrac{1}{2}\lambda \tag{6.214}$$

Substituting the solution of (6.214) into (6.211) and taking (6.212) into account, we obtain

$$t = \frac{1}{C_0} \int_0^{\lambda/2n_o} \sqrt{1 + \left(\frac{dz}{dx}\right)^2} dx = \frac{1}{2} \frac{\lambda}{C_0} = \frac{1}{2} T \tag{6.215}$$

The solution (6.250) confirms that the duration of the half period of the photon in transition from the linear–broken trajectory of the triangular function to its first harmonics remains unchanged. This is important because there are reference points on the trajectory of the photon at which the wave parameters do not change. However, the integral (6.250) does not make it possible to determine the required function $t(x)$ inside the half period of the photon.

This exhausts the mathematical possibilities of the analytical solution and only numerical methods remain. In any case, the proposed method can be used to determine the forces acting on the photon in the optical medium and obtain, in the final analysis, a dynamic equation of the motion of the photon. Analysis of this equation is outside the framework of this book.

6.11. Refractive index of the optical medium

The movement of a photon along a wave-shaped trajectory, which is described by the first harmonics of the triangular function, satisfies the condition of the constancy of the speed of light in the quantised medium. However, the angle of inclination of the tangent to the harmonic wave-shaped trajectory, which determines the refractive index of the medium, is a variable value and it is necessary to prove that the effectiveness of the optical medium n_0 is an averaged-out parameter. For this purpose, we again describe the absolute speed of the photon $\mathbf{C}_0$ as the vector sum of its longitudinal $\mathbf{C}_{p0}$ component along the X axis and the transverse components $\mathbf{C}_{z0}$ (6.156) along the Z axis

$$\mathbf{C}_0 = \mathbf{C}_{p0} + \mathbf{C}_{z0} \tag{6.216}$$

The values of the components $\mathbf{C}_{p0}$ and $\mathbf{C}_{z0}$ of the absolute speed $\mathbf{C}_0$ (6.216) can be written conveniently by means of the function of angle β (6.113), showing that the components $\mathbf{C}_{p0}$ and $\mathbf{C}_{z0}$ also represent the functional dependences on x on the wavelength λ during the period T

$$\begin{cases} \mathbf{C}_{p0} = C_0 \cos\beta \cdot \mathbf{1}_x = C_0 \cos\left\{ \operatorname{arctg}\left[\frac{4}{\pi} \sqrt{n_0^2 - 1} \cdot \sin\left(2\pi n_0 \frac{x}{\lambda} \right) \right] \right\} \cdot \mathbf{1}_x \\ \mathbf{C}_{z0} = C_0 \sin\beta \cdot \mathbf{1}_z = C_0 \sin\left\{ \operatorname{arctg}\left[\frac{4}{\pi} \sqrt{n_0^2 - 1} \cdot \sin\left(2\pi n_0 \frac{x}{\lambda} \right) \right] \right\} \cdot \mathbf{1}_z \end{cases} \tag{6.217}$$

Figure 6.18 shows the vector diagram of the variation of the longitudinal $\mathbf{C}_{p0}$ and transverse $\mathbf{C}_{z0}$ component of the absolute speed of the photon $\mathbf{C}_0$ in the optical medium in accordance with (6.217) at the wavelength λ during the period T, when the vector $\mathbf{C}_0$ changes its angle of inclination β (6.213) from 0 to $\pm\beta_{max}$ at the points (b) and (d) on the trajectory (Fig. 6.17)

$$\beta_{\max} = \pm \operatorname{arctg}\left(\frac{4}{\pi}\sqrt{n_0^2 - 1}\right) \tag{6.218}$$

The vector diagram in Fig. 6.18 differs in principle from the vector diagram in Fig. 6.13 where the longitudinal $\mathbf{C}_{p0}$ and transverse $\mathbf{C}_{z0}$ components of the speed $\mathbf{C}_0$ are connected with the angle β_0 (6.299) which is regarded as a constant

$$\beta_0 = \operatorname{arctg}\sqrt{n_0^2 - 1} \tag{6.219}$$

$$\operatorname{tg}\beta_0 = \sqrt{n_0^2 - 1} \tag{6.220}$$

Angle β_{max} (6.218) is larger than angle β_0 (6.219)

$$\frac{\operatorname{tg}\beta_{\max}}{\operatorname{tg}\beta_0} = \frac{4}{\pi} = 1.27 \tag{6.221}$$

As indicated by (6.219) and (6.220), angle β_0 is equivalent to the refractive index n_0 which is also a constant. However, investigations show that during the period angle β varies from 0 to $\pm\beta_{max}$ (6.218). This means that the refractive index n_0 of the optical medium changes in value during the period. Therefore, it can be assumed that the refractive index n_0 of the medium is an averaged-out parameter.

To prove this, it is necessary to find the mean value $\operatorname{tg}_{av}\beta$ of the tangent of angle β (6.230) and compare with $\operatorname{tg}\beta_0$ (6.229). However, $\operatorname{tg}\beta_0$ is determined by the linear–broken trajectory of the photon with the amplitude

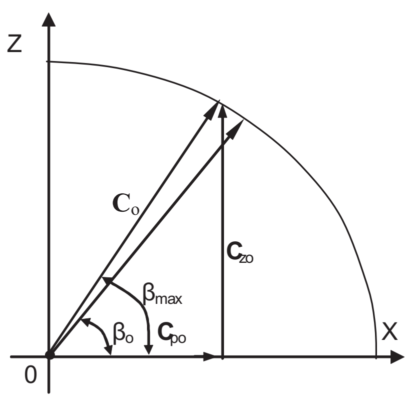

Fig. 6.18. Vector diagram of the longitudinal $\mathbf{C}_{p0}$ and transverse $\mathbf{C}_{z0}$ components of the absolute speed of the photon $\mathbf{C}_0$ in the optical medium.

ℓ_a (6.171) of the triangular function (Fig. 6.15). Amplitude ℓ_{a1} (6.181) of the cosine trajectory of the photon is determined by the amplitude of the first harmonics of the triangular function, determining the ratio of the amplitude (6.182)

$$\frac{\ell_{a1}}{\ell_a} = \frac{8}{\pi^2} \tag{6.222}$$

Evidently, as regards the averaged-out parameters of the linear and non-linear functions it is necessary to find out whether they can be reduced to the form suitable for comparison equating their amplitudes. In fact, the compared value of $\text{tg}\beta_0$ is determined by the amplitude ℓ_a, which differs from the amplitude ℓ_{a1} of the cosine function for the sought mean value $\text{tg}_{av}\beta$. Therefore, we reduce the amplitudes of these functions to the single value taking into account (6.222). The mean value of $\text{tg}_{av}\beta$ is equal to $\text{tg}\beta_0$ (6.220) only in this case.

$$\begin{aligned} \text{tg}_{av}\beta &= \frac{\ell_a}{\ell_{1a}} \frac{4n_0}{\lambda} \int_0^{\lambda/4n_0} \frac{4}{\pi}\sqrt{n_0^2 - 1} \cdot \sin\left(2\pi n_0 \frac{x}{\lambda}\right) dx = \\ &= \frac{\ell_a}{\ell_{1a}} \frac{8}{\pi^2} \sqrt{n_0^2 - 1} = \sqrt{n_0^2 - 1} \end{aligned} \tag{6.223}$$

$$\text{tg}_{av}\beta = \text{tg}\beta_0 = \sqrt{n_0^2 - 1} \tag{6.224}$$

Equation (6.224) shows that the refractive index n_0 of the optical medium is the averaged parameter $\text{tg}_{av}\beta$ for the photon travelling along the wave-shaped trajectory in a stationary optical medium

$$n_0 = \sqrt{\text{tg}_{av}^2\beta + 1} \tag{6.225}$$

When the optical medium also moves, as in the Fizo experiment, the refractive index of the medium changes. This problem has been examined in considerable detail in [2] when proving the reality of the light-bearing medium. It should be added that from the viewpoint of electrodynamics, the partial carrying away of the light by the moving optical medium can be regarded as an asynchronous effect when the field of the moving lattice of the optical medium passes with a certain gliding in relation to the moving photon. Naturally, the refractive index n_0 of the optical medium depends on the frequency of the electromagnetic field of the photon and is determined by the lattice parameters of the optical medium in which perturbations depend mainly on temperature and pressure. However, the investigation of these relationships is outside the framework of the present book. Naturally, knowledge of the structure of the photon and of the reasons for the decrease of the photon speed in optical media have the controlling effect on the change of the old considerations regarding the electrodynamics of the moving media [14].

Thus, the investigation show finally that without analysis of the parameters of the light-bearing medium it is not possible to examine the nature and structure of the photon as the particle-wave which is the integral part of the quantised space-time.

Conclusions

1. The new fundamental discoveries of the space-time quantum (quanton) and of the superstrong electromagnetic interaction (SEI) open a new era in the quantum theory, establishing the deterministic nature of the quantum mechanics and electrodynamics. Most importantly, the new fundamental discoveries explain the reasons for quantum phenomena hidden in the quantum nature of space-time. It may be confirmed that there are no non-quantised objects in the nature. The quantised objects include the radiation quantum (photon). Previously, it was assumed that energy quantisation takes place by means of radiation quantum. Now we have established the quantisation of the very radiation quantum by the quantons (space-time quanta) where the radiation quantum (photon) represents a secondary wave formation in the quantised space-time.

2. The new fundamental discoveries have made it possible to apply the classic concept in the quantum theory and, at the same time, describe for the first time the nature and structure of the photon whose parameters can be calculated, bypassing the static wave function. It has been established that the photon is a two-rotor relativistic particle whose electrical and magnetic rotors exist simultaneously and are located in the orthogonal polarisation planes. The intersection of the polarisation planes forms the main axis of the photon around which polarisation planes can rotate. The main axis of the photon is directed along the vector of the speed of movement of the photon in the quantised medium. In this form, the photon is a wave-particle, some concentrated bunch of electromagnetic energy of the quantised space-time, travelling at the speed of light.

3. The variable electromagnetic field of the photon satisfies the two-rotor Maxwell equation and the classic wave equation. The calculation parameters of the photon were determined for the first time: the strength of the electrical and magnetic fields in the photon rotors, the density of the electrical and magnetic bias currents, the currents themselves, and many other parameters which could not previously be calculated.

4. It has been established that the deceleration of light in the optical medium is determined by the wave trajectory of the photon as a result of the probability capture by the photon of the atomic centres of the lattice of the optical medium when the vector of the photon speed in the quantised medium does not coincide with the vector of speed in the optical medium. In fact, two waves propagate in the optical medium and these waves are permanently connected together:

a) the electromagnetic wave which travels with the speed of light $\mathbf{C}_0$ in the quantised medium and is transferred by the light-bearing medium;

b) the geometrical wave which propagates in the optical medium with phase speed $\mathbf{C}_{p0}$ lower than the speed of light $\mathbf{C}_0$, which is synchronised with the electromagnetic wave and determines the wave trajectory of the photon in the optical medium.

5. It has been shown that the wave trajectory of the photon in the optical medium can be represented by the first harmonics of the triangular periodic function. The condition of movement of the photon along the wave trajectory is the constancy of the speed of light in the quantised medium. In this case, the imaginary motion along a straight line in the optical medium in the same period of time as in the case of the wave trajectory is regarded as the deceleration of light in the optical medium. The calculations show that the refractive index of the light by the optical medium can be regarded as the averaged parameter of the medium in movement of the photon along the wavy trajectory.

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7

Nature of non-radiation and radiation of the orbital electron

In this book, the reasons for the non-radiation radiation of the orbital electron in the composition of the atom are examined for the first time using the classic approach. It is established that the atom is an energy-balanced system capable of stabilising the mass of the orbital electron in the entire speed range, including relativistic speed. The radiation of the orbital electron takes place in the range of relativistic speeds as a result of the mass defect of the electron in the atom nucleus and is associated with the effect on the electron of threshold (critical) accelerations, determining the discrete nature of radiation.

7.1. Introduction

From the viewpoint of classic physics, the behaviour of the orbital electron in the composition of the atom is anomalous because it completely contradicts the Maxwell electrodynamics in which the orbital electron, moving with acceleration on a complicated trajectory, including the stationary set of orbits in the form of an electronic cloud, surrounding the atom nucleus, should continuously emit electromagnetic waves. For example, the orbital electron in the composition of a proton nucleus of the hydrogen atom making a turn along the greatly elongated stationary orbit, continuously changes the strength of the electrical field **E** with time t, determined by the change of the distance **r** between the electron and the proton. In accordance with the laws of Maxwell electrodynamics, the orbital electron should continuously emit energy and, in the final analysis, should fall on the atom nucleus [1].

However, in reality, the situation is paradoxic. The electron on the stationary orbit does not emit electromagnetic energy and does not fall on the atom nucleus. The Maxwell electrodynamics, whose fundamental nature was not doubted, ceased to operate in the structure of the atom. The reasons for the anomalous behaviour of the orbital electron could not be explained. In addition to this, it was established that the observed radiation of the orbital electron is not associated with the nature of the trajectory of the orbit and is not continuous. It was found that the electron emits energy in portions (photons), and not continuously, and only at the moment of transition from the excited state to a lower orbit. The transition of the electron at the lower orbit increases the energy of electrostatic interaction of the electron and the atom nucleus with simultaneous emission of a photon. It is shown in this book that the energy balance is not compensated by a decrease of the kinetic energy of the electron because the classic calculation method cannot be used for the atom. Classic physics faces serious problems when describing the behaviour of the orbital electron and its radiation, and attempts have been made to solve these problems in quantum physics.

The formation of quantum physics is associated with the introduction of the wave function when the behaviour of the orbital electron is characterised by its probability state, represented by the electronic cloud. In fact, the orbit of the electron in the classic concept of the trajectory has disappeared as such from quantum theory. In addition, in accordance with the Heisenberg uncertainty principle, it was no longer possible to determine simultaneously the pulse and coordinates of the orbital electron because it was not possible to define concretely the orbit of the electron in the classic concept. At least, the previously described concept of the behaviour of the orbital electron has been accepted in modern physics and represents the basis of the quantum theory of radiation and non-radiation of the orbital electron in the composition of the atom. However, the question is how long can the uncertainty principle hold and in which direction should quantum theory develop?

The discovery of the space-time quantum (quanton) and of the superstrong electromagnetic interaction (SEI) has made it possible to return the deterministic base to the quantum theory and describe the behaviour of the elementary particles on the basis of the classic concept, treating their quantised structure as open quantum-mechanics systems [1–4]. This relates to the behaviour of the orbital electron in the composition of the atom, assuming that the atom is an open quantum mechanics system with the unique properties and the previously unknown parameters, enabling the orbital electron to emit photons or not emit at all, in contrast to the laws of classic electrodynamics. For modern quantum theory, the reasons for this phenomenon remained unknown up to the discovery of the space-time quantum (quanton) and the superstrong electromagnetic interaction (SEI).

It is well known that the new fundamental discoveries enable large additions to be made to the theory of radiation and non-radiation of the orbital electron in the composition of the atom, primarily the reasons for the phenomenon. In previous chapters, we explained the quantum theory of Maxwell electrodynamics in vacuum and the electromagnetic structure of vacuum [1], the quantum theory of gravitation, including elementary particles [2], nature and structure of the photon [3], the quantum structure of the discrete electron [4] and the quantised structure of the nucleons (chapter 5) [5].

In addition to the theory of nucleon interactions, it is also important to consider the zones of anti-gravitation repulsion of the alternating shell of the nucleons at distances shorter than the distance of the effect of nuclear forces. These are important in analysis of the stability of the shell of the nucleons when the forces of anti-gravitational repulsion of the monopole charges in the structure of the shell prevent the shell from collapse. In the structure of the atom, the anti-gravitational repulsion forces act against nuclear forces as forces of electrostatic attraction of the monopoles ensuring nucleus stability. The zones of anti-gravitational repulsion have been described in detail in [14] on the example of the discrete structure of the electron, treating the electron as a complicated quantum particle with its structure including the monopole electrical charge and the quantons of the medium, forming in the quantised medium several characteristic zones, including the zone of anti-gravitational repulsion.

The problem of radiation and non-radiation of the orbital electron in the composition of the atom is permanently linked with the discrete structure of the electron, the photon and the nucleons, and also with the new theoretical concepts presented in the theory of the elastic quantised medium (EQM) and the theory of Superintegration as a result of new fundamental discoveries of the quanton and the SEI [1–5].

Naturally, the theory of Superintegration of the fundamental interactions could not be ignored in unification of the principal relativity in the quantum theory, showing that the principal relativity is the fundamental property of the quantised space-time (elastic quantised medium). In particular, because of the quantised structure of the orbital electron in the composition of the atom as an open quantum mechanics systems, it has become possible to examine the reasons for photon radiation and non-radiation of the orbital electron. Undoubtedly, the primary position in this investigation is occupied by the fact that the two-rotor structure of the photon, as a relativistic wave particle, starts to form at speeds close to the speed of light [1–4]. This imposes restrictions on the Heisenberg uncertainty principle because at the moment of emission the orbital electron should have the speed close to the speed of light in the immediate vicinity of the atom nucleus. This condition makes it possible to define more accurately the coordinate of the electron and its momentum at the moment of photon emission. In detailed analysis of the dynamics of the orbital electron in the composition of the atom the very principle of uncertainty can be eliminated from quantum theory.

The attempts for understanding the behaviour of the orbital electron were made for the first time when analysing the circular orbit of the electron in the Bohr atom and subsequently the elliptical Zommerfeld trajectories on the example of the simplest hydrogen atom [6]. However, the reasons for the radiation and non-radiation of the orbital electron were not explained by the Bohr atom model. This was regarded as an impetus by Bohr to postulate the quantum state of the electron in the composition of the atom, accepting the discrete levels of the atom energy and the radiation energy of the atom as the difference of the concrete state. Regardless of the agreement in the results of the calculations in the simplest cases, the restricted nature of the mathematical apparatus based on the Bohr atom was evident. Further development of the quantum theory of the atom is associated with the introduction of the wave function which replaced the actual orbits of the electron in the composition of the atom by the electronic probability cloud. Thus, the quantum (wave) mechanics derived from the analysis the electron orbit as a physical reality, replacing it by the probability of the orbital electron (or an electron ensemble) being in the composition of the atom [7].

Undoubtedly, successes in the wave mechanics and calculation mathematical apparatus obtained on the basis of the statistical wave function, as now also shown in the Superintegration theory, were determined by the wave nature of all the elementary particles, being the integral part of the quantised space-time. Consequently, it was possible to derive analytically for the first time the wave equation of the electron in the form of the differential wave equation of the second order in partial derivatives on the basis of changes of the quantum density of the medium with time during movement of the electron [4]. The orbital electron is a quantised particle-wave with a discrete structure governed by the principle of the corpuscular wave dualism. In particular, the modification of the wave equation of not only the electron but of any elementary particle having a mass represents the basis of the wave function as a differential equation of the second order in partial derivatives.

The physicists know quite well that Einstein did not accept the statistical nature of the wave function ('God does not play dice') and that he was convinced that the quantum theory, like classic physics, should be based on the deterministic basis. 'It appears to be highly likely that sometimes in future improved quantum mechanics will be proposed with the return to the causality and justification of the Einstein viewpoint' – these are the words by the well-known theoretical physicist Paul Dirac in characterising the future of quantum theory [8]. The discovery of the space-time quantum (quanton) returns to physics the causality of understanding quantum phenomena showing that all the elementary particles are complicated quantum objects, not only elementary objects as indicated by their name [1–5].

It should be mentioned that as we penetrate deeper into the quantised medium, the energy concentration we must face becomes greater and greater. Naturally, the energy of the quantised medium determines the energy of the atom and of the atom nucleus, determining its discrete structure and the discrete structure of the electron as an integral part of the quantised medium. In particular, the continuity of the electron and of the quantised medium justifies the principle of corpuscular-wave dualism of the particle in the medium. The observed fraction of the radiation energy of the electron in this case is only a very small 'tip of the iceberg', and the main part of the electron energy is hidden in the abyss of the quantised medium and does not show itself directly in exchange processes of photon radiation but influences these processes [4].

The discrete quantised structure of the electron determines the behaviour of the orbital electron and helps to determine the reasons for its stability in the composition of the atom when there is no electron emission. In this case, we can concretise the state of the atom at the moment of emission of the orbital electron. The electron in the quantised medium should be regarded as a discrete particle capable of energy changes and exchange, both continuous on a complicated orbit and a jump-like at the moment of emission or absorption of radiation.

The history of quantum considerations with respect to the structure of matter started with the determination by Planck of the discrete nature of electromagnetic emission of the orbital electron in the composition of the atom:

$$W = \hbar \nu \tag{7.1}$$

Here W is the radiation energy, J; $\hbar = 1.05 \cdot 10^{-34}$ J is the Planck constant, ν is radiation energy, s^{-1}, Hz.

As regards the Bohr atom model, equation (7.1) was slightly changed. The energy of emission of the photon by the orbital electron is determined by the difference of the electron energies ΔW, for example, $W_1 - W_2$, where W_1 and W_2 is the electron energy in the first and second Bohr orbits, respectively

$$\Delta W = W_1 - W_2 = \hbar\nu = \Delta m_e C_0^2 \tag{7.2}$$

Equation (7.2) includes the mass defect Δm_e of the orbital electron and the gravitational potential C_0^2 of the quantised medium, whose introduction is already linked with the theory of EQM. Previously, the square of the speed of light c^2 [1–4] was used instead of the gravitational potential C_0^2 in (7.2).

However, even taking into account the Zommerfeld corrections of the circular Bohr orbits to elliptical orbits, the Bohr atom theory does not make it possible to calculate exactly the stationary space of the orbital electron. Situated on the greatly elongated elliptical orbit, the electron is capable of coming very close to the atomic nucleus, in fact falling on the nucleus, and changing in a very wide range of the energy of electrical interaction between the electron and the nucleus. As already mentioned, the electron does not emit in this paradoxic case, regardless of the resultant contradictions with Maxwell electrodynamics where the variation of the electrical field should generate electromagnetic radiation [6, 10].

Abandoning the further development of the Bohr atom model, physics also rejected the classic approaches in quantum theory when the understandable physical models and considerations were replaced by purely mathematical methods of processing the experimental results, using probability approaches. Almost simultaneously, Heisenberg and Schrödinger proposed two calculation models: matrix and statistical [1]. Since the parameters of the atom were not known, Heisenberg proposed to express the state of the orbital electron by a matrix, with computations of the matrix yielding the discrete parameters of the system corresponding to radiation. In fact, this was a purely mathematical approximation which did not make it possible to understand the reasons for the phenomenon. The statistical model of Schrödinger proved to be more universal, although of the same type. In this model, the state of the atom is described by a wave function ψ (probability amplitude) of the spatial coordinates (x, y, z) and time t

$$\psi(x, y, z, t) \tag{7.3}$$

The wave function (7.3) has no physical meaning but the square of its modulus $|\psi(x, y, z, t)|^2$ determines the probability of the particle being at time t in the appropriate coordinates (x, y, z), for example, in the elementary volume dV. Consequently, integrating $|\psi(x, y, z, t)|^2$ throughout the entire volume of the atom, the wave function (7. 3) should be satisfied by the unit probability, determining the presence of the orbital electron in the composition of the atom

$$\int_V |\psi(x,y,z,t)|^2 dV = 1 \tag{7.4}$$

Finally, the orbits of the atom disappeared from the wave mechanics and converted to a probability cloud (7.4) of the negatively charged matter consisting of orbital electrons. For the orbital electron to fall on the atom nucleus, the calculated probability of the orbital electron (7.4) being in the subsurface volume of the atom nucleus is assumed to be equal to 0.

Regardless of the fact that the physical meaning aalso disappeared when explaining the state of the atom, the successes of the calculation procedures of wave mechanics proved to be real, including case when solving the problems of many particles (solids) in atomic physics. The reality of the electron orbits and the presence of the wave properties of the particles were not so important. On the other hand, the application of only probability methods in the investigations of the state of the atom is an indication of not knowing the nature of physical phenomena taking place inside the atom. The statistical nature of the calculation facilities of the wave mechanics has transformed the atom into a 'black box' whose internal structure was not investigated, and only external manifestation of its properties in the form of the radiation spectrum could be processed mathematically.

Naturally, the phenomenological nature of the probability method of investigation, regardless of significant successes of wave mechanics, has not solved the main problem of the physics of elementary particles and the atomic nucleus. The nature of the nuclear forces was not known prior to the development of the EQM and the theory of the unified electromagnetic field, and the structure of its main elementary particles was not discovered: the electron, positron, proton, neutron, electron neutrino, photon. New fundamental discoveries have made it possible in quantum theory to move basically from the plurality model of the classic models of investigations, ending the dispute between Einstein and Bohr regarding the determinism of the quantum theory in favour of Einstein [12]. New discoveries made it possible, together with the introduction of the quantum of the space-time (quanton), to determine the quantised discrete nature of not only the radiation quantum but also of all elementary particles, including the orbital electron. In quantum theory it became possible to transfer from the phenomenological probability in description of the behaviour of elementary particles to the deterministic understanding of their nature.

What are the new features brought to the theory of radiation and non-radiation of the orbital electron by the theory of EQM and Superintegration? Below, we list only the new assumptions which were previously not considered in the behaviour of the orbital electron in the composition of the atom:

1. The presence of the gravitational potential well around the atomic nucleus, with the orbital electron rotating inside the well. An increase of the electrical energy of the electron–nucleus system observed when the electron and the nucleus come together is compensated by the equivalent decrease of the gravitational energy of the system inside the gravitational well, defining the energy of the atom in the non-excited state as a constant and preventing the orbital electron from emitting energy [9].
2. The complicated structure of the alternating shell of the nucleon in the composition of the atomic nucleus is characterised by the presence of the zones of gravitational attraction and anti-gravitational repulsion. On approach to the proton, the configuration of its electrical field changes. The radial electrical field of the non-compensated electrical charge with the positive polarity of the proton changes to the tangential electrical field of its alternating shell in the vicinity of the surface of the nucleus [5].
3. The presence of the quantised structure in the orbital electron as an open quantum-mechanics system inside the quantised medium permits changes of the energy state of the electron as a result of the mass defect which is the only reason for radiation of the photon. In this case, it is necessary to take into account the presence in the electron of the zone of anti-gravitational repulsion which in interaction with the identical zones of the shells of the nucleons in the composition of the atomic nucleus does not allow the electron to fall on the nucleus [4].
4. Finally, it has been established that the two-rotor structure of the photon can form only in the region of relativistic speeds [3]. This means that the orbital electron in the composition of the atom at the moment of emission of the photon should reach the speed close to the speed of light. As shown by calculations, this is possible only in the immediate vicinity of the atomic nucleus (in fact, in the very nucleus): the effect of the centrifugal force and critical acceleration makes the electron to lose part of the mass during a change in the trajectory. The photon is emitted as a result of the mass defect of the orbital electron in the relativistic region of the speeds by the mechanism of synchrotron radiation.

The previously mentioned reasons for the behaviour of the orbital electron in the composition of the atom are investigated in greater detail in this book in analysis of photon radiation. Naturally, the fact that the previously mentioned problems of the orbital electron have not been solved greatly complicates the calculations of wave mechanics, restricted to statistical parameters of the electron. The development of the quantum theory on the basis of new fundamental discoveries and the previously mentioned assumptions enable us to transfer to the classic equations describing the state and behaviour of the orbital electron.

For example, the radial component of the speed of the orbital electron at the maximum distance from the atomic nucleus is equal to 0, and in the immediate vicinity of the atomic nucleus reaches the speed close to the speed of light. It is now clear that the probability of the electron being found at a specific radial distance from the nucleus correlates with the speed of the electron, describing a rosette-like trajectory and, consequently, determining the probability structure of the electron cloud. In particular, new approaches to the problem of the orbital electron make it not only possible to describe its trajectory but also determine the reasons for its probability parameters. Regardless of the deterministic nature of the new quantum mechanics, the methods of statistical physics with its probability parameters remain unshakable and in a number of cases they are controlling, as indicated by the example of capture by the photon of the atomic nucleus of the lattice of the optical medium in determination of the wave trajectory of the photon [3]. However, in contrast to the statistical nature of the wave function, the new probability parameters of the electron are characterised by the completely understandable physical nature.

The results will be of interest to experts in the area of the physics of elementary particles and the atomic nucleus and also quantum physics. However, most importantly, the results are of considerable applied significance in the development of quantum generators with high efficiency, for the development of quantum energetics and superconducting high-temperature materials, when the parameters of the optical medium determine the radiation or non-radiation of the orbital electron and conduction electrons and also determine the electrical conductivity (conduction) of the conductor (semiconductor), and in many other areas of science and technology.

The aim of this book with a limited volume is not to present analytically all possible spectrum of radiation of the atoms in the trajectories of the orbital electrons. This is a very large analytical study which should be preceded by the investigation of the current theory of the orbital electron, directed at determining the reasons for its unique behaviour in the composition of the atom, including at the moment of photon emission. The reasons for the behaviour of the orbital electron in the composition of the atom are studied in this book.

7.2. Concept of the discrete quantised electron

The orbital electron is capable of emitting a photon only because of its discrete structure in the quantised medium, being an open quasi-mechanical systems, like the atom as a whole. To understand the reasons for photon emission or non-emission by the orbital electron, it is necessary to mention the main assumptions of the theory of the electron, published in [4]. Previously, the following properties of the electron were known: charge $e = -1.6 \cdot 10^{-19}$ C, mass $m_e = 0.91 \cdot 10^{-30}$ (0.511 MeV), magnetic momentum $\mu_e = 1.00116\ \mu_B$ (μ_B is the Bohr magneton), radius (classic) $r_e = 2.82 \cdot 10^{-15}$ m, spin $\frac{1}{2}\hbar$, stable, lifetime $\tau > 2 \cdot 10^{22}$ years [13].

Prior to the development of the theory of EQM and TUEM (theory of the unified electromagnetic field), the electron was treated as an independent elementary particle being the carrier of the elementary electrical charge with negative polarity and mass. It was assumed that the electron is completely isolated from the quantised space-time, being an independent material substance, like 'matter in itself'. Regardless of the fact that this contradicted the principle of the corpuscular-wave dualism and the capacity of the particle mass to manifest itself in the form of the distorted space-time, the stereotype of this thinking was abandoned only as a result of discovering the superstrong electromagnetic interaction (SEI) [1].

In fact, the SEI returns to physics not only the light-bearing medium (electromagnetic aether) but on the whole determines the structure of the already quantised space-time in the form of the superstrong electromagnetic interaction (SEI) combining all the known interactions. It is now no longer rational to isolate the elementary particles from the quantised space-time and regard them as an integral unit with the quantised medium where the mass is reflected through the spherical deformation of the quantised medium. Consequently, the transfer of the mass of the particle in the space is determined by the wave transfer of spherical deformation of the quantised medium determining the wave and corpuscular properties of the particle [2].

The structure of the quantised medium, as a carrier of the superstrong interaction, and its parameters have been examined in detail in [1]. The structure of the quantised discrete electron as the compound part of the quantised medium was described in [4]. Therefore, it is rational to present only the main assumptions of the theory of Superintegration relating to the behaviour of the electron in the quantised medium which are essential for justifying the behaviour of the orbital electron in the composition of the atom.

It should be mentioned that until recently the physical vacuum was regarded as a substance with the minimum energy level manifested as a result of fluctuation of the zero energy level. This was a highly erroneous assumption based on the visual examination of the vacuum as an apparent emptiness since it was not not possible to penetrate directly into its quantised structure with the discreteness of the order of 10^{-25} m using direct instrument measurements.

The EQM theory changes the principal views regarding the physical vacuum and postulates that it has the maximum energy level and treats the physical vacuum as the only source of electromagnetic energy to which all other types of energy, including gravitational energy, are reduced in the final analysis. The energy is counted from the maximum level of the vacuum energy, although in re-normalisation this level may be regarded as a zero level and the observed changes of energy may be regarded as the fluctuation of the zero level when the equilibrium state of the quantised medium is disrupted. However, this is not so important, because the quantised medium in the equilibrium state can be visually perceived as an empty space. This visual perception is applied to all properties of the quantised space-time. The manifestation of electromagnetism and gravitation in the quantised medium is determined as the disruption of the electromagnetic and gravitational equilibrium of the medium [1, 2].

The main parameter, characterising the non-perturbed quantised medium, is the quantum density of the medium ρ_0, which determines the concentration of quantons in the unit volume of the space-time

$$\rho_0 = \frac{k_3}{L_{q0}^3} = 3.55 \cdot 10^{75} \frac{\text{particles}}{\text{m}^3} \tag{7.5}$$

where $L_{q0} = 0.74 \cdot 10^{-25}$ m is the quanton diameter; $k_3 = 1.44$ is the coefficient of filling of the volume by the spherical particles.

Gravitational perturbation of the quantised medium is accompanied by the redistribution of quantum density ρ which now already differs from ρ_0. Thus, for the electron whose mass formation is associated with the spherical deformation of the quantised medium, the distribution of the quantum density is described by the Poisson equation

$$\operatorname{div}(\mathbf{D}\gamma_n) = \operatorname{div}\operatorname{grad}(\rho\gamma_n) = 4\pi\frac{\rho_0}{C_0^2} G\rho_m\gamma_n \tag{7.6}$$

where $G = 6.67 \cdot 10^{-11}$ Nm²/kg² is the gravitational constant; ρ_m is the density of the matter with the mass m, kg/m³; $C_0^2 \approx 0.9 \cdot 10^{17}$ J/kg (m²/s²) is the gravitational potential of the non-perturbed vacuum; **D** is the vector of spherical deformation of the quantised medium, particles/m⁴; γ_n is the normalised relativistic factor which has a specific value for the electron travelling with the speed v

$$\gamma_n = \frac{1}{\sqrt{1 - \left(1 - \frac{R_e^2}{r_e^2}\right)\frac{v^2}{C_0^2}}} \tag{7.7}$$

where $R_e = 6.74 \cdot 10^{-58}$ m is the electrical radius of the electron (the radius of the point charge); $r_e = 2.82 \cdot 10^{-15}$ m is the classic radius of the electron.

The normalised relativistic factor γ_n restricts the mass and energy of the particle when the latter reaches the speed of light by the limiting parameters $m_{\max}$ and W_{emax} [4]

$$m_{e\max} = \frac{C_0^2}{G} r_e = 3.8 \cdot 10^{12}\,\text{kg} = 4.2 \cdot 10^{42} m_e \tag{7.8}$$

$$W_{e\max} = m_{e\max} C_0^2 = \frac{C_0^4}{G} r_e = 3.4 \cdot 10^{29}\,\text{J} = 4.2 \cdot 10^{42} W_0 \tag{7.9}$$

It can be seen that the limiting parameters of the electron are $4.2 \cdot 10^{42}$ times greater than the mass m_e and rest energy W_0 of the electron.

The classic radius of the electron r_e determines the calculation parameters of the gravitational boundary of the electron in the condition when its electrical energy W_e is equal to the gravitational energy W_0 of the rest state $m_0 C_0^2$, determining the depth r'_e of the gravitational boundary [4]

$$W_e = W_0, \quad \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r_e} = m_e C_0^2 \tag{7.10}$$

$$r'_e = r_e \pm R_e \tag{7.11}$$

The electrical radius R_e of the point charge of the electron indicates the equivalence of its maximum electrical energy W_{emax} and the limiting gravitational energy $W_{\max}$ (7.9) with the deformation energy of the quantised medium

$$W_{e\max} = W_{\max}, \quad \frac{1}{4\pi\varepsilon_0} \frac{e^2}{R_e} = \frac{C_0^4}{G} r_e \tag{7.12}$$

From (7.12) and (7.10) we obtain that the electrical radius R_e is equal to the gravitational radius R_g of the electron [4]

$$R_e = R_g = \frac{G m_e}{C_0^2} = 6.74 \cdot 10^{-58}\,\text{m} \tag{7.13}$$

The gravitational radius of the electron R_g is only the calculation auxiliary parameter with no actual meaning, because the electron is a non-collapsing object. The electrical radius R_e of the point electrical charge of the electron is important for the electron.

If a massless point elementary electrical charge ($-e$ or e^-) is placed in the quantised medium, the quantons under the effect of electrical forces and also, as shown in [4], magnetic forces, start to move to the central charge ($-e$) spherically deforming the medium. Two characteristic regions should be specified here: the region of compression and the region of tension separated by the gravitational boundary r_e' (7.11). Mathematically, the deformed state of the quantised medium is described by the Poisson equation (7.6). The solution of this equation is represented by the distribution of the quantum density of the medium for the region of tension ρ_1 and the region of compression ρ_2 [4]

$$\begin{cases} \rho_1 = \rho_0\left(1-\dfrac{R_e}{r}\gamma_n\right), & r \ge r_e \\ \rho_2 = \rho_0\left(1+\dfrac{R_e}{r}\gamma_n\right), & r_e \ge r \ge R_e \end{cases} \tag{7.14}$$

Solution of (7.14) confirms the effect of the principle of spherical invariance for the initial electron when regardless of its uniform and straight line speed v, which is included in γ_n (7.7), the distribution of quantum density ρ_1 and ρ_2 remains spherical in relation to the point charge ($-e$) of the electron. The nonuniformity of the quantum density (7.14) is characterised by the deformation vector **D** of the medium which is included in (7.6) as a quantum density gradient

$$\mathbf{D} = \operatorname{grad}\rho \tag{7.15}$$

$$\begin{cases} \mathbf{D}_1 = \rho_0\dfrac{R_e}{r^2}\gamma_n \cdot \mathbf{1}_r, & r \ge r_e \\ \mathbf{D}_2 = -\rho_0\dfrac{R_e}{r^2}\gamma_n \cdot \mathbf{1}_r, & r_e \ge r \ge R_e \end{cases} \tag{7.16}$$

Here $\mathbf{1}_r$ is the unit vector directed away from the central point charge ($-e$) of the electron along the radius r.

The region of tension for ρ_1 determines the direction of the deformation vector $\mathbf{D}_1$ in (16) from the central charge of the electron, and the region of compression for ρ_2 determines the direction of the deformation vector $\mathbf{D}_2$ towards the central charge ($-e$). On the sphere with radius r_e which characterises the gravitational boundary (7.11) of the electron in the quantised medium, the deformation vectors $\mathbf{D}_1$ and $\mathbf{D}_2$ are applied to the boundary from different sides in the opposite direction.

It is characteristic that the flow $\mathbf{\Phi}_1$ of the deformation vector $\mathbf{D}_1$ (7.16) on the closed surface $4\pi r^2$ around the region of tension ρ_1 is proportional to the mass of the particle taking into account (7.30) and to proportionality coefficient k_m and is directed to the external region of space:

$$\mathbf{\Phi}_1 = \int_S \mathbf{D}_1 dS = 4\pi\rho_0 R_e \gamma_n \cdot \mathbf{1}_r = 4\pi \frac{\rho_0}{C_0^2} G m_e \gamma_n \cdot \mathbf{1}_r = k_m m \cdot \mathbf{1}_r \tag{7.17}$$

$$m = m_e \gamma_n \tag{7.18}$$

If the deformation $\mathbf{D}_1$ of the medium is removed from (7.17), the mass m disappears. The equation (7.17) again shows convincingly that the mass of the particle is a secondary formation as a result of the spherical deformation of the quantised medium.

Prior to the development of the theory of EQM and Superintegration, physics did not examine the internal region of the particle. When it was possible to look inside the electron, it was found that it contains minus mass, hidden from examination and characterised by deformation vector $\mathbf{D}_2$. At the distances smaller than the classic radius of the electron, the minus mass start to be evident in the form of the force of anti-gravitational repulsion determining the negative value of the vector of the strength (–**a**) of the gravitational field [2]

$$\begin{cases} \mathbf{D}_1 = \rho_0 \dfrac{R_e}{r^2}\gamma_n \cdot \mathbf{1}_r = \dfrac{\rho_0}{C_0^2}\dfrac{Gm_e}{r^2}\gamma_n \cdot \mathbf{1}_r = \dfrac{\rho_0}{C_0^2}\mathbf{a}\gamma_n, & r \geq r_e \\ \mathbf{D}_2 = -\rho_0 \dfrac{R_e}{r^2}\gamma_n \cdot \mathbf{1}_r = \dfrac{\rho_0}{C_0^2}\dfrac{G(-m_e)}{r^2}\gamma_n \cdot \mathbf{1}_r = \dfrac{\rho_0}{C_0^2}(-\mathbf{a})\gamma_n, & r_e \geq r \geq R_e \end{cases} \tag{7.19}$$

Equation (7.19) confirms that the deformation vector $\mathbf{D}_1$ ($-\mathbf{D}_2$) (7.16) is an analogue of the vector of the strength **a** of the gravitational field of the electron which determines the freefall acceleration **a** in the external region and the acceleration of free repulsion (–**a**) in the internal region.

The anti-gravitational repulsion effect is even stronger at the gravitational boundary r'_e (7.11) of the electron which divides the regions of compression and tension of the quantised medium. To determine the maximum value of the deformation vector $\mathbf{D}_{max}$, a 'jump' $\Delta\rho$ of the quantum density of the medium (7.14) is defined on the surface of the gravitational boundary of the electron

$$\Delta\rho = \rho_1 - \rho_2 = -\rho_0 \frac{2R_e}{r_e}\gamma_n \tag{7.20}$$

The width of the gravitational boundary from (7.11) equals $\Delta r = 2R_e$ so that we can determine the vector $\mathbf{D}_{max}$ taking (7.10) into account

$$\mathbf{D}_{max} = \frac{\Delta\rho}{\Delta r}\mathbf{1}_r = -\frac{\rho_0\gamma_n}{r_e}\mathbf{1}_r = -\frac{4\pi\varepsilon_0 m_e C_0^2}{e^2}\rho_0\gamma_n\mathbf{1}_r \tag{7.21}$$

The maximum value of the strength of the gravitational field ($-\mathbf{a}_{max}$) of the electron at the gravitational boundary is determined on the basis of the equivalence of the strength with the deformation vector (7.21)

$$\mathbf{a}_{max} = \frac{C_0^2}{\rho_0}\mathbf{D}_{max} = -\frac{C_0^2}{r_e}\gamma_n \mathbf{1}_r = -3.2\cdot 10^{31}\gamma_n \mathbf{1}_r \left[\mathrm{m/s^2}\right] \quad (7.22)$$

It can be seen that the gravitational boundary of the electron is the zone of gravitational repulsion (7.22) which predetermines its capture by the atom nucleus, with the exception of capture of the proton by the electron.

The quantum density of the medium (7.14) and the vector of deformation of the medium (7.16) are new parameters of the electron which are noticeable and non-formal. However, these parameters are not used widely in physics. As shown in (7.19) and (7.22), the new parameters of the quantised medium are connected with the well-known vector of strength **a** of the gravitational field and, consequently, the gravitational potential φ which is an analogue of the quantum density of the medium ρ[2]

$$\varphi = \frac{C_0^2}{\rho_0}\rho, \quad \rho = \frac{\rho_0}{C_0^2}\varphi \quad (7.23)$$

Substituting (7.23) into (7.6) we obtain the well-known Poisson gravitational equation for the gravitational potential φ

$$\operatorname{div}(\mathbf{a}\gamma_n) = \operatorname{div}\operatorname{grad}(\varphi\gamma_n) = 4\pi G\rho_m\gamma_n \quad (7.24)$$

Therefore, the complete solution of the Poisson gravitational equation (24) can be found only in the Superintegration theory, analysing the distribution of the quantum density of the medium (7.14) for the electron in the region of tension and compression of the medium and determining the analogue distribution of the gravitational potentials $\varphi_1 = C^2$ and φ_2 for the regions of tension and compression of the medium, respectively [2]

$$\begin{cases} \varphi_1 = C^2 = \dfrac{C_0^2}{\rho_0}\rho_1 = C_0^2\left(1 - \dfrac{R_e}{r}\gamma_n\right), & r \ge r_e \\ \varphi_2 = \dfrac{C_0^2}{\rho_0}\rho_2 = C_0^2\left(1 + \dfrac{R_e}{r}\gamma_n\right), & r_e \ge r \ge R_e \end{cases} \quad (7.25)$$

Figure 7.1 shows the gravitational diagram of the electron in the form of distribution of the gravitational potentials (7.25) for the internal region (zone) of compression (*c–d–e*) and the external region of tension (*a–b–c*). The detailed description of the gravitational diagram of the electron is found in [2].

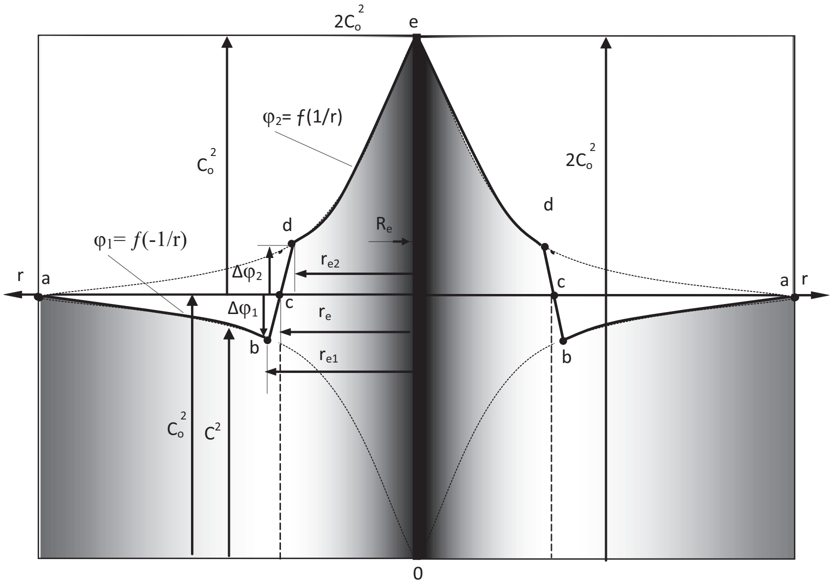


Fig. 7.1. Gravitational diagram of the electron in the form of distribution of the gravitational potential in the zone of compression (*d–e*) and the region of tension (*a–b*) of the spherically deformed quantised space-time.

Attention should be given to the fact that the equilibrium state of the quantised medium is represented by the line of the gravitational potential C_0^2 (or quantum density ρ_0), with deformation changes in the medium during the formation of the electron mass taking place in relation to this potential. The depth of the quantised medium is determined by the difference of the gravitational potentials 0–C_0^2 (or 0–ρ_0). The gravitational potential has the maximum value $2C_0^2$ (or $2\rho_0$) on the surface of the electrical radius R_e (7.13) of the electron.

Only on the basis of the quantum density of the medium ρ_0 can it be concluded that vacuum is characterised by the gravitational potential C_0^2 and not $\varphi = 0$, as was erroneously assumed before the EQM theory was developed. This is confirmed by the equivalence of the energy W_0 and the rest mass m_e of the electron

$$W_0 = \int_0^{C_0^2} m_e d\varphi = m_e C_0^2 \tag{7.26}$$

Integral (7.26) determines the work associated with the transfer of mass m_e as a gravitational charge from the virtual infinity with the zero gravitational potential to the region of the quantised medium with the gravitational potential C_0^2 when a particle with mass m_0 is formed. Equation (7.26) is the simplest and easiest to understand conclusion of the equivalence of mass and energy. Using a reversed procedure, we obtain from (7.26) that the quantised medium has the potential C_0^2.

The formation of the electron mass is determined by the spherical deformation of the quantised medium (7.17). The gravitational boundary between the zones of compression and tension is represented by the line (b–c–d) which is characterised by the anti-gravitational repulsion effect (7.22), like the entire zone of compression with the negative deformation vector ($-\mathbf{D}_2$) (7.19). It is characteristic that the energy zone of compression hides in itself the colossal energy W_{emax} (7.14) associated with the point dimensions of the electrical radius R_e (7.13) of the electron.

The zone of tension (*a–b–c*) is characterised by a gravitation well whose deformation energy is determined by the integral (7.26) and corresponds to half the rest mass. As reported in [4], the second half of the deformation energy is introduced in a small amount into the minus mass of the electron (part of the gravitational hillock), balancing the tension of the gravitational well and determining the stability of the electron in the quantised medium. The gravitational well includes the zone of gravitational attraction characterised by the distribution function of the gravitational potential $\varphi_1 = C^2$ (7.24) which determines the external gravitational field of the electron. The gravitational potential C^2 is the potential of action because it actually characterises the distribution of the gravitational potential and the quantum density of the medium for the electron.

With the increase of the speed of the electron, the integral (7.26) is multiplied by the normalised relativistic factor γ_n (7.7), determining the spherical invariance of the gravitational diagram irrespective of the speed of movement. Consequently, the movement of the electron in the quantised medium should be treated as the movement of its point electrical charge ($-e$) with radius R_e (7.30) characterising the transfer in the space of the gravitational diagram of the spherical deformation of the medium. This determines the wave transfer of mass and explains the fundamental nature of the principle of corpuscular-wave dualism of the particle.

In fact, in the 'matter in itself' concept, the electron has no mass. The electron mass is quantised in its nature and represents a bunch of the spherically deformed quantised medium capturing during wave motion into its composition a very large number of quantons, forming the quantised structure of the electron. Consequently, the electron mass can get fragmented and manifest itself in the form of a mass defect and is the equivalent of the elastic energy of spherical deformation of the quantised medium which, after release, determines the radiation energy of the photon.

Understanding this and knowing the quantised structure of the electron, we can analyse the condition of its radiation or non-radiation.

The partial (or complete) mass loss by the electron in the form of the mass defect is associated with the release of the elastic energy of deformation of the quantised medium. Since the quantised medium has the form of a static electromagnetic field, being the carrier of superstrong interaction (SEI), the release of part of the energy of the elastic deformation of the medium by the electron generates a wave electromagnetic process in the medium and this process is observed as photon emission.

The description of the electron structure is incomplete without describing its spherical magnetic field together with the radial electrical field of the point charge and connection with the gravitational diagram. Previously, the spherical fields, i.e., the fields closed on the sphere and completely balanced, were not investigated in the theory of electromagnetism. However, the spherical magnetic field in particular has made it possible to explain the presence of magnetic 'spin' in the electron which is not explained by the rotation of the electron, including rotation around the natural axis, and is associated with the specific features of the behaviour of the quantised medium around the point charge of the electron [4].

Figure 7.2 shows the scheme of formation of the spherical magnetic field in the vicinity of the central point charge of the electron (a) and in movement away from it (b). In projection, the quanton has the form of an electromagnetic quadrupole including two dipoles: electrical and magnetic, and the axes of the dipoles are orthogonal to each other. In the immediate vicinity of the point charge of the electron the quantons try to orient the

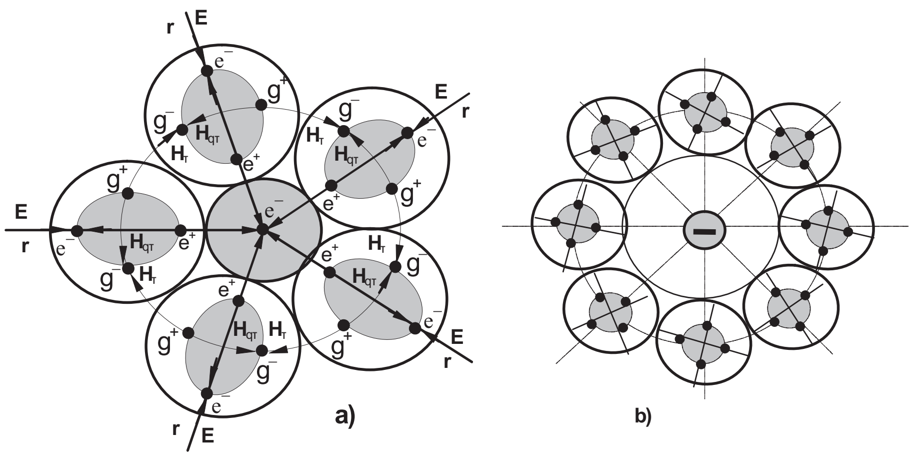


Fig. 7.2. Diagram of formation of the spherical magnetic field in the vicinity of the point charge of the electron (a) and away from it (b).

axes of the electrical dipoles of the force lines of the radial electrical field of the spherical charge of the electron. In this case, the axes of the magnetic dipoles close on the sphere, forming the spherical magnetic field of the electron. In particular, this electron field provides the maximum contribution to the deformation of the quantised medium in formation of the electron mass [4].

For the simultaneous description of the radial electrical and spherical magnetic field of the electron, it is convenient to introduce the concept of the complex electron charge q expressing it in the electrical units of measurement of the charge, taking into account the relationship between the elementary magnetic g and electrical e charges $g = C_0 e$, where i is the imaginary quantity

$$q = e + \frac{1}{C_0} ig \tag{7.27}$$

The complex charge of the electron q (7.27) can be expressed in the magnetic units of measurement of the charge or in electrical and magnetic units $q = e + ig$.

Consequently, the complex static electromagnetic potential φ_q of the electron can be represented by the distribution function of the actual electrical φ_e and the imaginary magnetic φ_g potentials of the point complex charge q (7.27)

$$\varphi_q = \frac{q}{4\pi\varepsilon_0 r} = \frac{1}{4\pi\varepsilon_0 r}\left(e + \frac{ig}{C_0}\right) = \frac{e}{4\pi\varepsilon_0 r} + \frac{1}{\varepsilon_0 C_0}\frac{ig}{4\pi r} = \varphi_e + \frac{1}{C_0} i\varphi_g \tag{7.28}$$

The complex strength $\mathbf{Q}$ of the static electromagnetic field of the electron is determined as the gradient of the function of the complex potential φ_q (7.28)

$$\mathbf{Q} = \text{grad}(-\varphi_q) == \frac{e}{4\pi\varepsilon_0 r^2}\mathbf{1}_r + \frac{1}{\varepsilon_0 C_0}\frac{g}{4\pi r^2} i\mathbf{1}_r = \mathbf{E} + \frac{i\mathbf{H}}{\varepsilon_0 C_0} \tag{7.29}$$

The vectors of the strength of the radial electrical $\mathbf{E}$ and spherical magnetic $i\mathbf{H}$ fields of the electron are orthogonal and their moduli are connected by the relation:

$$H = (\varepsilon_0 C_0) E = \frac{g}{4\pi r^2} \tag{7.30}$$

The strength of the spherical magnetic field $i\mathbf{H}$ is determined by the components $\mathbf{H}_\tau$ and $\mathbf{H}_{q\tau}$ (Fig. 7.2a) which show that their moduli (modulus $i\mathbf{H}$ is denoted by H_i) are equal for the equilibrium state of the magnetic field when moving away from the central charge of the electron (Fig. 7.27b)

$$H_i = H_\tau = H_{q\tau} \quad (7.31)$$

It was shown in [4] that the spherical magnetic field of the electron, because of its closed form, has a considerably stronger force effect on the quantised medium than the effect of the radial magnetic field.

The presence in the electron of the spherical magnetic field makes it possible to determine the parameter of the spin of the electron S_e which for the orbital electron is measured in the units of $\hbar$ (where $\hbar = 1.05 \cdot 10^{-34}\ J \cdot s$ is the Planck constant)

$$S_e = \frac{1}{2}\hbar \quad (7.32)$$

It should be mentioned that the Planck constant $\hbar$ is equivalent to the momentum of the amount of motion of the orbital electron on the first Bohr orbit with radius r_0

$$\hbar = m_e v \cdot r_0 \quad (7.33)$$

The Bohr magneton μ_B determines the magnetic momentum of the orbital electron in the composition of the atom as a contour with current in the SI taking $\hbar$ (7.33) into account

$$\mu_B = \frac{1}{2} ev \cdot r_0 = \frac{1}{2}\hbar \frac{e}{m_e} = 9.27 \cdot 10^{-24} \frac{\text{J}}{\text{T}} = \text{A} \cdot \text{m}^2 = \text{Dc} \cdot \text{m} \quad (7.34)$$

The magnetic momentum of the orbital electron μ_B (7.34) is measured in the units of magnetic charge [Dc · m]. Therefore, the electrical charge e in the magnetic momentum of the electron μ_B should be replaced by the equivalent modulus g of the imaginary magnetic charge ig/C_0 of the electron from (7.27)

$$\mu_B = \frac{1}{2}\hbar \frac{g}{m_e C_0} \quad [\text{A} \cdot \text{m}^2 = \text{Dc} \cdot \text{m}] \quad (7.35)$$

Equation (7.35) determines the magnetic momentum of the orbital electron reaches expressed by the elementary magnetic charge g.

Equation (7.35) includes the Compton wavelength λ_0 of the electron

$$\lambda_0 = \frac{\hbar}{m_e C_0} = 3.86 \cdot 10^{-13} \text{m} \quad (7.36)$$

Taking equation (7.36) into account, we obtain the value of the magnetic momentum μ_B (7.35) of the orbital electron in the composition of the atom and express it through the elementary magnetic charge g and the Compton wavelength λ_0

$$\mu_B = \frac{\lambda_0}{2} g = 9.27 \cdot 10^{-24} \, \text{Dc} \cdot \text{m} \tag{7.37}$$

Equation (7.37) shows that the equivalent of the Bohr magneton μ_B is the magnetic dipole consisting of two elementary magnetic charges $\pm g$, situated at the distance equal to half the Compton wavelength $\lambda_0/2$. The magnetic axis of the dipole, connecting the magnetic charges $\pm g$, is orthogonal to the plane of the electron orbit for a single turn. The magnetic momentum μ_B (7.37) is connected with the first Bohr orbit which can be regarded as the average parameter of the complex stationary orbit in the simplest case of the hydrogen atom. The rotation of the orbital electron results in the magnetic polarisation of the atom which is determined by the equation (7.37).

Naturally, the above considerations, relating to the magnetic momentum of the orbital electron in the composition of the atom, cannot be transferred directly to the free electron which, in contrast to the atom, does not have distinctive magnetic polarisation. The magnetic spherical field of the free electron is polarised only topologically on the sphere, without disrupting the magnetic equilibrium of the medium. On the other hand, the magnetic dipoles of the quantons, oriented on the sphere in the composition of the electron, carry out topological orientational magnetic polarisation of the quantised medium around the electrical charge of the electron (Fig. 7.27). Evidently, it may be attempted to take into account the given magnetic polarisation of the free electron by introducing the imaginary magnetic moment.

Formally, equation (7.37) shows that the Compton wavelength λ_0 and the imaginary magnetic charge of the electron ig determine its magnetic momentum which is the imaginary parameter for the free electron

$$\mu_B = \frac{\lambda_0}{2} ig = \sqrt{-1} \cdot 9.27 \cdot 10^{-24} \, \text{Dc} \cdot \text{m} \tag{7.38}$$

In the case of the orbital electron, its imaginary magnetic momentum (7.30) is transferred to the actual parameter (7.37).

It is interesting to consider the purely hypothetically minimum magnetic momentum of the electron $\mu_{e\min}$, determined by the interaction of the magnetic charge with the identical charge at the distance of the classic electron radius r_e

$$\mu_{e\min} = ig \cdot r_e = \sqrt{-1} \cdot 1.35 \cdot 10^{-25} \, \text{Dc} \cdot \text{m} \tag{7.39}$$

Dividing (7.39) by (7.38) we obtain the required value of the fine structure α

$$\frac{\mu_{e\min}}{\mu_Б} = 2\frac{r_e}{\lambda_0} = 2\frac{1}{137} = 2\alpha \tag{7.40}$$

$$\alpha = \frac{r_e}{\lambda_0} = \frac{1}{137} \tag{7.41}$$

As indicated by (7.40), α is determined by the ratio r_e/λ_0. This is understandable since the classic radius of the electron r_e determines its rest energy $m_e C_0^2$. On the other hand, the Compton wavelength λ_0 is connected with the photon energy which is equivalent to the rest energy of the electron $m_e C_0^2$

$$\hbar \frac{C_0}{\lambda_0} = m_e C_0^2 \tag{7.42}$$

In fact, the constant of the fine structure α (7.41) determines the relationship between the corpuscular (r_e) and wave (λ_0) parameters of the electron on the basis of the electromagnetic nature of the electron in the quantised medium.

Figure 7.3 shows the structure of the electron in the quantised space-time as a result of its spherical deformation by the radial electrical field of the central charge. The structure of the quantised electron was obtained as a result of computer simulation of the deformation of the medium (for better understanding, the scale is not given). The centre of the electron contains a point electrical charge. The dark region shows the zone of compression of the quantised medium around the charge, the light region is the zone of tension which gradually merges with the non-perturbed quantised medium. Although the quanton electron is characterised by a rotor with narrow gravitational boundary between the zones of compression and tension, it appears to be 'spread' of the space, being its compound and inseparable part [4].

Thus, the brief analysis of the electron structure shows that the electron,

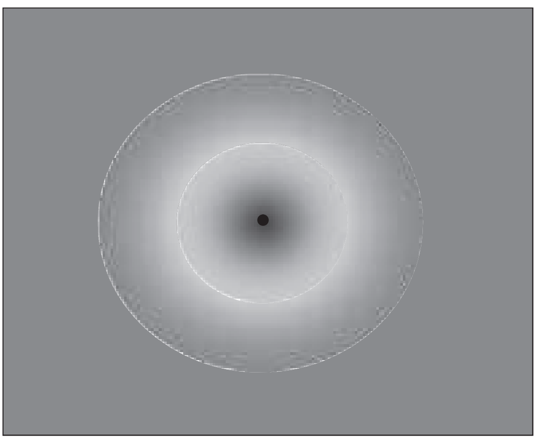


Fig. 7.3. Computer simulation of the structure of the electron in the quantised space-time as a result of its spherical deformation by the radial electrical field of the central charge.

being the integral part of the quantised space-time, has a discrete quantised structure. The discrete mass of the electron in the form of the spherically deformed region of the quantised medium around the central electrical charge (e^-) of the electron should be capable of changing through the mass defect. As already mentioned, the Maxwell electrodynamics does not work inside the atom, i.e., the variation of the strength of the electrical field between the orbital electron and the atom nucleus does not cause any electromagnetic radiation. Therefore, the photon radiation of the orbital electron can be explained on the basis of its electrondynamics in the composition of the atom, and the mass defect must be considered as the reason. This is justified taking into account the discrete structure of the quantised electron and, more accurately, its mass, which is capable of disintegration through the mass defect. Taking into account that the mass (mass defect) is the equivalent of the elastic energy of the spherically deformed quantised medium which is based on the superstrong electromagnetic interaction (SEI), the transformation of this energy into electromagnetic photon radiation is the only possible reason for the photon radiation of the orbital electron. In particular, this aspect of the nature of the radiation of the orbital electron through its mass defect has not been explained theoretically in quantum mechanics.

7.3. Special features of the structure of the proton, neutron and the atomic nucleus

The orbital electron rotates in the composition of the atom inside the gravitational well of the atomic nucleus whose effect was not previously taken into account in quantum theory. In particular, the rotation of the orbital electron inside the gravitational well of the nucleus determines its unique properties. However, prior to analysing of the behaviour of the orbital electron inside the gravitational well of the nucleus, we examine the structure of the atomic nucleus from the viewpoint of the concept of Superintegration of fundamental interactions in which the nuclear forces are manifested through the superstrong electromagnetic interaction as the forces of electrostatic attraction of the alternating shells of the nucleons (the proton and the neutron) [5].

The internal structure of the proton, the neutron and, correspondingly, the atomic nucleus was not known prior to the development of the Superintegration theory with the exception of the fact that the nucleus consists of nucleons (protons and neutrons) and the mentioned elementary particles have a complicated structure and in fact are not elementary. At the same time, a certain amount of experience has been accumulated in the investigations of nucleons and the atomic nucleus whose properties are described below.

The proton: mass $m_p = 1.67 \cdot 10^{-27}$ kg = 938.3 MeV ≈1836 m_e, the charge $+e = 1.6 \cdot 10^{-19}$ C, the magnetic momentum μ_p=2.79 μ_n (μ_n is the nuclear magneton), spin ½$\hbar$, the mean quadratic radius $0.8 \cdot 10^{-15}$ m, stable, lifetime $\tau > 1.6 \cdot 10^{25}$ years [14].

The neutron: mass $m_n = 1.675 \cdot 10^{-27}$ kg = 939.6 MeV ≈ 1840 m_e, $m_n - m_p$ = 1.3 MeV, charge – electrically neutral with the accuracy to 10^{-22} e, magnetic moment $\mu_p = -1.91$ μ_n (μ_n is the nuclear magneton), μ_p/μ_p–3/2, spin ½$\hbar$, the mean quadratic radius $0.8 \cdot 10^{-15}$ m, unstable in the free state, lifetime $\tau \approx 15.3$ min [15].

To understand the reasons for the behaviour of the orbital electron in the composition of the atom, it is necessary to know and understand the structure of the nucleons and the atomic nucleus and the nature of nuclear forces. In this respect, the Superintegration theory does not ignore the generally accepted positions in which the composition of the atomic nucleus is regarded as a complicated structure including two types of particles: protons and neutrons, connected together by nuclear forces. The difference is that the nature of the nuclear forces in the Superintegration theory is electrical [5]. Previously, it was assumed that up to the development of quantum chromodynamics (QCD) the nature of the nuclear forces cannot in principle be electrical because one of the nucleons (neutron) is an electrically neutral particle but is capable of interaction with other nucleons in the composition of the atomic nucleus. It was also assumed that this interaction results in the formation of special nuclear forces representing an independent fundamental interaction referred to as the strong interaction.

The concept of the independence and peculiarity of the nuclear forces contradicts the concept of Superintegration of interactions according to which all the known forces (interactions) should in the final analysis be reduced to the single force represented by the superstrong electromagnetic interaction. This is the distinguishing feature of the uniqueness of nature in the Superintegration theory which determines the electromagnetic nature of our universe. Discussion has been going on for several decades regarding the strong interaction and it was erroneously assumed that there is no stronger interaction in the nature than the nuclear interaction. The logics of these discussions should be reduced to the integration of the known interactions through the strong interaction which should control all other forces.

However, nobody has yet succeeded in proposing a Superintegration theory which would be based on nuclear forces. Consequently, we unintentionally arrive at the concept of the fifth force which could integrate the strong interaction with all other interactions (gravitation, electromagnetism, electroweak interactions). This fifth force can be represented only by the Superforce in the form of the superstrong electromagnetic interaction. Only the Superforce can control all other forces. This is the golden rule of mechanics. As we penetrate deeper into the matter (inside the quantised medium) we encounter higher and higher energy concentrations. The effect of nuclear forces is evident at distances of the order of 10^{-15} m, and the effect of the Superforce of the SEI at 10^{-25} m.

One of the fundamental manifestations of the Superforce is the formation of the mass of elementary particles. It should be mentioned that the discrete structure of the elementary particles, including the nucleons, is the compound part of the quantised medium. The only common feature of all the elementary particles having mass, and these particles include the orbital electron and the nucleons, is the capacity of the particles to carry out spherical deformation of the quantised medium resulting in the formation of the mass of the particles [2, 4].

However, from the technical viewpoint, the process of formation of the mass of the electron and the nucleon takes place by different mechanisms. Whilst in the electron of the electrical charge of the electron pulls the quantons to its centre, carrying out spherical deformation of the quantised medium [4], then in, for example, the neutron which is an electrically neutral particle, the mechanism of spherical deformation of the medium is associated with the structure of its alternating shell, and the paired ratio of the monopole charges of the shell determines the electroneutrality of the neutron with increasing distance from it. On the other hand, the proton, having a non-compensated electrical charge with positive polarity in the composition of the shell, has the same mechanism of formation of its mass as the neutron and the spherical deformation of the quantised medium is carried out by the alternating shell of the nucleon. In particular, the interaction of the alternating shells of the nucleons determines the electrical nature of the nuclear forces at distances of the order of 10^{-15} m [5].

Attention should be given to the fact that the new concept of the nuclear interactions provides a strong impetus to the development of the quantum chromodynamics (QCD). In QCD, the nuclear forces are determined by the quark structure of the nucleons, assuming that the quarks are tiny electrical charges included in the structure of the nucleons and they determine the electrical nature of the nuclear forces. Regardless of the attempts to attribute to the quarks the properties of whole electrical charges, the QCD does not solve the problem of formation of the mass of the nucleons and of the atomic nucleus in the quantised medium. All the contradictions of the QCD, formed during its development, have been removed by transferring the main aspect of quantisation of the nucleons by the quarks to the quantised medium. Four whole charges play the role of new quarks: two electrical (+1*e* and –1*e*) and two magnetic (+1*g* and –1*g*), which are included in the composition of the quanton (the space-time quantum). Consequently, the formation of elementary particles in the quantised medium requires only whole electrical charges (+1*e* and –1*e*). For the electron and the positron, the whole electrical charge is a central charge, and spherical deformation of the quantised medium, forming the particle mass, takes place around the central charge [4]. In the case of the nucleons, the whole electrical charges are included in the composition of the alternating shell which also carries out the spherical deformation of the quantised medium, forming the nucleon mass [5]. QCD does not possess such universal and non-contradicting assumptions.

The shell model of the nucleons is confirmed by experiments which showed that the nucleons are particles of complicated composition and they include a large number of the centres of electrical nature which are determined by the alternating shell of the nucleons. In the past, this resulted in the quark concept of the structure of nucleons and in the development of the QCD. This book does not discuss all the current problems of the QCD which, in fact, have already been solved in the Superintegration theory, and is aimed at returning the concept of integrated quarks forming the structure of the nucleons, taking into account the fact that it is necessary to search for whole electrical charges. The presence in natgure of the whole charges has been confirmed by experiments and they are not doubted, in contrast to the proof of the presence in nature of the tiny electrical charges.

Most importantly, the whole electrical charges are harmonically included in the shell model of the nucleons. For this purpose, the whole charges of the negative and positive polarity must be distributed on the sphere in the form of an alternating network with the alternation of the polarity of the charges in the nodes. The structure of the nucleons has been examined in considerable detail in [5] and it is not therefore necessary to repeat it and it is sufficient to mention the main assumptions relating to the photon, especially to the nature of radiation or non-radiation of the orbital electron in the composition of the simplest hydrogen atom whose nucleus consists of a proton. It must be mentioned that in [5] no mention is yet made of the forces of anti-gravitational repulsion between the elementary electrical charges which were investigated in [4] and their inclusion in [5] completes the description of the nature of the nuclear forces as the forces of electrical interaction at the distances of the order of 10^{-15} m between the alternating shells of the nucleons.

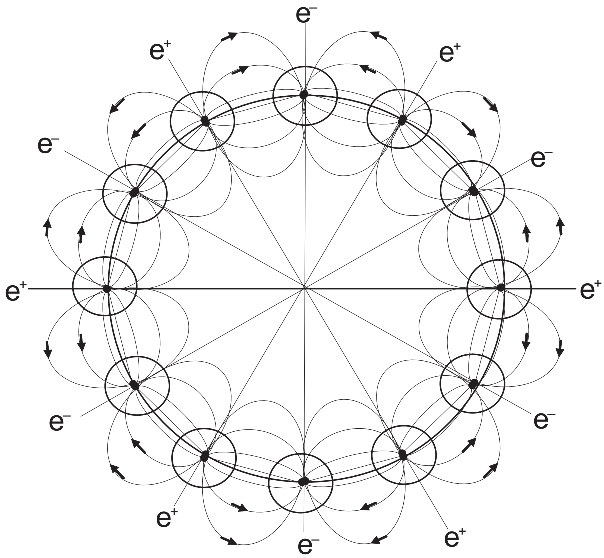


Fig. 7.4. Distribution of the electrical charges in the cross-section of the alternating shell of the nucleon and the alternating electrical field of the shell.

Figure 7.4 shows the distribution of the electrical charges (+*e* and –*e*) in the cross-section of the alternating shell of the nucleon and the alternating electrical field of the shell. The charges at the nodes of the alternating network are indicated by points. In the neutron, the alternating network is completely electrically neutral because it includes the paired number of the charges of different polarity, compensating the charge signs. In the proton, the composition of the alternating shell includes the uncompensated electrical charge of positive polarity. This shell model of the nucleon satisfies its properties:

– the alternating shell of the nucleon determines the complicated internal structure of the nucleon with a large number of electrical centres, regardless of the presence of the uncompensated charge of positive polarity at the proton and the electrical neutrality of the neutron;

– the alternating shells of the nucleons inside the atomic nucleus can interact with each other by short-range forces of electrical attraction and repulsion which are perceived as nuclear forces;

– the alternating shell of the nucleon has the role of the gravitational boundary of the particle, ensuring the strong spherical compression of the quantised medium in the formation of the nucleon mass which is almost 2000 times greater than the electron mass;

– the nucleon shell in the form of the alternating network freely penetrates through the quantised medium resulting in the wave transfer of the nucleon mass and, correspondingly, the mass of the atomic nucleus, satisfying the principle of corpuscular-wave dualism [5].

On the other hand, the presence of the alternating shell of the nucleon explains the behaviour of the orbital electron inside the atomic nucleus. This will be investigated on the example of approach of the electron to a proton nucleus when the radial electrical field of the proton changes to the alternating electrical field of the shell of the proton which has a tangential component (Fig. 7.4). It has already been mentioned that the forces of anti-gravitational repulsion operate in the vicinity of the proton nucleus between the orbital electron and the proton and they prevent the electron from falling on the nucleus. Now, it should be added that the orbital electron in the vicinity of the atomic nucleus penetrates into the field of the effect of tangential forces which may both push the electron forward or inhibit its movement, or act alternately by deceleration and acceleration. Although not very likely, the electron can also be captured by the proton because of the complicated configuration of the alternating electrical field of the proton as a result of tunnelling of the electron into the proton shell [5].

The complicated behaviour of the electron in the vicinity of the atomic nucleus indicates that the radiation of the orbital electron takes place in the immediate vicinity of the atomic nucleus, in the field of the strongest acceleration to which the electron is subjected. This is also determined by the condition of formation of the photon in the range of relativistic speeds [3]. In other cases, the electron cannot radiate at any coordinate point of its orbit. However, prior to investigating the conditions of non-radiation of the orbital electron, it must be mentioned that the electron in the atom is situated inside the gravitational well of the nucleus. The effect of the gravitational well of the behaviour of the orbital electron was not previously taken into account.

Figure 7.5 shows the gravitational diagram of the proton (or the atomic nucleus) which differs from the gravitational diagram of the electron (Fig. 7.1). The diagram is presented in a slightly simplified form, assuming that the gravitational boundary of the proton is continuous and not discrete as in Fig. 7.4. This assumption is not important for the evaluation of the behaviour of the orbital electron in the composition of the atom. It is important to note that outside the limits of the gravitational boundary of the proton a gravitational well is found in the external region of the space. All possible orbits of the electrons pass through the well.

The proton mass forms as a result of the spherical compression of the alternating shell of the proton together with the quantised medium (Fig. 7.4). Regardless of the fact that the distance between the charges of the alternating shell of the proton is approximately $1.2 \cdot 10^{-16}$ m and the quanton

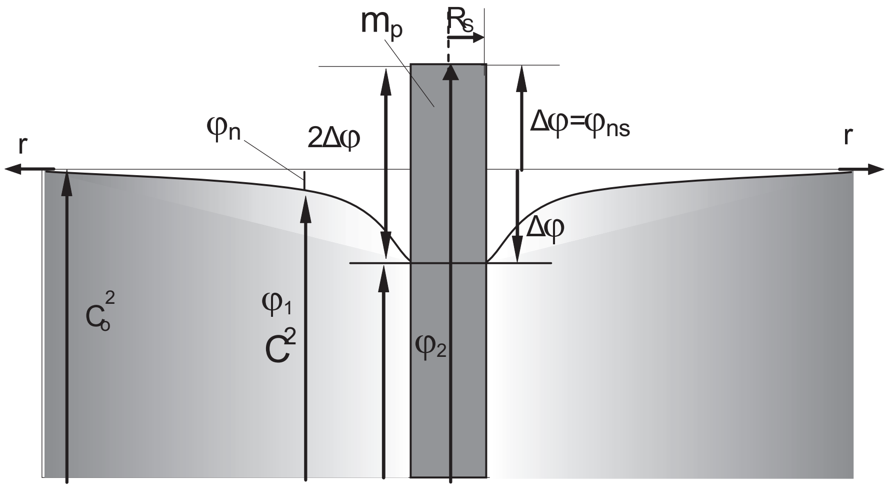


Fig. 7.5. Simplified gravitational diagram of the proton (atomic nucleus) in the form of distribution of the gravitational potentials in the spherically deformed quantised medium perturbed by mass m_p.

diameter is of the order of 10^{-25} m, the shell permits compression of the quantised medium. The effect of the electrostatic gate operates when the quantons, situated between the charges of the alternating shell in the field with a very high strength, form oriented chains which appear to be a continuation of the shell. Since the compression stress of the quantised medium by the shell is incomparably smaller in relation to the tension of the quantised medium, during movement of the proton in space the electrostatic gate does not interfere with the penetration of the medium through the proton shell. The analogue of the electrostatic gate and the effect itself have been verified reliably by the author of the book for the electrostatic field of the lattice of the alternating electrons in dosing devices of fine dispersion powders.

As a result of compression of the alternating shell of the proton inside the shell, the quantum density of the medium increases because it decreases on the external side. This has been investigated in detail in [2]. It is important to note that a gravitational well forms on the external side of the shell which represents the gravitational boundary in the medium. Since the quantum density of the medium is an analogue of the gravitational potential, the gravitational diagram in Fig. 7.5 shows the distribution of the gravitational potentials (for γ_n=1); the distribution function of this potential slightly differs from (7.27) for the electron

$$\begin{cases} \varphi_1 = C^2 = C_0^2\left(1 - \dfrac{R_g}{r}\gamma_n\right), & r \geq R_S \\ \varphi_2 = C_0^2\left(1 + \dfrac{R_g}{R_S}\gamma_n\right) \end{cases} \tag{7.43}$$

Equation (7.43) includes the root mean square radius $R_S = 0.8\cdot10^{-50}$ m of the proton and its gravitational radius R_g, which is a purely calculation parameter

$$R_g = \frac{Gm_p}{C_0^2} \tag{7.44}$$

Function (7.43) is sufficient for compiling the balance of the gravitational potentials inside the gravitational well of the proton (for $n = 1$) at the distance r

$$C^2 = C_0^2 - \varphi_n = C_0^2 - \frac{Gm_p}{r} \tag{7.45}$$

where φ_n is the Newton potential of the proton, m^2/s^2.

At the gravitational boundary with the radius R_S there is a 'jump' of the gravitational potentials $2\Delta\varphi = 2\varphi_{ns}$, where φ_{ns} is the Newton potential at the interface on the external side for $r = R_S$. The distribution function of the gravitational potential $\varphi_1 = C^2$ (7.44) and (7.45) inside the gravitational well is used as the basis in analysis of the behaviour of the orbital electron in the composition of the proton nucleus of the atom and was not previously taken into account in quantum mechanics.

Thus, the presence of the gravitational well at the proton nucleus of the hydrogen atoms makes it possible to link the behaviour of the orbital electron inside the gravitational well of the atomic nucleus with the fact that the gravitational well in particular is a factor of energy stabilisation of the atom as a whole and the reason for the non-radiation of the orbital electron.

7.4. Reasons for the non—radiation of the orbital electron

We discuss the simplest case of the behaviour of the orbital electron for the hydrogen atom with the proton nucleus when the electron falls on the nucleus. The gravitational well of the proton is described by the distribution of the gravitational potential of action $\varphi_1 = C^2$ (7.44) and (7.45) in the conditions of the effect of the electrical potential φ_e of the proton nucleus of the atom

$$\varphi_e = \frac{1}{4\pi\varepsilon_0}\frac{e}{r} \tag{7.46}.$$

Figure 7.6 shows the conventional turn of the trajectory of the orbital electron inside the gravitation well of the proton nucleus of the atom when, regardless of the continuous change of the distance *r* between the electron and the proton, the orbital electron does not generate continuous electromagnetic radiation. In particular, the presence of the gravitational well must be taken into account when analysing the reasons for the non-radiation of the orbital electron. Regardless of the small gravity force in comparison with the electrical force, as already mentioned, the energy of the gravitational well is determined by the spherical deformation of the quantised medium and not by gravity [2]. The attraction of the electron to the proton is determined by the electrical interaction. However, the behaviour of the electron inside the gravitational well of the nucleus greatly differs from the behaviour in the electrical field of the nucleus, if the effect of the gravitational well is not taken into account. It is characteristic that the gravitational potential C^2 (7.45) of the proton decreases when approaching the atom nucleus and the electrical potential φ_e (7.46) increases.

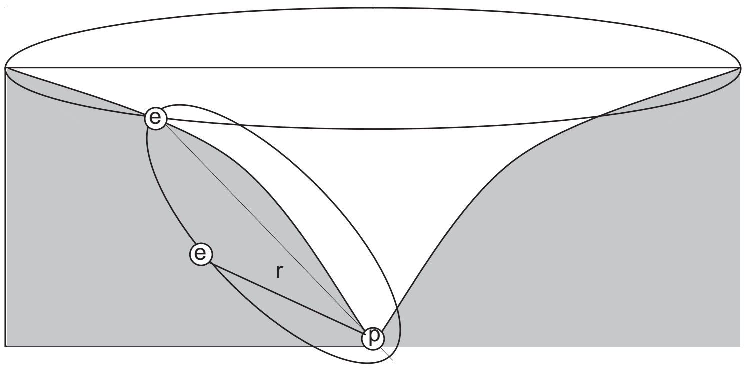


Fig. 7.6. Non-radiation of the orbital electron *e* in the conventional turn inside the gravitational well of the proton *p* of the nucleus of the atom with continuous radiation of the distance *r* between the electron *e* and the proton *p*.

It would appear that the total gravitational energy $W_{e\text{–}p}$ for the electron–proton system (*e–p*) is determined by the energy of deformation of the quantised medium by the electron and proton as the sum of the energies of the particles:

$$W_{e-p} = (m_e + m_p)C_0^2 \tag{7.47}$$

Consequently, the fraction of the gravitational energy W_{Ge} of the electron as the elastic energy of deformation of the quantised medium, in the total gravitational energy of the atom $W_{e\text{–}p}$ (7.47) can be taken into account by coefficient k_e. On the condition that $m_p \gg m_e$, we determine k_e and W_{Ge}

$$k_e = \frac{m_e}{m_p + m_e} \approx \frac{m_e}{m_p} \tag{7.48}$$

$$W_{Ge} = k_e W_{e-p} = \frac{m_e}{m_p + m_e}(m_e + m_p)C_0^2 = m_e C_0^2 \tag{7.49}$$

However, equations (7.47) and (7.49) were derived without considering the combined interaction of the electron and the proton when they are situated at a large distance from each other outside the gravitational well of the atom nucleus. However, when the electron and the proton come closer to a distance of short-range interaction, their spherical gravitational fields overlap each other and the proton field becomes dominant and displaces the electron into its gravitational well. In this case, the energy of the gravitational interaction of the electron–proton system with the quantised medium depends on the distance between the electron and the proton.

To determine the energy of interaction of the electron–proton system with the quantised medium, we use a new procedure taking into account that the transfer of limiting mass m_{emax} (7.8) inside the electron through its gravitational well (*a–b–c*) (Fig. 7.1) with a depth equal to the Newton potential φ_n of the electron at the distance $r_{e1} = r_e + R_e \approx r_e$ determines the gravitational rest energy W_0 (7.28) of the electron:

$$W_0 = \int_0^{-\varphi_n} m_{e\max} d\varphi == m_{e\max}(-\varphi_n) = -\frac{C_0^2 r_e}{G}\frac{Gm_e}{r_e} = -m_e C_0^2 \tag{7.50}$$

Actually, the hidden mass m_{emax} is found inside the electron in the rest state. The transfer of the mass into the depth of the electron is associated with work W_0 (7.50). Attention should be given to the fact that the Newton potential φ_n in the balance of the gravitational potentials (7.45) of the electron has the negative sign which also determines the rest energy W_0 (7.15) as energy with a negative sign. Usually, the rest energy (7.28) is used with the positive sign. The sign of the energy is important only when forming an energy balance which for the free electron is determined by the balance of the gravitational potentials inside its gravitational well

$$C^2 = C_0^2 - \varphi_n = C_0^2 - \frac{Gm_e}{r} \tag{7.51}$$

The distribution of the rest energy W_0 (7.15) of the electron as the energy of deformation of the quantised medium inside the gravitational well determines the equivalence of the gravitational and electrical W_e energies of the electron [4]

$$W_0 = W_e = m_e C_0^2 \frac{r_e}{r} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r} \quad (7.52)$$

Taking into account the negative sign of gravitational energy W_0 (7.50) of the electron, it may be assumed that its rest energy is completely balanced by electrical energy $W_e - W_0 = 0$.

For the electron moving from the rest state with the speed v, taking into account the effect of the principle of spherical invariance for the elementary particles, we introduce the normalised relativistic factor γ_n (7.7) into the equations (7.50), (7.51) and (7.52) which also takes into account the kinetic energy of the orbital electron

$$W = W_0\gamma_n = \gamma_n \int_0^{\varphi_n} m_{\max} d\varphi = m_{\max}\varphi_n\gamma_n = m_0 C_0^2 \gamma_n \quad (7.53)$$

$$C^2 = C_0^2 - \varphi_n\gamma_n = C_0^2 - \frac{Gm_e}{r}\gamma_n \quad (7.54)$$

$$W = W_0\gamma_n = W_e\gamma_n = m_e C_0^2 \frac{r_e}{r}\gamma_n = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}\gamma_n \quad (7.55)$$

Equation (7.54) makes it possible to form the balance of the total energy of the free electron in the quantised medium by multiplying (7.54) by $m_{e\max}$ (7.8) with (7.50) taken into account

$$m_{e\max}C^2 = m_{e\max}C_0^2 - m_{e\max}\varphi_n\gamma_n = m_{e\max}C_0^2 - m_{e\max}\frac{Gm_e}{r}\gamma_n \quad (7.56)$$

Equation (7.56) includes:

– the limiting energy of the electron $W_{e\max}$ (7.9)

$$W_{e\max} = m_{e\max}C_0^2 = \frac{C_0^4}{G} r_e \quad (7.57)$$

– the hidden energy of the electron W_c

$$W_c = m_{e\max}C_0^2 \quad (7.58)$$

– the observed electron energy W (7.55)

$$W = m_{e\max}\varphi_n\gamma_n = \frac{C_0^2}{G} r_e \frac{Gm_e}{r}\gamma_n = m_e C_0^2 \gamma_n \frac{r_e}{r} \quad (7.59)$$

The energy of the electron W (7.59) is determined by the total energy (7.53) of deformation of the quantised medium inside the gravitational well of the electron at $r_e = r$

$$W = m_e C_0^2 \gamma_n \tag{7.60}$$

Substituting (7.57), (7.58), (7.60) into (7.56), we can express the total balance of energy of the free electron in the quantised medium

$$W = W_{e\max} - W_c$$

$$m_e C_0^2 \gamma_n = \frac{C_0^4}{G} r_e - m_{e\max} C^2 \tag{7.61}$$

The total energy balance (7.61) of the free electron in the quantised medium indicates that its observed energy is determined by the difference between the limiting energy W_{emax} (7.57) and hidden energy W_c (7.58). With the increase of the speed of the free electron the hidden energy is transferred into the observed region, increasing the depth of the gravitational well of the electron in the quantised medium.

For the orbital electron, which is not free, it is necessary to re-examine its total energy balance (7.61), taking into account the interaction of the orbital electron with the proton nucleus of the atom. For this purpose, we use the previously mentioned procedure for the case of the bonded orbital electron in the composition of the atom and determine the gravitational energy W_{Ge-p} of the electron–proton system in transfer of the limiting mass $m_{\max}$ (7.8) of the electron through the gravitational well of the proton with a depth φ_n (7.45) as a result of particles coming closer to the distance r by analogy with (7.50)

$$W_{Ge-p} = m_{e\max}(-\varphi_n)\gamma_n = -\frac{C_0^2}{G} r_e \frac{Gm_p}{r} \gamma_n = -m_p C_0^2 \gamma_n \frac{r_e}{r} \tag{7.62}$$

As indicated by (7.62), the functional dependence of the gravitational energy W_{Ge-p} of the interaction of the electron–proton system with the quantised medium on the distance r between the particles is determined by the energy $m_p C_o^2 \gamma_n$ of the proton and the classic electron radius r_e.

The fraction of the gravitational energy W_{Ge} of the electron in the electron–proton system W_{Ge-p} (7.62) is determined by the multiplier k_e (7.48)

$$W_{Ge} = k_e W_{Ge-p} = -\frac{m_e}{m_p} m_p C_0^2 \gamma_n \frac{r_e}{r} = -m_e C_0^2 \gamma_n \frac{r_e}{r} \tag{7.63}$$

The normalised relativistic factor γ_n in (7.63) takes into account the speed of the orbital electron and its kinetic energy on the orbit in the composition of the gravitational energy (7.63) of the electron–proton system. When moving away from the proton, the energy (7.63) decreases and at infinity turns to 0.

It is interesting to note that the gravitational energy of the orbital electron W_{Ge} (7.63) in the composition of the proton nucleus of the atom as a function of the distance between the electron and the proton is determined like the gravitational energy (7.59) of deformation of the medium of the gravitational well of the free electron. The difference lies in the fact that the energy W_{Ge} (7.63) is characterised by the approach of the electron to the proton and energy W (7.59) by movement from the electron to the quantised medium.

The gravitational energy of the orbital electron W_{Ge} is the negative energy because the Newton potential φ_n of the proton in the balance (7.45) is negative and reduces the gravitational potential of action C^2 on approach to the proton. The negative value of energy (7.63) means that this component of the gravitational energy reduces the energy of the electron in its energy balance for the electron–proton system by the value W_{Ge} when these particles come together.

The equivalence of the gravitational and electrical energies (7.55) of the free electron is also found for the orbital electron in the composition of the proton nucleus when its gravitational energy W_{Ge} (7.63) in the electron–proton system is equivalent to the electrical energy W_e of the interaction of the electron and proton charges

$$W_e = W_{Ge} = m_e C_0^2 \gamma_n \frac{r_e}{r} = m_e C_0^2 \gamma_n \frac{1}{4\pi\varepsilon_0} \frac{e^2}{m_e C_0^2} \frac{1}{r} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r} \gamma_n \quad (7.64)$$

$$W_e = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r} \gamma_n \quad (7.65)$$

Equation (7.64) can be presented in a more convenient form of the energy balance for the orbital electron in the electron–proton system

$$W_e - W_{Ge} = 0$$

$$\frac{1}{4\pi\varepsilon_0} \frac{e^2}{r} \gamma_n - m_e C_0^2 \gamma_n \frac{r_e}{r} = 0 \quad (7.66)$$

Equation (7.66) was derived by the previously mentioned calculations which show that the orbital electron in the system of the proton nucleus (and also for any atom nucleus) should not radiate during the change of the distance r between the electron and the atom nucleus. In fact, when an atom falls on the nucleus the increase of the electrical energy of the interaction of the electron with the nucleus on approach to the nucleus is fully compensated by the equivalent decrease of the gravitational energy of the system.

Thus, the atom is a self-regulating system whose energy is maintained constant because in the case of the orbital electron only the energy of its interaction with the quantised medium as the rest energy $W_0 = -m_e C_0^2$ (7.50) remains unchanged and determines the energy balance of the orbital electron

$$\begin{aligned} W_0 &= -m_e C_0^2 + W_e - W_{Ge} = -m_e C_0^2 = \text{const} \\ -m_e C_0^2 &+ \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}\gamma_n - m_e C_0^2 \frac{r_e}{r}\gamma_n = \\ &= \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}\gamma_n - m_e C_0^2\left(1 + \frac{r_e}{r}\gamma_n\right) = \text{const} \end{aligned} \tag{7.67}$$

The equivalence of the gravitational energy W_{Ge} (7.64) and the electrical energy W_e (7.65) of the orbital electron of the electron–proton system in the composition of the atom whose energy (7.61) remains constant for any coordinate r of the electron on the orbit explains why the orbital electron does not generate continuous electromagnetic radiation. The problem may be formulated more accurately, assuming that the atom is a unique energy system which should not radiate energy continuously because of the complete balancing of its electrical and gravitational components, irrespective of the distance between the orbital electron and the atom nucleus.

However, the atom does emit photons discretely. If the physics of the atomic nucleus previously faced the problem of explaining the reasons for non-radiation of the orbital electron in the composition of the atom, it is now necessary to find the reasons for its photon radiation. It may be assumed the variation of the gravitational potential C^2 (7.45) of the action of the proton that inside the gravitational well changes the rest energy $W_0 = m_e C_0^2$ of the electron as a result of the fact that constant C_0^2 should be substituted by function C^2. We calculate the variation of the rest energy ΔW_0 of the orbital electron inside the gravitational well of the proton for the maximum case in which the electron comes closer to the proton to the distance of, for example, $r = 2r_e$

$$\Delta W_0 = m_e C_0^2 - m_e C^2 = m_e \varphi_n = \frac{G m_e m_p}{2r_e} = 1.8 \cdot 10^{-53}\,\text{J} = 1.1 \cdot 10^{-36}\,\text{eV} \tag{7.68}$$

As indicated by (7.68), the variation of the rest energy of the orbital electron inside the proton nucleus of the atom is so small that it cannot cause photon radiation of the electron. Possibly, the energy (7.68) is indeed emitted by the atom but the nature of this radiation is not yet known, it may be gravitational radiation. However, this constantly acting radiation with the frequency of rotation of the electron at the orbit of the atom cannot be measured by the currently available measurement method.

Thus, the investigation show that the atom is a balanced energy system which should not emit photon radiation is the result of changes of the electrical energy of the electron on the atom orbit. Prior to examine the reasons for the radiation of the atom, it is necessary to introduce a number of additions into the calculations described previously and relating to the electrical energy W_e (7.65) of the orbital electron in the relativistic region.

The effect of the gravitational factor γ_n (7.7) on the electrical energy W_e of the relativistic electron can be regarded as the variation of the relative dielectric permittivity ε_1 of the quantised medium of the electron–proton system in the range of the speeds close to the speed of light:

$$W_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}\gamma_n = \frac{1}{4\pi\varepsilon_0\varepsilon_1}\frac{e^2}{r} \tag{7.69}$$

$$\varepsilon_1 = \frac{1}{\gamma_n} \tag{7.70}$$

For the non-relativistic speeds $\varepsilon_1 \approx 1$. The variation of dielectric permittivity ε_1 (7.70) of the quantised medium with the increase of the speed of the electron is determined by the increase of the tension of the medium inside the gravitational well of the electron (Fig. 7.1) which in turn is situated inside the gravitational well of the atom nucleus (Fig. 7.5). Attention should be given to the fact that the relative dielectric permittivity $\varepsilon_1 < 1$ since it is connected with the tension of the quantised medium inside the gravitational well.

In the range of non-relativistic speeds for $v \ll C_0$, expanding the factor γ_n (7.7) into a series and rejecting insignificant terms, from (7.67) we obtain the balance of the energy of the orbital electron

$$\gamma_n \approx 1 + \frac{v^2}{2C_0^2} \tag{7.71}$$

$$\begin{aligned} W_0 &= -m_e C_0^2 + \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}\left(1 + \frac{v^2}{2C_0^2}\right) - m_e C_0^2 \frac{r_e}{r}\left(1 + \frac{v^2}{2C_0^2}\right) = \\ &= -m_e C_0^2 + \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r} - m_e C_0^2\frac{r_e}{r} + \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}\frac{v^2}{2C_0^2} - \frac{m_e v^2}{2}\frac{r_e}{r} = \text{const} \end{aligned} \tag{7.72}$$

Equation (7.72), like (7.67), shows that the electrical energy W_e of the orbital electron in its energy balance has an additional term which depends on the electron speed, and the kinetic energy of the electron as, in addition to the speed parameter, a connection for the distance between the electron and the proton nucleus. This relates not only the simplest hydrogen atom but also to all atomic systems.

That the atom is completely balanced from the energy viewpoint was proven in the theory of Superintegration, introducing the corrections associated with the deformation of the quantised medium by the atomic nucleus and the electron–proton system. In fact, the radial electrical field of the electron on approach to the proton nucleus transformed to the field of the electrical dipole of the electron–proton system, disrupting the spherical symmetry of the field of the electron. All this takes place inside the gravitational well of the proton. As a result, an increase of the electrical energy of the electron–proton system when the two come closer together is fully compensated by the decrease of the gravitational energy of the system which is not connected with the gravity fields.

The energy-balanced atom does not generate continuous radiation regardless of the nature of the trajectory of the orbital electron with the orbit of the electron having a complicated trajectory with the variable speed and acceleration. These complicated orbit are perceived as the electron cloud in the composition of the atom.

The completely compensated electrical and gravitational components of the orbital electron in the composition of the atom were not examined in the physics of elementary particles and the atomic nucleus. All the calculations were carried out for the homogeneous and isotropic space-time inside the atom, without taking into account its deformation inside the gravitational well of the atom nucleus. Naturally, the incomplete model of the atom created considerable difficulties in quantum theory.

Only by taking into account the heterogeneity of the quantised medium, determined by its tensioning inside the gravitation well and compression inside the proton (neutron) and the electron in the composition of the atom is possible to carry out more accurate calculations of the atom, corresponding to the experimental observations. Maxwell electrodynamics does not work inside the atom. This is determined by the fact that the Maxwell energetics and, more accurately, balancing of its electrical and gravitational components of the atom, is based on the super strong electromagnetic interaction (SEI) which determines the electromagnetic nature of all interactions, and not allowing the atom to continuously radiate energy. In fact, the above calculations recover the classic nature of quantum theory, confirming Einstein's believe that the quantum theory should lead to the deterministic nature of the laws of quantum physics.

7.5. Reasons for proton radiation of the orbital electron

In the previous section, it was shown that the orbital electron on any orbit cannot continuously radiate electromagnetic energy regardless of the complexity of its trajectory. Bohr postulated the stationary condition of the atom in which the atom does not radiate. This Bohr postulate has now been strictly substantiated.

On the other hand, Bohr also postulated that the atom emits discretely the photon energy at the moment of transition from a higher to a lower orbit. The energy of photon radiation at the moment of such a transition is determined by the difference of the energy state (7.2) of the orbital electron on the given orbits. The incorrectness of this assumption already becomes clearly evident when explaining the reasons for non-radiation of the orbital electron when the concept of the electron orbit requires efficient explanation. As already mentioned, the wave mechanics excluded the very concept of the electron orbit, replacing it with a probability electron cloud. Therefore, the Bohr postulate, describing the moment of radiation of the photon in transition from one orbit to another, is governed by the Heisenberg uncertainty principle in which the coordinate of the electron trajectory at the moment of radiation is not determined.

In fact, returning to examining only one turn of the electron orbit, even if the orbit is non-stationary, it is not possible to determine the coordinate of the trajectory when the electron should 'jump' from the orbit and emit a photon (Fig. 7.6). All the coordinates of the electron orbit are equally important because in accordance with the energy balance (7.67) of the orbital electron in the composition of the atom, the electron is not capable of emitting a photon. This means that the reason for the photon radiation of the orbital electron cannot be the jump of the electron to a lower orbit because this contradicts the energy balance (7.67). This leaves the second non-contradicting assumption according to which the transition of the electron to another orbit takes place already after photon radiation. This transition of the electron is a consequence whose reason must be determined and justified.

It was shown in [3] that the photon, as a two-rotor wave particle, can form only in the region of relativistic speeds. This means that for the orbital electron to emit a photon, the electron should be accelerated to a speed very close to the speed of light. The atom, as a self-regulating system, must not permit the relativistic increase of the mass of the orbital electron in order to avoid disrupting the mass of the atom as a whole. Partially, this is confirmed by the energy balance (7.67) of the orbital electron, showing that the Maxwell electrodynamics does not operate inside the atom in interaction of the orbital electron with its nucleus. The uniqueness of the structure of the atom should also be manifested in the fact that the relativism laws cannot operate inside the atom in the sense that they should lead to an unlimited increase of the mass of the orbital electron in the speed range close to the speed of light.

Naturally, the electricity, magnetism and gravitation are combined together inside the atom, and the radiation spectrum can be linked quite accurately with the results of calculations through the variation of the electrical component. As it has been shown, the specific features of the behaviour of the orbital electron in the composition of the atom are such that in principle the atom should not radiate with the variation of the electrical component. Therefore, the main reason for the photon radiation of the orbital electron in accordance with (7.2) can only be its mass defect. In nuclear reactions, the concept of photon radiation as a result of the mass defect of the nucleus has been generally accepted and is not doubted. It is now necessary to show that the mass defect of the electron is also the reason for photon radiation of the orbital electron.

It is well known that the electron moving uniformly and in a straight line does not radiate. Radiation is the result of acceleration (deceleration) of the electron. In experiments, this has been confirmed by bremsstrahlung and synchrotron radiation [16]. It is fully logical to assume that there is some critical acceleration $\mathbf{a}_{cr}$ of the orbital electron which determines the moment of its photon radiation. In this case, the radiation momentum is determined by the condition of reaching the critical acceleration by the electron ($\mathbf{a}$ is electron acceleration)

$$\mathbf{a} \geq \mathbf{a}_{cr} \tag{7.73}$$

As already mentioned, the electron mass is determined by the elastic energy of spherical deformation of the quantised medium. Evidently, the mechanism of photon radiation in acceleration of the electron above the critical value (7.73) is determined by the disruption of spherical symmetry of its gravitational field which is characterised by some critical displacement of its point charge in relation to the centre of the spherical gravitational boundary of the electron, disrupting its symmetry. To restore the symmetry of the field, the electron should release its asymmetric part in the form of the energy of elastic deformation of the quantised medium to photon radiation. This determines the mass defect of the orbital electron which after releasing part of the energy into radiation changes the trajectory of the orbit to a lower one, forming a new electron cloud from the trajectories around the atomic nucleus.

Previously, the state of the theory of the orbital electron was such that it was not possible to determine the moment of radiation of the electron on its trajectory. Assuming that the moment of radiation is associated with some critical acceleration $\mathbf{a}_{cr}$ (7.73) of the orbital electron in the range of relativistic speeds, it may be assumed that the critical acceleration is reached only at the surface of the atomic nucleus. Only at the surface of the core can the electron reach the relativistic speed and change the trajectory in the vicinity of the nucleus, ensuring the required radius of the trajectory and critical acceleration. Consequently, the solution of the problem of radiation of the orbital electron is reduced to determining the critical acceleration $\mathbf{a}_{cr}$, directly linked with the instantaneous speed of the electron and the radius of its orbit in the vicinity of the atomic nucleus.

Figure 7.7 shows the diagram of the radiation of the photon ν by the orbital electron *e* on the proton *p* nucleus of the atom. This scheme is an analogue of synchrotron radiation when the photon is emitted as a result of the electron reaching critical acceleration $\mathbf{a}_{cr}$ in movement of the electron along the radius. The direction of photon radiation ν coincides with the vector of the speed of the electron **v** at the moment of radiation, possibly with a small angle of the raster. The photon behaves as part of the electron mass, selecting the direction of its movement which coincides with the direction of movement of the electron at the moment of radiation. The recoil pulse of the photon to the electron is directed against the direction of movement of the electron, reducing its speed and determining the transfer of the electron from the excited state to the stationary orbit.

The concept of radiation of the orbital electron on the atom nucleus makes it possible to concretise the very moment of radiation when the position of the atom at the moment of radiation is known. Figure 7.7 shows a set of instantaneous trajectories where one of them corresponds to the stationary orbit without photon radiation, and the others to excited orbits, capable of radiation by the electron of a photon with a specific energy and frequency. Naturally, the electron orbits are quantised because they

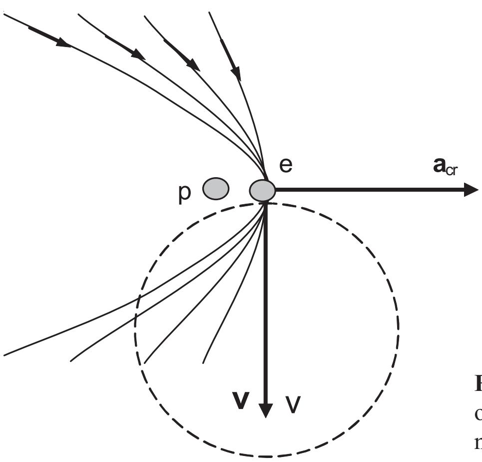


Fig. 7.7. Radiation of a photon ν by the orbital electron *e* at the proton *p* atom nucleus.

determine the quantised state of its speed and the radius of the trajectory in the vicinity of the atomic nucleus.

To calculate the speed parameters of the electron in the vicinity of the proton nucleus, we examine the case of nonrelativistic incidence of the electron on the proton along the axis X with the origin of the coordinates on the proton. It is important to determine the speed of the electron at the moment of coming closer to the proton which is determined by the electrical force $\mathbf{F}_e$ of the Coulomb attraction of the electron and the proton:

$$\mathbf{F}_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{x^2}\mathbf{1}_x \tag{7.74}$$

The equation of movement of the electron falling on the proton is described by the well-known nonrelativistic dynamics equation

$$\mathbf{F}_e = m_e\frac{d\mathbf{v}}{dt}, \quad \text{or} \quad \mathbf{F}_e = m_e v\frac{d\mathbf{v}}{dx} \tag{7.75}$$

Substituting (7.74) into (7.75) and separating the variables we can write the differential equation with the integration limits with respect to speed from 0 to v, and with respect to the distance from $x_0 = 0$ to $x = 2r_e$, where $2r_e$ is the minimum distance between the centres of the charges of the electron and the proton

$$\int_0^v v\,dv = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{m_e}\int_{x_o}^{2r_e}\frac{dx}{x^2} \tag{7.76}$$

Integrating (7.76)

$$\frac{v^2}{2} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{m_e}\left(\frac{1}{2r_e} - \frac{1}{x_0}\right) \tag{7.77}$$

Accepting that $r_e \ll x_0$, we multiply the right-hand part of (7.77) by C_0^2/C_0^2, and taking into account the equation for the classic radius of the electron r_e, we determine the speed of incidence of the electron in the vicinity of the proton

$$v = C_0 \tag{7.78}$$

As indicated by the solution of (7.78), even when falling from a small height on the proton, the nonrelativistic electron does reach the speed of light which would appear to be not realistic from the classic viewpoint. On the other hand, the results show that under the condition of radiation on an atom nucleus all orbital electrons are relativistic and the dynamics equation (7.75) should include the normalised relativistic factor γ_n (7.7). This is determined by the the speed of the electron being independent of the coordinate axes when the electron comes very close to the proton nucleus. However, the electron falls on the proton along a complicated trajectory (not a straight line), including the radial and tangential components.

The relativistic equation of the dynamics of the orbital electron should include the relativistic factor γ_n (7.7) in (7.75) taking into account the reduced mass m'_e of the orbital electron determined below:

$$\mathbf{F}_e = \frac{d(m'_e \mathbf{v} \gamma_n)}{dt}, \quad \text{or} \quad \mathbf{F}_e = v\frac{d(m'_e \mathbf{v} \gamma_n)}{dx} \tag{7.79}$$

The solution of the equation (7.79) should be connected with the total energy balance (7.67) of the orbital electron replacing the notation of the distance r by x

$$W_0 = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{x}\gamma_n - m_e C_0^2\left(1+\frac{r_e}{x}\gamma_n\right) = \text{const} \tag{7.80}$$

Equation (7.80) includes the electrical energy W_e (7.69) of the interaction of the electron with the proton and the total gravitational energy W_G of the orbital electron in the composition of the proton nucleus of the atom

$$W_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{x}\gamma_n \tag{7.81}$$

$$W_G = -m_e C_0^2\left(1+\frac{r_e}{x}\gamma_n\right) \tag{7.82}$$

From (7.81) we determine the electrical energy $\mathbf{F}_e$, acting on the orbital electron from the side of the proton charge

$$\mathbf{F}_e = \frac{dW_e}{dx} = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{x^2}\gamma_n \mathbf{1}_x \tag{7.83}$$

From (7.82) we determine the reduced mass m'_e of the orbital electron in the composition of the proton atom of hydrogen

$$m'_e = \frac{W_G}{C_0^2} = -m_e\left(1+\frac{r_e}{x}\gamma_n\right) \tag{7.84}$$

Substituting (7.34) into (7.78) we obtain

$$\mathbf{F}_e = v\frac{d(m'_e \mathbf{v} \gamma_n)}{dx} = -m_e v \frac{d\left(1+\frac{r_e}{x}\gamma_n\right)\mathbf{v}\gamma_n}{dx} \tag{7.85}$$

Substituting (7.83) into (7.85) and after separating the variables, we obtain the relativistic equation of dynamics of the orbital electron, whose solution should be found in relation to speed v

$$\frac{v}{\gamma_n} d\left(1+\frac{r_e}{x}\gamma_n\right)\gamma_n v = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{m_e}\frac{dx}{x^2} \tag{7.86}$$

It is not possible to completely separate the variables with respect to x in (7.86). Taking into account that the solution (7.86) depends on the value of x in the vicinity of the proton, equation (7.86) can be simplified in the first approximation, accepting the minimum distance $x = 2r_e$ in its left part

$$\frac{v}{\gamma_n} d\left(\gamma_n v+\frac{1}{2}\gamma_n^2 v\right) = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{m_e}\frac{dx}{x^2} \tag{7.87}$$

In the second approximation (7.97), the relativistic factor can be taken away from below the differential sign. Consequently, in integration taking into account that the integral of the right-hand part of (7.87) has already been determined as $C_0^2/2$ in (7.77), we obtain

$$\int v dv + \frac{1}{2}\int \gamma_n v dv = \frac{C_0^2}{2} \tag{7.88}$$

Equation (7.88) can be simplified by replacing the normalised relativistic factor γ_n (7.7) by the conventional relativistic factor γ, making more severe the conditions at which the limiting parameters of the relativistic electrons are not restricted

$$\gamma_n \approx \gamma = (1 - v^2/C_0^2)^{-0.5} \tag{7.89}$$

Substituting (7.89) into (7.88) gives

$$\int v dv + \frac{C_0}{2}\int (C_0^2 - v^2)^{-0.5} v dv = \frac{C_0^2}{2} \tag{7.90}$$

Integrating (7.19) we obtain the equation linking the speed of the orbital electron in the vicinity of the proton nucleus of the atom with the speed of light at the minimum distance $x = 2r_e$

$$\frac{v^2}{2} - \frac{C_0}{2}\sqrt{C_0^2 - v^2} = \frac{C_0^2}{2} \tag{7.91}$$

The solution of (7.91) includes the real and imaginary value of the speed. It is interesting to consider the real value of the speed

$$v = C_0 \tag{7.92}$$

Verification of the validity of the solution (7.92) by substitution into (7.91) shows that the solution of (7.92) is accurate. It would appear that we have obtained a paradoxic result, identical with (7.78), when the orbital electron is capable of reaching the speed of light in the composition of the atom even when solving the relativistic equation. In fact, the limiting speed of the orbital electron is slightly higher than the speed of light because a number of assumptions has been made in the solutions

$$v = C \leq C_0 \qquad (7.93)$$

The speed of the electron (7.93) in the relativistic range is denoted through $C \leq C_0$ because the result (7.92), as already mentioned, has been obtained with certain assumptions, simplifying the solution of the equations. However, even if all the assumptions are removed because of the large volume of complicated computations, the speed (7.93) of the orbital electron in the vicinity of the atomic nucleus is close to the speed of light, albeit slightly lower. This is not important now. It is important to note that the solution of the nonrelativistic (7.74) and relativistic (7.79) equations of the dynamics of the orbital electron results in almost identical results (7.78) and (7.92).

On the other hand, the arbitrarily selected parameter of the distance between the electron and the proton $x = 2r_e$ is limiting, with the particles not being able to come closer together, regardless of the fact that the calculation radius of the proton $0.8 \cdot 10^{-15}$ m is slightly smaller than the classic radius of the electron $r_e = 2.8 \cdot 10^{-15}$ m. It would appear that there is still some gap in which they can come closer together. However, it is evident that, as already mentioned, this gap is determined by the forces of anti-gravitational repulsion which prevent the proton from capturing the electron, except for an unlikely effect of electron capture.

The classic solution for the speed of the orbital electron when approaching the proton nucleus of the atom to the distance $x = 2r_e$ can be determined from the relativistic equation for the energy balance. In this case, the increase of the energy of the orbital electron in acceleration in the electrical field regardless of the form of its trajectory is determined by the difference of the electrical potentials φ_e of the proton field through which the electron has passed:

$$m_e C_0^2 (\gamma - 1) = e\varphi_e$$

$$\text{where } e\varphi_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{2r_e} = \frac{m_e C_0^2}{2} \qquad (7.94)$$

The solution of (7.94) is

$$\gamma = \frac{3}{2}, \quad v = 0.75C_0 \tag{7.95}$$

It would appear that the solution $v = 0.75\ C_0$ (7.95) corresponds to the condition in which the speed of the relativistic electron is relatively high but considerably lower than the speed of light. However, the solution (7.95) was obtained from the incomplete energy balance of the electron (7.94) which does not correspond to the balanced nature of the energy of the atom, as the total balance (7.67) giving the solution $v = C \leq C_0$ (7.92), (7.93).

The fact that the speed of the orbital electron reaches the speed of light in the solution $v = C \leq C_0$ (7.93) or is very close to the speed of light, does not contradict the model of synchrotron radiation of the electron, and it was shown by experiments that the electron is capable of radiation only in the range of relativistic speeds, close to the speed of light. This position is also in agreement with the condition of radiation of the electron only at relativistic speeds [3]. The orbital electron cannot pulled into the atom at the moment of radiation. However, the radiation of the electron in a synchrotron has been studied quite extensively, and the synchrotron model, as the model of radiation of the orbital electron with corrections for the energy balancing of the atom, shows further potential for development [16].

Naturally, the results showing that the speed C (7.93) of the orbital electron is very close to the speed of light would cause objections because the theory of relativity does not enable the electron to reach the speed of light. However, the theory of relativity was not completed by Einstein and was completed in the theory of EQM and Superintegration not only as the theory of gravitation but also as the theory of integration of gravitation and electromagnetism and also of all other fundamental interactions. The theory of EQM and Superintegration confirms the assumptions of the theory of relativity, assuming that the orbital electron cannot exceed the speed of light, and this condition is fulfilled in the resultant solution (7.93).

In the rectangular coordinates (x, y, z) the vector of speed **C** (7.93) of the orbital electron at the moment of radiation can be expanded with respect to the unit vectors **i, j, k**

$$\mathbf{C} = v_x\mathbf{i} + v_y\mathbf{j} + v_y\mathbf{k} \tag{7.96}$$

$$\mathbf{C} = \frac{\partial x}{\partial t}\mathbf{i} + \frac{\partial y}{\partial t}\mathbf{j} + \frac{\partial z}{\partial t}\mathbf{k} \tag{7.97}$$

The modulus of speed C and its direction $\mathbf{n}_c$ are determined taking into account (7.96) or (7.97)

$$C = \sqrt{v_x^2 + v_y^2 + v_z^2} \quad (7.98)$$

$$\mathbf{n}_c = \frac{\mathbf{C}}{C} = \frac{v_x\mathbf{i} + v_y\mathbf{j} + v_y\mathbf{k}}{\sqrt{v_x^2 + v_y^2 + v_z^2}} \quad (7.99)$$

There is another important question which requires explanation. When the electron reaches the speed of light $C \approx C_0$, its mass should reach the limiting value (7.8)

$$m_{e\max} = m_e \gamma_n = \frac{C_0^2}{G} r_e = 3.8 \cdot 10^{12}\,\text{kg} = 4.2 \cdot 10^{42}\, m_0$$
$$\text{at} \quad v = C_0^2 \quad (7.100)$$

However, the experiments have not indicated any increase of the mass of the atom as a result of the colossal increase of the mass (7.99) of the orbital electron when the electron should become periodically a massive nucleus and the proton an orbital particle, and vice versa. Therefore, it turns out that the atom does not show any relativistic increase of the mass of the orbital electrons. This only confirms the validity of the complete balancing of the atom energy (7.67) which is maintained constant regardless of the distance between the electron and the proton and also the speed of the orbital electron. The atom is a complicated self-regulating system where the radial electrical field of the orbital electron is responsible for the formation of its mass. When the electron and the proton come closer together, their fields form the field of the electrical dipole and the increase of the energy of this field results in the stabilisation of the mass of the relativistic electron, ensuring energy balance (7.67).

Naturally, the balancing of the energy (7.67) of the orbital electron in the composition of the atom suggests that the electron orbits of the atom are not ballistic from the classic viewpoint in which the movement of the particle (solid) in the central force field of attraction is not described by circular or elliptical orbits [6]. Historically, the theory of the atom, starting with the Bohr atom, repeated initially the circular planetary trajectories of the electron orbits and subsequently transferred to elliptical orbits, on the basis of ballistic calculations. However, it turned out that the model of the Bohr atom is too simplified and does not explain the entire radiation spectrum. In the final analysis, the wave mechanics arrived at the statistical model of the orbital cloud in the composition of the atom when the electron appears to get lost (dissolve) in the orbital cloud, taking into account the uncertainty principle.

Now the Superintegration theory returns fully determined parameters to the atom model and it is possible to concretise the orbits of the atom which are not ballistic in the classic sense of the meaning. The ballistics of the orbital electron is corrected not only by the energy balancing of the atom but also by the additional momentum received by the electron in the vicinity of the proton nucleus from the tangential component of the electrical field of the alternating shell of the proton (Fig. 7.4). In addition to this, in the vicinity of the proton nucleus the orbital electron is subjected to the effect of the forces of anti-gravitational repulsion preventing the electron from falling on the proton. In the final analysis, the trajectory of the electron orbit is complicated and has not as yet been calculated. However, it is now already possible to propose the nature of the trajectory of the orbital electron, taking into account that its radiation takes place in the immediate vicinity of the nucleus.

Figure 7.8 shows the trajectory of the orbital electron *e* in relation to the proton nucleus *p* of the atom (a) and the electron cloud of the stationary orbit around the nucleus (b). It is the trajectory of the electron falling on the nucleus when the vertical component of the speed in the apogee is equal to 0 and the speed in the vicinity of the proton nucleus reaches the maximum value $v = C \leq C_0$ (7.92). If we examine the probability parameters of the position of the electron on the orbit, it is quite clear that the electron can be detected in most cases in the region of small speeds at a large distance from the nucleus and this determines the most probable region in the form of the probability electron cloud. This is in agreement with the main assumptions of wave mechanics. However, the Superintegration theory permits the nature of electron orbits to be concretised and, most importantly, concretise the moment of radiation of the electron.

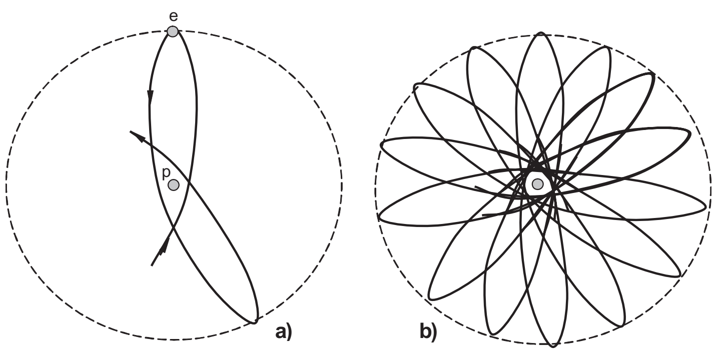


Fig. 7.8. Trajectory of the orbital electron *e* in relation to the proton nucleus *p* of the atom (a) and the electron cloud of stationary orbits around the nucleus (b).

It can already be claimed that the trajectories of the orbital electron are not situated in the same plane because the additional momentum, received by the electron as a result of the effect of the electrical field of the alternating shell of the proton nucleus, has a directionality vector. It appears that one turn of the orbital electron around the nucleus is positioned in the plane of the orbit but already the next turn changes of the position of the plane of the electron orbit in space. The planes of the two orbits 1 and 2 in the rectangular coordinate system can be expressed by the initial coordinates of the point (x_{01}, y_{01}, z_{01}) and (x_{02}, y_{02}, z_{02}) situated in different planes and the parameters of the vectors $\mathbf{N}_1(A_1,B_1,C_1)$ and $\mathbf{N}_2(A_2,B_2,C_2)$ perpendicular to the given planes, respectively [17]:

$$\begin{aligned} &A_1x + B_1y + C_1z + D_1 = 0 \\ &D_1 = -(A_1x_{01} + B_1y_{01} + C_1z_{01}) \end{aligned} \tag{7.101}$$

$$\begin{aligned} &A_2x + B_2y + C_2z + D_2 = 0 \\ &D_2 = -(A_2x_{02} + B_1y_{02} + C_1z_{02}) \end{aligned} \tag{7.102}$$

The orbital angle $\varphi_{1\text{-}2}$ between the planes is important, i.e., the angle of rotation of the plane of the orbit for the turn of the orbital electron around the atomic nucleus:

$$\cos\varphi_{1-2} = \pm\frac{A_1A_2 + B_1B_2 + C_1C_2}{\sqrt{A_1^2 + B_1^2 + C_1^2}\sqrt{A_2^2 + B_2^2 + C_2^2}} \tag{7.103}$$

The presence of the orbital angle φ_{1-2} (7.103) of rotation of the orbital plane of the electron can be substantiated only if the atomic nucleus transfers the additional nuclear momentum $\mathbf{p}_a$ to the orbital electron. The direction of the vector of this pulse does not agree with the direction of speed $\mathbf{C}$ of the electron (7.96)

$$\mathbf{p}_a = \sum_{t_0}^{t} \mathbf{F}_a(t)t \tag{7.104}$$

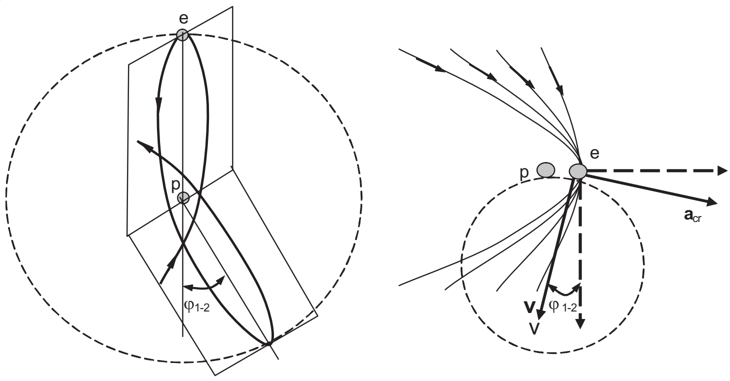
The nuclear momentum $\mathbf{p}_a$ (7.104) is written in the form of the sum of the individual pulses in the entire section of the effect of the force of the nucleus $\mathbf{F}_a(t)$ as a function of time (or coordinates) from the origin of the effect t_0 on the orbital electron to the end of the effect t. Equation (7.104) can be presented in the integral form, although this is not important at the moment. The additional nuclear momentum $\mathbf{p}_a$ on the electron in the vicinity of the alternating shell of the proton nucleus is comparable with the nuclear forces as regards the magnitude and is determined by the effect of the vector of the strength $\mathbf{E}_a(t)$ of the alternating shell as the function of the coordinates presented with respect to time t

$$\mathbf{p}_a = \sum_{t_0}^{t} e\mathbf{E}_a(t)t \tag{7.105}$$

In the opposite case, the electron orbit should be situated in the same plane like the orbits of the planets, but the electron moves along a complicated trajectory generating the electron cloud around the nucleus from the trajectories situated in different planes. This again confirms that in the vicinity of the atomic nucleus the orbital electron is subjected to the effect of the additional nuclear momentum $\mathbf{p}_a$ (7.105) determined by the effect of the electrical field of the alternating shell of the proton nucleus (Fig. 7.4). Consequently, the plane of trajectory of the electron orbit changes by the angle φ_{1-2} (7.103).

It should be mentioned that the orbital angle φ_{1-2} (7.103) is of the statistical nature, both with respect to magnitude and direction. This is determined by the complicated configuration of the field of the alternating shell of the proton nucleus [7]. At the moment of approach to the surface of the proton nucleus which consists of the nodes of the alternating network, the electron interacts in a completely random manner with a large number of the nodes of the network and constantly changes the orbit plane. In the final analysis, we obtain an electron cloud around the atomic nucleus, even for a single orbital electron. Consequently, the scheme in Fig. 7.8 can be made more accurate for the case in which the orbit plane rotates in the vicinity of the proton nucleus. Figure 7.9 shows the rotation of the plane of the stationary orbit of the electron through the angle φ_{1-2} (a) and at the moment of radiation of the photon ν on the proton nucleus p of the atom (b) in transition from one orbit to another.

The effect of the structure of the nucleons of the atomic nucleus in the case in which the nucleons form a network of alternating fields on the surface of the nucleus causes that the behaviour of the orbital electron in the composition of the atoms greatly differs from its behaviour in the composition of the positronium (orthopositronium) in the absence of a similar network [18, 19]. For comparison, these are very useful models which enable us to analyse the behaviour of the electron in the composition of the atom and the positronium. It is not quite correct to assume that positronium is a hydrogen-like system because in positronium the role of the atomic nucleus appears to be played by the positron with a positive electrical charge, like the proton. However, the positron, in contrast to the proton, although it is the carrier of the electrical charge with positive polarity, does not have the alternating shell which gives the nuclear properties to the atom. In particular, the alternating shell determines the large mass of the nucleons and prevents



a *b*

Fig. 7.9. Rotation of the plane of the stationary orbit of the electron through the angle φ_{1-2} (a) and at the moment of radiation of the photon ν on the proton nucleus *p* of the atom (b).

the orbital electron from falling on the atomic nucleus and determines the stability of atomic structure in contrast to the positronium.

Positronium does not have the properties of the atom because the positron does not have the properties of the atomic nucleus. The combined incidence of the electron on the positron, vice versa, results in two- or three-photon annihilation of the particles. The gravitational boundaries and the zones of anti-gravitational repulsion in the electron and the positron break open, resulting in their charges coming together to the distance smaller than the classic radius of the electron. It should be mentioned that the Superintegration theory supplements for the first time the reaction of annihilation of the electron and the positron by the appearance of the electron neutrino ν_e. We can write the two-photon reaction of annihilation with emission of 2γ gamma-quanta, denoting the electron and the positron as e_m^- and e_m^+ (index $_m$ indicates the presence of the mass in the particle, the index ± the presence of the electrical charge)

$$\begin{gathered} e_m^- + e_m^+ \to 2\gamma + e^- e^+ \to 2\gamma + \nu_e \\ \text{where} \quad e^- e^+ \to \nu_e \end{gathered} \tag{7.106}$$

The annihilation of reaction (7.106) shows that only the plus mass of the particles transfers into the emission of two gamma quanta 2γ. The charges form an electrical dipole $e^-\,e^+$ which is nothing else but the electron neutrino ν_e. In particular, the electrical dipole $e^-\,e^+$ is the elementary bit of information in vacuum according to which a pair of particles existed: the electron and the positron, fulfilling the law of conservation of information. On the whole, the electron neutrino carries the total latent energy of the electron and the positron ensuring that all the conservation laws are fulfilled [4].

The electron and the positron have the same mass but charges with opposite signs. Therefore, examining the positronium, it may be regarded as an electrical dipole and a gravitational dumbbell, formed by equivalent masses of the particles. In all likelihood, in rotation of the dumbbell the centrifugal forces acting on the mass of the particles are capable of preventing for a short period of time the electrical charges from rapidly coming together and determine the lifetime of the positronium. However, in any case, the electrostatic forces of the charges overcome the centrifugal forces and gravitation and lead to annihilation of the particles. In the final analysis, there is the combined incidence of the electron and the positron on each other. As shown by calculations, the speed of incidence of the particles at the annihilation distance is in the relativistic range. This is also in agreement with the assumption according to which the photon radiation, including gamma quanta, takes place at relativistic speeds. However, in contrast to the hydrogen atom, there are no mechanisms of stabilisation of the particle mass in the relativistic range of speeds working in the positronium atom and this may result in three-photon (or greater) radiation.

The instability of positronium stresses again that the stability of the simplest hydrogen atom is determined by the complicated structure of the proton nucleus. This relates to all atomic nuclei consisting of protons and neutrons. A shortcoming of all currently available atom theories is that the calculations were carried out taking into account only the electrical charge of the atomic nucleus which generates the radial electrical field, and the tangential component of the field of the alternating shell and the presence of the gravitational well at the nucleus were completely ignored. In this case, the hydrogen atom differs from the positronium only by the larger mass of the nucleus which does not explain the greatly differing properties of the hydrogen atom in comparison with positronium.

However, the properties of positronium and the hydrogen atom differ so much that they could be explained in the Superintegration theory only after discovering the structure of the elementary particles: electron, positron, nucleons, and also the structure of the atomic nucleus. As shown, as regards the physical nature the interaction between the electron the proton is not capable of causing annihilation of these particles. However, the interaction between the electron and positron cannot take place without their annihilation. For this reason, positronium is not capable of radiating low-energy photons like atomic structures.

In particular, the specific features of the structure of the atom nucleus determine not only its stability but also the emission of the orbital electron.

Figure 7.10 shows the moment of transition of the orbital electron ν e from the orbit 2 to the low stationary orbit 1 with the emission of a photon with a frequency ν at the moment of coming together with the proton nucleus *p*. It may be seen that the electron is transferred from the excited orbit 2 to the stationary orbit 1 only after emission of the photon by the orbital electron on the atomic nucleus. Consequently, the well-known assumptions of the quantum theory can be made more accurate. These assumptions state erroneously that the radiation by an electron takes place at the moment of transition of the electron from the excited to stationary orbit. The moment of radiation (coordinate and time) itself has not been accurately defined. The EQM theory states more accurately that the transition of the electron to the stationary orbit already takes place after radiation of the photon by the electron directly on the atom nucleus.

On the stationary orbit 1, the distance between the orbital electron and the proton constantly changes but the electron on the stationary orbit is not capable of radiation. For the electron to be capable of radiation, it must be transferred to the excited orbit. As already mentioned, the condition of radiation of the orbital electron on the atom nucleus is the acceleration of the electron **a** which must reach some critical acceleration $\mathbf{a} \geq \mathbf{a}_{cr}$ (7.83).

In the simplified classic form, the acceleration **a** and the direction of acceleration $\mathbf{n}_a$ of the orbital electron are determined by the variation of the speed **v** with time *t* during movement along a complicated orbital

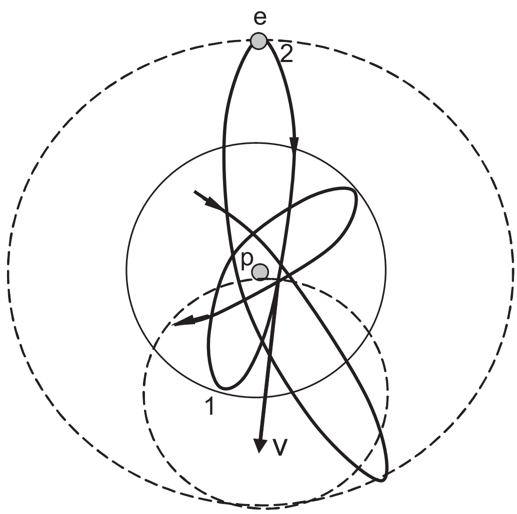


Fig. 7.10. The transition of the orbital electron *e* from the orbit 2 to the low stationary orbit 1 with the emission of a photon with frequency ν in the vicinity of the proton nucleus *p*.

trajectory:

$$\mathbf{a} = \frac{\partial v_x}{\partial x}\mathbf{i} + \frac{\partial v_y}{\partial y}\mathbf{j} + \frac{\partial v_z}{\partial z}\mathbf{k} \tag{7.107}$$

$$a = \sqrt{\left(\frac{\partial v_x}{\partial x}\right)^2 + \left(\frac{\partial v_y}{\partial y}\right)^2 + \left(\frac{\partial v_z}{\partial z}\right)^2} \tag{7.108}$$

$$\mathbf{n}_a = \frac{\mathbf{a}}{a} = \frac{\frac{\partial v_x}{\partial x}\mathbf{i} + \frac{\partial v_y}{\partial y}\mathbf{j} + \frac{\partial v_z}{\partial z}\mathbf{k}}{\sqrt{\left(\frac{\partial v_x}{\partial x}\right)^2 + \left(\frac{\partial v_y}{\partial y}\right)^2 + \left(\frac{\partial v_z}{\partial z}\right)^2}} \tag{7.109}$$

Equation (7.107) reflects only the external side of the problem, treating acceleration as a metric and time parameter. However, the physical nature of acceleration is far deeper than that which can be measured by devices. In the final analysis, the nature of acceleration is associated with the additional redistribution of the quantum density of the medium inside the gravitational boundary of the particle, establishing the additional gradient of the quantum density of the medium in the direction of the effect of acceleration [2].

At the present moment, the modulus of critical acceleration a_{cr} can be determined approximately from the value of the Coulomb force F_e of interaction of the orbital electron with the proton atomic nucleus. It is taken into account that the atom is balanced from the viewpoint of energy and is a structure ensuring stabilisation of the rest mass of the electron m_e which does not depend on its speed on the orbit, even at speeds very close to the speed of light $v = C \le C_0$ (1793). This enables us to determine the modulus of maximum acceleration $a_{\max}$ of the orbital electron at the distance $2r_e$ from the proton surface

$$a_{\max} = \pm\frac{F_e}{m_e} = \pm\frac{1}{4\pi\varepsilon_0}\frac{e^2}{(2r_e)^2 m_e}\frac{C_0^2}{C_0^2} = \frac{C_0^2}{4r_e} = \pm 0.8\cdot 10^{31}\,\text{m/s}^2 \tag{7.110}$$

The sign (±) in (7.110) indicates that in the vicinity of the surface of the alternating shell of the proton the electron is subjected to both the attraction forces of positive charges and the repulsion forces of negative charges, situated in the nodes of the network of the alternating shell (Fig. 4). It should be mentioned that the expression (7.110) is acceptable only for the rough estimation of acceleration and force. The exact determination of these parameters is associated with solving a relatively complicated mathematical problem of determination of the functional dependence of the spherical distribution of the electrical potentials and the strength of the field of the alternating shell of the nucleon, both in the presence of the excess charge of positive polarity and total electrical neutrality of the shell.

In any case, even the approximate evaluation of acceleration $a_{\max}$ (7.110) shows that the orbital electron in the vicinity of the proton nucleus is subjected to the effect of colossal alternating acceleration. The alternating nature of acceleration in the range of relativistic speeds has a vibrational effect on the orbital electron and attempts to 'shakeout' the electrical charge of the electron from the gravitational field, alternately disrupting the spherically deformed quantised medium.

On the other hand, the trajectory of the orbital electron in the vicinity of the proton nucleus is distorted (Fig. 7.7, 7.8, 7.9, 7.10), and the minimum radius of distortion $R_{\min}$ is determined by the normal forces acting on the electron in the direction to the surface of the shell of the proton nucleus. These forces are comparable with the electrical force of attraction of the positive charge of the proton at the distance $2r_e$ from the proton surface and determine the identical acceleration $a_{\max}$ (7.110). Consequently, we can estimate the minimum radius $R_{\min}$ of distortion of the trajectory of the orbit of the electron in the region of relativistic speeds:

$$R_{\min} = \frac{C_0^2}{a_{\max}} = 4r_e = 1.13 \cdot 10^{-14}\,\text{m} \tag{7.111}$$

The stationary (first) orbit of the non-excited electron can be characterised by distance R_1 of the largest distance from the proton nucleus of the atom. Naturally, the limiting parameters of speed C_0, acceleration $a_{\max}$ (7.110) and radius $R_{\min}$ (7.111) cannot characterise the orbital electron in the first stationary orbit because the electron in the stationary orbit does not radiate and its acceleration a_1 in the vicinity of the proton nucleus always remains lower than critical acceleration a_{cr} (7.73) and $a_{\max}$ (7.110)

$$a_1 = \frac{C_1}{R_{1C}} < a_{cr} < a_{\max} \tag{7.112}$$

Equation (7.112) includes the maximum relativistic speed $C_1 < C_0$ of the orbital electron in the first stationary orbit and minimum radius R_{1C} of the distortion of the orbit in the vicinity of the proton nucleus on the condition that $R_{1C} > R_{\min}$ (7.111). For the orbital electron to be capable of radiation, it must be transferred to the excited orbit. For example, in transition to the second orbit, with the maximum distance from the proton nucleus equal to R_2 the electron reaches the speed $C_2 < C_1$ in the vicinity of the proton nucleus, distorting the orbit on the radius R_{2C}. Since the excited electron is forced to radiate a photon on the proton nucleus, its acceleration a_2 should reach or exceed the critical value a_{cr} (7.73):

$$a_2 = \frac{C_2}{R_{2C}} > a_{cr} \tag{7.113}$$

Thus, the radiation of the orbital electron in transition from the second to the first orbit is associated with the variation of at least two parameters: relativistic speed of the electron C_2 and the radius R_{2C} of distortion of the trajectory of the orbit in the vicinity of the proton nucleus. This tendency is also maintained for subsequent orbits (3...*n*) of the electron and determines the number of unequal ratios:

$$\begin{gathered} a_n > \ldots > a_3 > a_2 > a_{cr} \\ \frac{C_n}{R_{nC}} > \ldots > \frac{C_3}{R_{3C}} > \frac{C_2}{R_{2C}} > a_{cr} \end{gathered} \tag{7.114}$$

where a_n, C_n, R_{nC} is the acceleration, the relativistic speed of the orbital electron and the radius of distortion of the orbit in the vicinity of the proton nucleus, respectively.

It appears that as the height of the orbit from which the electron falls on the proton increases, i.e., the distance (the radius vector) of the orbital electron from the atomic nucleus in the apogee, the acceleration of the electron in the vicinity of the proton nucleus also increases and the energy of the radiated photon becomes greater. However, as already mentioned, the behaviour of the orbital electron in the vicinity of the proton nucleus of the atom is affected by the random nature of interaction of the electron with the alternating shell of the nucleus which is a spontaneous disruption of the inequality (7.114). This may be expressed in the fact that in incidence on the nucleus, for example from the third orbit, the acceleration of the electron a_{3-2} may be lower than acceleration a_3, i.e. $a_{3-2} < a_3$ and the electron after emission of the photon transfer to the second orbit, remaining in the excited state. Subsequently, after emission of a photon, the electron transfer from the second to first stationary orbit.

Since the interaction of the orbital electron with the proton nucleus of the atom is of spontaneous nature, the orbital electron in changing three? The same orbit can emit every time photons of different energy on frequency, determining the spectral series of photon emission typical of a specific orbit.

Analysing the condition of emission of the orbital electron, i.e., critical acceleration a_{cr} (7.114), it is important to note that an increase of the relativistic speed of the orbital electron increases the radius of distortion of the orbit and determines by the ratio of the acceleration of the electron in the vicinity of the proton nucleus. For the electron to radiate, it is inserted to select the parameters of its relativistic speeds and radius of the orbit resulting in the fulfilment of the condition (7.114). However, since the increase of the relativistic speed of the orbital electron increases the radius of curvature of the orbit of the electron, the critical acceleration should be of discrete nature.

In fact, the increase of the relativistic speed of the orbital electron increases its acceleration. However, this is accompanied by a simultaneous increase of the radius of distortion of the orbital leading to a decrease of the acceleration of the orbital electron. In the final analysis, the orbital electron may reach the critical acceleration only discretely, determining the linear radiation spectrum.

If the orbital electron is investigated from the viewpoint of the theory of automatic regulation in movement of the electron to the regime in which is critical acceleration is reached followed by emission of a photon, this will be some vibrational wave process of transfer to the emission regime. However, this is a purely mathematical model. We can carry out special calculations which are well-known for the hydrogen atom, but this is not necessary. At the moment, it is important to show the physical role of critical acceleration a_{cr} of the orbital electron in irradiation of the linear spectrum when the wave transfer to the radiation regime determines the discrete nature of the radiation of the atom whose radiation energy ΔW is equivalent to the mass defect Δm_e (7.2) of the orbital electron

$$\Delta W = W_1 - W_2 = \hbar\nu = \Delta m_e C_0^2 \tag{7.115}$$

where W_1 and W_2 is the electron energy prior to emission and after emission of a photon on the first and second orbit at the moment of emission on the atom nucleus, respectively.

In this book, we do not examine the problems of excitation of the orbital electron associated with an increase of its energy and mass in transition to a higher orbit at the moment of absorption of the external photon because this is a separate fundamental problem connected with the effect of the atom as a selective receiver of electromagnetic radiation.

It has not yet been possible to find the exact solution for critical acceleration a_{cr} of the electron because it is connected with the exact solution of the field of the alternating shell of the proton nucleus and a number of other parameters of the atom which is a relatively complicated mathematical problem. However, the problem has been formulated for the understandable physical model and its solution will definitely be found. In this stage of investigations we determine the limiting parameters of acceleration a_{max} (7.110). It is also important to present the physical models which would ensure the stability of the atom when the atom does not radiate, and the conditions of disruption of its stability at the moment of emission of the orbital electron. It should be noted that the investigated models of the atom inside the quantised medium and their analysis are in the initial stage of investigations and, naturally, time is required and new investigators are essential for the final development of mathematical facilities.

However, it is already clear that the quantum theory is governed by the deterministic analysis where the physical model of the atom capable of predicting the behaviour of the orbital electron is known. One can criticise incompleted studies and also difficulties which must be overcome in the development of new theoretical directions but they are not hidden and are convincingly presented as fundamental problems requiring serious attention.

It is important that the old considerations regarding quantum mechanics which resulted in colossal contradictions in the period of development and are associated with the quantum jumps inside the atom, have finally been overcome. It has been established that such quantum jumps of the orbital electrons simply do not exist in nature. Radiation of any orbital electron takes place only on the atomic nucleus when it reaches the speed of light or a speed close to this speed. After irradiation on the atomic nucleus, the electron is transferred smoothly without any jump to a lower orbit (Fig. 7.10).

In this book, it is important to show all the factors considered by the new model of the atom taking into account the alternating shell of the nucleons and the presence of the gravitational well around the atom nucleus inside which the orbital electron rotates. We have mentioned a list of tasks which must be solved in order to derive the total equation of dynamics of the orbital electron and determine its possible orbit trajectories, describing the electronic cloud. Evidently, the analytical solution of the given problem with all the given factors taken into account are difficult to obtain by the numerical solutions realistic using computing methods. Consequently, it may be asserted that quantum physics will become deterministic sending to history the principle of uncertainty since the equations of dynamics of the orbital electron and the form of its trajectory enable us to know both the coordinate on the trajectory and the electron momentum.

The analysis shows that the photon radiation of the orbital electron in the composition of the atom is possible only as a result of the mass defect of the electron in the range of relativistic speeds when the electron is situated in the immediate vicinity of the atom nucleus in the field of critical acceleration causing separation of part of the electron mass whose elastic energy is transferred into photon radiation.

7.6. The role of superstrong interaction in photon radiation

As already mentioned, the emission of the orbital electron is associated with transformation of its mass defect to electromagnetic photon radiation. The mass defect of the electron represents part of the energy of its spherical deformed gravitational field. This is the elastic energy of deformation of the quantised medium. Thus, the problem of radiation of the orbital electron is reduced to the transformation of the static gravitation to dynamic electromagnetism. However, to be completely accurate, then it should be said that the static gravitational field in the form of the spherically deformed quantised medium for the moving electron is instantaneous, fixed at the given moment of time because in the next moment of time the electron transfers to the next local region of the quantised medium in relation to the stationary quantised space-time. This is the wave transfer of electron mass in the space having the form of wave transfer in the medium of its gravitational field [2, 4].

Prior to the development of the EQM theory, it was assumed that the source of photon radiation of the atom is the variation of its electrical component which generates the electromagnetic radiation in accordance with the Maxwell equations. This approach to the problem is natural from the viewpoint of the history of the development of the theory of electromagnetism because there was no other explanation of the nature of photon radiation. On the other hand, this approach was contradicted by the Maxwell equations according to which the atom should continuously radiate energy because of the continuous variation of the electrical field between the orbital electron and the atomic nucleus. In the final analysis, the electron should fall on the nucleus. However, the atom has proved to be a stable system emitting energy in portions, also in the excited state, and the orbital electron does not fall on the nucleus. Photon radiation is not associated with the change of the electrical component and is linked with the mass defect (7.114) of the orbital electron at the moment of its radiation on the nucleus.

At the present time, the theory of electromagnetism contains a distinctive and understandable mechanism of excitation of the electromagnetic wave by the electromagnetic masses and has absolutely no mechanism of excitation of photon radiation as a result of the mass defect of the elementary particle, with the exception of postulating the principle of equivalence of mass and energy. In [1] the nature of the electromagnetic wave was described and the Maxwell equations were derived for the first time analytically as a result of electromagnetic polarisation of the quanton and a group of quantons. Electromagnetic perturbation is regarded as a disruption of electromagnetic equilibrium of the quantised medium which is the carrier of superstrong electromagnetic interaction (SEI).

In [3], the two-rotor structure of the photon is described and it is shown that the photon is a specific electromagnetic wave whose formation takes place only in the range of relativistic speeds. The photon is a relativistic particle. To radiate a photon, the orbital electron should be accelerated to a speed close to the speed of light. In [3] this asumption is in complete agreement with the results of investigations described in this book.

In [2] the authors describe the nature of gravitational perturbation of the quantised medium which is also based on the superstrong electromagnetic interaction. The difference between electromagnetism and gravitation in the quantised medium can be expressed through the displacement of electrical Δx and magnetic Δy charges in the quanton [2]

$$\Delta x = \pm \Delta y \tag{7.116}$$

The sign (+) in (7.116) corresponds to gravitational interactions in the quantised medium. The quantum density of the medium changes as a result of its spherical deformation in compression and tension. The sign (–) in (7.116) determines the electromagnetic interaction through the polarisation of the quantised medium where the quantum density of the medium remains constant.

The mechanism of the transfer of the mass defect to electromagnetic perturbation is associated with the substitution of the sign (+) by the sign (–) in equation (7.115). This substitution of the sign determines the transition of the energy of elastic deformation of the quantised medium to the energy of its electromagnetic polarisation. It is now necessary to examine specific physical models which enable the orbital electron to fragment the energy of elastic deformation of the quantised medium followed by its transformation into photon emission.

Figure 7.11 shows the simplified scheme of elastic separation of part of the mass m_e of the orbital electron under the effect of critical acceleration $\geq \mathbf{a}_{cr}$ in the region of relativistic speeds as a result of disruption of the spherical symmetry of the gravitational field of the electron. Prior to emission of the photon, the orbital electron 1 is represented by its gravitational boundary with radius r_e. After emission of the photon on the proton nucleus p, the radius of the gravitational boundary 2 of the orbital electron e decreases by the value Δr_e thus determining the value of the mass defect Δm_e and the energy of photon emission. The point electrical charge 3 inside

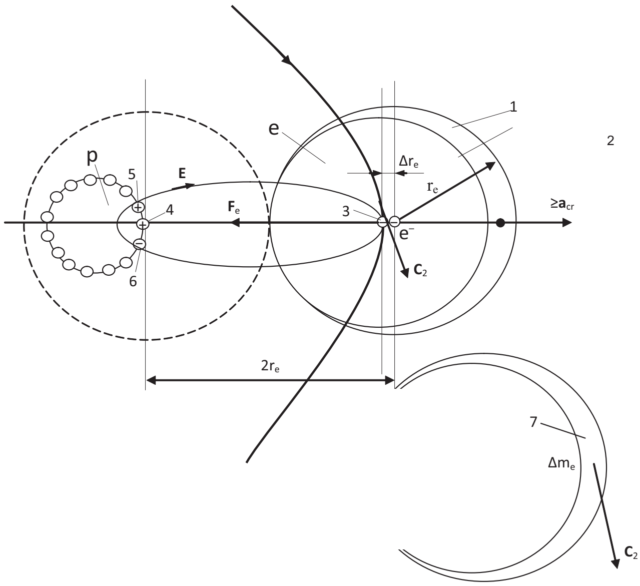


Fig. 7.11. Scheme of elastic separation of part of mass Δm_e of the orbital electron under the effect of critical acceleration $>a_{cr}$ as a result of the disruption of the spherical symmetry of the gravitational field of the electron.

the electron is displaced by the distance Δr_e in the direction of the proton.

We examine in greater detail the processes taking place during the interaction of the proton nucleus *p* and the orbital electron *e* at the moment of emission of the photon. Proton *p* has the alternating shell, including the excess electrical charge 4 with positive polarity. Coulomb attraction forces act between the charge 4 of the proton and the charge 3 of the orbital electron. These forces displace the charge 3 by the distance Δr_e from the centre of the electron 1, disrupting its spherical symmetry even prior to photon emission.

On the other hand, the orbital electron is subjected to the effect of the centrifugal force determined by critical acceleration $\geq \mathbf{a}_{cr}$. This force acts selectively only on the electron mass m_e which is represented by the elastic energy of the spherical deformation of the quantised medium. The centrifugal forces do not affect the electrical charge 3 of the electron because these forces are connected only with the gravitational interactions.

As already mentioned, the scheme in Fig. 7.11 is simplified because the electron mass is determined by its gravitational well (Fig. 7.1) which is found on the external side of the gravitational boundary, and in Fig. 7.11 the electron is represented by the internal region. This is not of great importance because the displacement of the electrical charge 3 of the electron over the distance Δr_e inside the gravitational boundary relates to such displacement in relation to the spherically symmetric centre of the gravitational well. Therefore, all the considerations relating to the analysis of the mass defect of the electron are connected with the displacement of the charge in relation to its spherical gravitational boundary. This is also convenient for graphical representation because it does not overload the figure with unnecessary details.

Thus, the charge of the electron 3 is subjected to the effect of the electrical force which tries to move the charge in the direction of the proton. The mass of the electron 1 and the form of the spherically deformed region of the quantised medium is subjected to the effect of centrifugal acceleration with the force directed in the opposite direction. The electrical and centrifugal forces try to disrupt the spherical symmetry of the electron.

However, in the quantised medium the electron is subjected to another additional tension forces of the medium determined by superstrong interaction (SEI). In particular, the colossal tensions of the quantised medium determine the conditions of stability of the gravitational boundary of the electron only if it is spherically symmetrical. If the spherical symmetry of the electron is disrupted above the critical threshold, the tension forces of the medium automatically restore the spherical symmetry of the electron, releasing its asymmetric part into radiation through the mass defect Δm_e. Thus, the role of SEI is fundamental in ensuring the principle of spherical invariance in the quantised medium. Without the effect of SEI the orbital electron could not emit energy in portions.

Figure 7.11 shows the moment of separation of the mass Δm_e of the asymmetric part 7 of the electron which, because of inertia, continues to move in the direction of the vector of instantaneous speed $\mathbf{C}_2$ at the moment of separation. Speed $\mathbf{C}_2$ corresponds to the instantaneous speed of the state of the electron on the second orbit. After separation of the asymmetric part, the electron is subjected to the effect of the recoil momentum $\Delta m_e C_2$ in the reversed direction and its speed decreases to the instantaneous speed C_1 determined by the condition of the balance of the amount of motion

$$\Delta m_e C_2 = m_e(C_2 - C_1), \quad \text{from which} \quad C_1 = C_2\left(1 - \frac{\Delta m_e}{m_e}\right) \quad (7.117).$$

Regardless of the fact that all the speeds in (7.117) are relativistic, the solutions are very simple because the atom, being the energy-balanced system, ensures the constant mass of the orbital electron, including in the relativistic speed range. The mass defect of the orbital electron is not connected with the relativistic conditions of the possible increase (decrease) of the mass. The consequence of these actions with the orbital electron when its asymmetric part 7 becomes separated is the transition of the electron to the first stationary orbit. On the first stationary orbit the atom maintains the constant mass of the electron, corresponding only to this orbit.

As already mentioned, the alternating shell of the proton has many noteworthy properties, including the fact that it may provide an additional momentum for the electron as a result of the effect of the tangential component of the electrical field of the shell. We separate two energy-balanced charges 5 and 6 (Fig. 7.11) of the shell whose electrical field **E** in the form of a closed line of force extends to the orbital electron 3, acting on it by its tangential component. This may supply to the orbital electron a very small amount of energy which compensates radiation (7.68) and at the same time provides an additional momentum to the electron and determines the stability of its stationary orbit. It is not clear how the synchronisation of the movement of the electron with the moment of the effect of the additional momentum in the direction of its speed takes place. Possibly, movement of the electron on the stationary orbit is in agreement with the effect of the principle of auto-phasing. The nature of the latter must be determined.

In any case, after separation of the asymmetric part 7 the electron remains in the stationary orbit and does not emit the photon. To provide more information, the asymmetric part 7 in Fig. 7.11 is separated from the electron in the form of its mass defect Δm_e. It may be assumed that the process of transformation of the asymmetric part 7 to electromagnetic radiation takes place in fact on the electron itself. Asymmetric part 7 is the elastically deformed part of the quantised medium and its deformation energy determines the mass defect of the electron Δm_e. Now, when this elastic energy of the quantised medium is not connected with the electron, it is similar to a spring trying to release its gravitational energy.

Since the released energy of elastic deformation relates to the energy of the gravitational field, it should be suggested that it generates a momentum of the gravitational wave [20, 21]. In fact, gravitational energy is transformed into photon radiation which is of the electromagnetic nature. This transformation can take place as a result of the capacity of the quantised medium for self-organisation when the release of the gravitational energy of elastic deformation of the quantised medium as a result of superstrong electromagnetic interaction causes transverse oscillations of the charges inside the quantons. Consequently, the electrical and magnetic bias currents form in the medium. In the range of relativistic speeds the electrical and magnetic bias currents of the charges cause self-organisation of the two-rotor structure of the photon. However, the photon has also the longitudinal component of the bias currents [3].

Figure 7.12 shows the scheme of the two-rotor structure of the low-energy photon emitted by the orbital electron (the structure of the photon was described in detail in [3]). Now it is important to mention that the two-rotor structure of the photon can form only as a result of the mass defect of the orbital electron in the range of relativistic speeds. The wavelength of photon emission determines the photon diameter. In the case of the high-energy photons, a decrease of the photon diameter increases the cross-section of the rotors ensuring the strong dependence of the energy of electromagnetic polarisation of the quantised medium by the photon on the radiation frequency. With increasing frequency the rotors of the high-energy photon seem to 'bulge' [3].

It is necessary to mention, albeit briefly, the mechanism of photon emission in nuclear fission and synthesis reactions. Like the mechanism of emission of the photon by the orbital electron in the composition of the atom, the mechanism of photon emission in nuclear reactions is also determined by the mass defect of the atomic nucleus, more accurately, the nucleons in the composition of the nucleus. This is a fact. Another condition of photon radiation by the orbital electron is that the electron forms the photon in the range of relativistic speeds, i.e., speeds close to the speed of light. Is this condition compulsory in the formation of photon emission in nuclear actions which at first sight appear not connected with the relativism?

This question receives a positive answer, assuming that in the fission reactions the process of 'rolling-up' of new nuclei in the region of strong interactions is so fast that the 'rolling-up' of the nucleons into a new, albeit smaller nucleus, takes place with a high speed, possibly close to the speed of light. Regardless of the short duration of the process, this may proved to

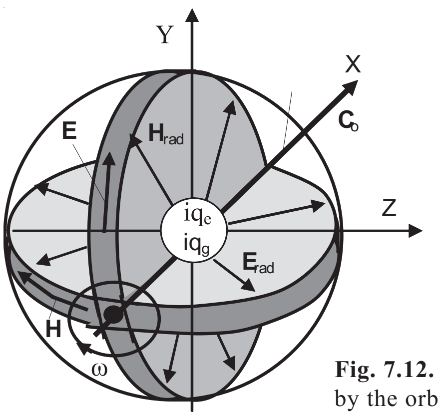


Fig. 7.12. The two-rotor structure of the photon emitted by the orbital electron.

be sufficient for separating the photon as a result of the mass defect of the nucleus. Although it is fully possible that as a result of the mass defect of the nucleons the elastic energy of deformation of the quantised medium is, as a result of self-organisation, capable of creating the two-rotor photon structure at lower speeds. However, these assumptions require confirmation by additional theoretical investigations.

It is fully realistic to reach relativistic speeds in synthesis reactions. In a thermonuclear bomb, the merger of the proton–neutron nuclei is associated with their preliminary acceleration as a result of a detonation nuclear explosion followed by deceleration during fusion of the nuclei. The detonation nuclear explosion causes acceleration and forces sufficient for overcoming the electrostatic repulsion of the proton charges and at the same time the photons reach relativistic speeds. The attempts for inducing controlled thermonuclear synthesis only by heating plasma to superhighs temperature evidently did not take into account these additional factors which determine the occurrence of the thermonuclear reaction with the generation of photon radiation energy.

7.7. Gravitational radiation of the atom

In order to understand better the reasons for the transformation of gravitational energy to electromagnetic photon radiation, it is necessary to describe more accurately the main differences between gravitational and electromagnetic radiation. The views existing in physics regarding the gravitational waves are erroneous because they assume that the nature of the gravitational wave, like the nature of the electromagnetic wave, should be based on the transverse oscillations of space-time. This has not been confirmed by experiments. Intensive research to find transverse gravitational waves over many decades have been unsuccessful and have no future. As shown in the EQM theory, only the bias currents in the electromagnetic waves are characterised by transverse oscillations [1].

After discovering the superstrong electromagnetic interaction (SEI) when the structure of the quantised space-time was determined, the nature of gravitational waves as the waves of longitudinal oscillations in the quantised medium similar to acoustic waves was investigated in [20, 21]. The quantised space-time resembles more a solid because of the colossal tensions of the quantised medium and dense packing of the quantons in the ordered structure with the highest quantum density, being the carrier of SEI [1]. This medium can contain both transverse electromagnetic wave perturbations and longitudinal gravitational perturbations which in the final analysis are electromagnetic and associated with the disruption of gravitational equilibrium of the superstrong electromagnetic interaction.

In an ideal case, the source of the gravitational wave can be periodic deformation of the quantised medium causing longitudinal oscillations in the medium as a result of periodic changes of mass m, for example, in accordance with the harmonic law with the cyclic frequency ω in relation to the amplitude value of the mass m_a

$$m = m_a \sin \omega t \tag{7.118}$$

A source with parameters (7.118) of a continuous gravitational perturbation would be ideal, but its realisation is associated with the periodic transfer of the plus mass and the minus mass and vice versa. These changes of mass in space lead to longitudinal oscillations of the quantised medium which are described by the wave equation, like equation (7.80), replacing the speed v by the speed of propagation of the gravitational wave C_0:

$$\frac{\partial^2 \rho}{\partial t^2} = C_o^2 \left(\frac{\partial^2 \rho}{\partial x^2} + \frac{\partial^2 \rho}{\partial y^2} + \frac{\partial^2 \rho}{\partial z^2} \right) \tag{7.119}$$

or

$$\frac{\partial^2 \rho}{\partial t^2} = C_0^2 \left(\frac{\partial D}{\partial x} \mathbf{i} + \frac{\partial D}{\partial y} \mathbf{j} + \frac{\partial D}{\partial z} \mathbf{k} \right) \tag{7.120}$$

The solutions of the equations (7.119) and (7.120) are periodic changes of the quantum density of the medium and its deformation D in relation to the amplitude values ρ_a and D_a, respectively, and also for the spherical gravitational wave

$$\rho = \rho_o - \rho_a \sin \omega t \tag{7.121}$$

$$\mathbf{D} = \mathbf{D}_a \sin \omega t \tag{7.122}$$

The deformation vector **D** (7.122) of the quantised medium is longitudinal and oscillate in the direction of propagation of the gravitational wave and determines the direction of the vector of its speed $\mathbf{C}_0$.

Naturally, the atom cannot realise the ideal case of gravitational radiation. However, the atom is capable of continuous gravitational radiation. Previously, we investigated the case in which the atom carries out, as a result of the rotation of the orbital electron inside the gravitational well of the nucleus, very small periodic changes of gravitational energy with the amplitude $\Delta W_0 = 1.1 \cdot 10^{-36}$ eV (7.68). It was shown that the nature of this radiation is not yet known. However, analysis of the small change in the mass of the orbital electron inside the gravitation well of the nucleus shows that gravitational radiation may take place in this case because the periodic changes of the mass generate longitudinal oscillations of the quantised medium.

Actually, moving inside the gravitation well closer to the proton nucleus, the orbital electron is found in the region of the gravitational potential of action C which is lower lower than the equilibrium potential C_0 of the non-perturbed quantised medium. However, the gravitational potential in particular determines the electron energy and, correspondingly, its mass, whose variation Δm_0 is associated with the variation of energy ΔW_0 (7.68)

$$\Delta m_e = \frac{\Delta W_0}{C_0^2} = m_e \left(1 - \frac{C^2}{C_0^2}\right) = \frac{G m_e m_p}{2 r_e C_0^2} = \frac{1}{2} m_p \frac{R_e}{r_e} = 2 \cdot 10^{-70}\,\text{kg} \quad (7.123)$$

The periodic continuous radiation of the mass (7.123) of the orbital electron is extremely small but it does take place during the movement of the electron along a complicated trajectory. Naturally, the recording of the gravitational radiation generated during this process is outside the sensitivity of the currently available measuring systems. To obtain the energy of gravitational radiation of only 1 eV it is necessary to combine the energy of the order of 10^{36} (68) orbital electrons. If we consider the heavy nuclei of the atoms in which the depth of the gravitational well may be $\sim 10^2$ times greater than the proton well, and photons of at least ten orbital electrons in the atoms are emitted synchronously and in phase, the mass of the active part of such a gravitational emitter is of the order of 10^6 kg with the radiation energy of 1 eV. Therefore, the construction of generators of gravitational waves is connected with the simultaneous effect of strong magnetic and electrical fields on the active part of the emitter [20, 21]. In this case, we should consider the formation of a new direction in quantum electronics associated with the development of gravitational generators (grazers) (not to be confused with lasers – quantum generators of gamma radiation).

On the other hand, investigations of even very weak continuous gravitational signals emitted by the orbital electrons would make it possible to determine the nature of periodicity of the signals in the form of a specific functional dependence which is naturally connected with the nature of movement of the electron along the trajectory inside the atom. This means that in future it would be possible to investigate the functional dependences of the trajectories of the orbital electrons regardless of their complexity.

10 .8. Probability electronic cloud

The deterministic nature of the behaviour of the orbital electron in the atom, regardless of its complicated trajectory, makes it possible to explain the reasons for the application in physics of the probability parameters in quantum mechanics when the structure of the electron, the proton, the neutron, the photon, the atomic nucleus and the quantised space-time was not known. Einstein was right when he said that the 'God does not throw the dice'.

Figure 7.13 shows the calculation model (Fig. 7.8) of the greatly elongated orbit of the orbital electron. The coordinates *X–Y* have been added. Taking into account the fact that the orbital electron *e* carries out periodic oscillations around the proton nucleus *p* of the simplest atom along the greatly elongated orbit, we can approximate the projection of its orbit, for example, on the *Y* axis by the harmonic function, fixing the deflection of the electron *y* from the proton nucleus:

$$y = A_e \cdot \sin \omega t \tag{7.124}$$

here is A_e is the amplitude of deflection of the electron from the proton nucleus, *m*; ωt is the cyclic frequency of oscillations of the electron

$$\omega t = \frac{2\pi}{T} t \tag{7.125}$$

here T is the period of rotation of the electron on the orbit, s.

In accordance with (7.124) at the moment of time $t = 0$ $y = 0$ and the electron is situated in the immediate vicinity of the proton nucleus.

The counting of time t is determined by the deflection y (7.124) of the electron from the origin of the coordinates

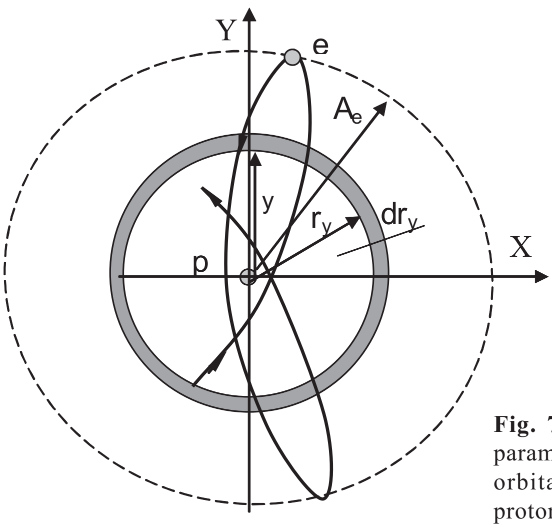


Fig. 7.13. Calculation of probability parametersof the electron cloud of the orbital electron *e* in relation to the proton nucleus *p* of the atom.

$$t = \frac{T}{2\pi} \arcsin \frac{y}{A_y} \tag{7.126}$$

The projection of the speed of the electron v_y is expressed by the first derivative with respect to time t from (7.124)

$$v_y = \frac{\partial\, y}{\partial\, t} = -\omega A_e \cos \omega t \tag{7.127}$$

The maximum speed of the electron is in the vicinity of the nucleus. Evidently, the probability of detection of the electron in the vicinity of the atom nucleus is minimum and on the surface of the nucleus it is reduced to 0.

The orbital electron, describing a spherical rosette around the nucleus, occupies a specific volume (Fig. 7.8b) with the radius A_e, and the equation (7.124) describes the electron cloud linking the deflection y (7.124) with the radius r_y of the specific layer of the cloud, $y = r_y$ (Fig. 7.13).

We separate an arbitrary spherical volume dV_y of the electron cloud with a radius r_y and thickness dr_y (Fig. 7.13):

$$dV_y = 4\pi r_y^2 dr_y \tag{7.128}$$

In wave mechanics, 1 (7.4) is the probability of the electron located in the total volume of the cloud, integrating the square of the wave function over the entire volume. The problem is simplified if the condition (7.124) is used. In this case, the probability dp_v of the electron being in some spherical volume of the cloud is proportional to the time dt required by the electron to pass through the thickness dr_y of the cloud:

$$dp_v = f(y)dt \tag{7.139}$$

here $f(y)$ is the function of the cloud which is to be determined.

Evidently, the probability equal to 1 is determined by the integral with respect to time in movement of the electron in the section equal to A_y which the electron passes in a quarter of the period $T/4$

$$\int_0^{T/4} f(y)dt = 1 \tag{7.140}$$

As a result of analysis of the duration of passage of the layers of the electron cloud by the electron, it can be seen that the probability p_v of the electron situated in a specific layer of the cloud is determined by the ratio of the time t, required to pass through the layer, to $T/4$, and taking into account the function (7.126) we obtain

$$p_v = 4\frac{t}{T} = \frac{2}{\pi}\arcsin\frac{y}{A_y} \qquad (7.131)$$

Verification of (7.131) shows that when the electron passes through the entire volume of the electron cloud at $y = A_y$, the probability of the electron being located in the cloud is equal to 1, since arcsin 1 = $\pi/2$.

The probability function (7.131) can be used to determine the probability of the electron beam in the layer of the electron cloud at different ratios y/A_y away from the nucleus.

Table 7.1. Probability p_v of the orbital electron of being in the layer of the electron cloud

y/A_y	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
p_v	0	0.064	0.13	0.194	0.262	0.333	0.41	0.49	0.59	0.71	1.0

As indicated by Table 7.1, the probability of the orbital electron being on the surface of the atomic nucleus is almost 0. In the vicinity of the atomic nucleus the probability is minimum and starts to increase slowly with the increase of the distance, rapidly increases at the periphery of the electron cloud. This is in agreement with the experimental results.

Naturally, in this case, we consider the method of calculating the probability of finding the orbital electron (and not the accuracy of the method) which requires serious corrections because of the assumptions made. The determination of the exact function for the trajectory of the orbital electron taking a large number of factors into account, presented in the chapters of this book, requires extensive and time-consuming computations.

Most importantly, it has been shown for the first time that the probability methods in quantum mechanics have a fully determined base, as insisted by Einstein.

7.9. Conclusion

The discovery of the quantised structure of the electron, as the compound part of the quantised space-time in the Superintegration theory, shows that its radiation is associated with its mass defect.

It has been shown for the first time that the orbital electron has a complicated orbit, rotating inside the gravitational well of the atomic nucleus. In particular, this factor is stabilising and ensures the constancy of the electron energy on approach to the nucleus when the increase of the electrical component is fully compensated by the decrease of the gravitational energy of the system as a whole.

Has been shown that the radiation of the orbital electron takes place at speeds close to the speed of light by synchrotron radiation which takes place when the centrifugal critical acceleration is reached. The electron is not capable of maintaining the spherical symmetry of the deformed quantised space-time which forms its mass, and part of the deformation energy, which has been lost, is transferred to the energy of photon emission.

It has been shown that the reason for the probability electron cloud of the orbital electron inside the atom has a fully determined base and is associated with special features of the trajectory of the electron.

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8
Thermal photons
Molecule recoil in photon emission

In the development of quantum thermodynamics in the Superunification theory it was necessary to deal with the paradox contradicting classic approaches. It has been established that atom recoil in photon emission is inversely proportional to photon energy. The strongest recoil is characteristic of thermal low-energy photons. This result is explained by the special feature of the two-rotor structure of the photon – the compound and inseparable part of the quantised space-time. The electrical rotor of the photon induces an electrical field in the quantised space-time which, acting on the charge of the atom nucleus, produces a momentum, ensuring a recoil of the atom (molecule) and their oscillations. The atom (molecule) is repulsed from the electrically polarised quantised space-time and not from the photon. Only in this case can calculations produce the results corresponding to the actual processes and eliminate the existing energy paradox.

8.1. Energy paradox in atom recoil

The results of the previously described investigations of photon emission by the orbital electron [1], including the results obtained previously for the photon structure [2], open new prospects for the development of quantum thermodynamics. Taking into account the restrictions of the current molecular thermodynamics, the development of quantum considerations regarding the nature of heat make it possible to investigate the principle of various concepts such as temperature, heat capacity and heat forming capacity (the heat of combustion of fuel), linking the nature of these thermodynamic parameters with the nature of thermal photons.

Regardless of the advances in molecular thermodynamics and molecular-kinetic theory of heat, the reasons for the thermal motion of the molecule are ignored and considerations are restricted to concluding that the manifestation of heat is associated with the thermal motion of the molecules. However, what does prevent the atoms and molecules from moving (vibrating) and determines the temperature parameters of matter? The only reason for this motion is the atom recoil (molecule recoil) in emission and re-emission of the photon, or in interaction with the photon without re-emission. It is difficult to propose another concepts. Despite this, the mentioned concept has not been developed any further because of a number of reasons:

1. The two-rotor structure of the photon and the method of calculating the electromagnetic parameters of the rotors were not known. This problem was solved in [3].
2. The nature of emission of the photon as a result of the mass defect of the orbital electron was not known. This problem is solved in this book.
3. There were clear contradictions between molecular thermodynamics and quantum theory. In accordance with (6.1), the photon energy increases with increasing frequency. However, the observed atom (molecule) recoil is characterised by an inverse dependence and increases with decreasing frequency energy in the infrared region disrupting apparently the energy balance. In interaction with the atom (molecule), the photon does not behave in the classic fashion.

In his studies, Planck faced a similar non-classic problem when investigating the radiation of a black body with the radiation intensity proportional to the field frequency (1). This contradicted classic electrodynamics in accordance with which the intensity of electromagnetic radiation is determined by the strength of the field. The authors of [3] describe the reasons for the proportionality of the energy (6.1) to the photon radiation frequency when the unique structure of the photon as a relativistic particle determines the non-classic behaviour of the photon:

$$W = \hbar \nu \tag{8.1}$$

where $\hbar$ is the Planck constant, ν is radiation frequency, Hz.

8.2. Classic approach to calculating the atom recoil

From the classic viewpoint, the momentum **p** of the orbital electron at the moment of photon emission is equivalent to the photon momentum and determined by the mass defect Δm_c of the electron and the speed of the photon $\mathbf{C}_0$:

$$\mathbf{p} = \Delta m_e \mathbf{C}_0 \tag{8.2}$$

The modulus of the momentum p (8.2) can be connected with the frequency of photon emission (8.1):

$$p = \frac{\Delta m_e C_0^2}{C_0} = \frac{\hbar \nu}{C_0} \tag{8.3}$$

At the moment of photon emission, the momentum p (8.3) should recoil not only to the orbital electron but also to the atom (molecule) as a whole. The recoil speed n, for example, of a hydrogen molecule with mass $2m_p$ (where m_p is the proton mass), can be determined on the basis of the equivalence of the amount of motion $2m_p$ of the molecule and the momentum of the photon p (8.3):

$$2m_p v = \frac{\hbar \nu}{C_0} \tag{8.4}$$

Equation (8.4) is used to determine the speed of recoil n of the hydrogen molecule in emission of a thermal infrared photon, for example, with a frequency of $2.3 \cdot 10^{14}$ Hz (wavelength l = $1.3 \cdot 10^{-6}$ m) from the Paschen series:

$$v = \frac{\hbar \nu}{2m_p C_0} \approx 0.02\,\mathrm{m}/c << 1800\ \mathrm{m/s} \tag{8.5}$$

The mean speed of thermal motion of the hydrogen molecule at temperature $t = 0°\mathrm{C}$ is ~1800 m/s. The results of calculations carried out using the classic equation (8.5) give too low a value of the recoil speed (by almost a factor of 10^5). At the same time, as already mentioned, an increase of the photon emission frequency reduces the recoil speed (instead of increasing it), as shown by (8.5). To obtain a speed of 1800 m/s, the molecule should emit approximately 10^5 photons in the direction opposite to the direction of thermal motion. It is not possible to produce charge synchronous radiation in one direction, taking into account the random nature of the radiation process. At the same time, the process of continuous radiation of the molecule is not substantiated from the energy viewpoint because emission is possible only from the state of preliminary excitation. Even if we examine the problem of multiple photon re-emission, and also the effect of both the accelerating and decelerating momentas, it may be seen that again the molecule cannot be accelerated to the required speed of thermal motion. In particular, the random nature of thermal motion should determine the required speed of the molecule as a result of recoil at the moment of photon emission. However, the calculation results are not in agreement with the observed facts.

Thus, the classic approaches are not suitable for investigating the recoil of atoms (molecules) at the moment of emission (absorption) of the photon. If we use equation (8.5), there should be no recoil. However, this contradicts experimental observations of the Brownian motion of the particles determined by molecule recoil in interaction with thermal photons and has been regarded for a long time as the fluctuation of thermal vibrations of the particles as a result of random bombardment with the molecules because only an increase of the temperature increases the intensity of thermal oscillations of Brownian particles (without interrupting this vibrations). Like perpetual motion, the Brownian motion is never interrupted and its intensity increases with increasing temperature.

8.3. Method of calculating atom (molecule) recoil in photon emission

Since the classic approaches do not work in analysis of molecule recoil in interaction with a thermal photon, the reasons for thermal motion of the molecules must be found in the two-rotor structure of the photon (Fig. 6.10, 8.1).

It was shown in [1, 2] that the non-classic motion of the photon in the optical medium along the wave trajectory is associated with the capture of the atomic centres of the lattice of the optical medium by the photon rotor. The wave trajectory of the photon is longer than the straight path. For this reason, the phase speed C_p in the optical medium is lower than the speed of the photon C_0 in the quantised space-time. In particular, knowledge of the structure of the photon has made it possible to determine the reasons for the reduction of the speed of the photon in the optical medium which were not previously known.

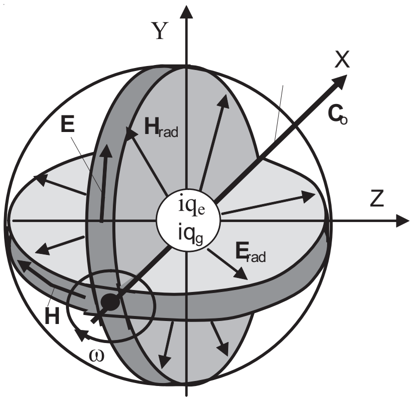

Fig. 8.1. Two-rotor structure of the photon emitted by an orbital electron.

The information on the two-rotor structure of the photon (Fig 8.1) will now be applied for the evaluation of the force momentum under the effect on the atom (molecule). The solution will not be found on the basis of the principle of equivalence of the momentum (8.3) of the photon to the amount of motion of the molecule (8.4), and it will be determined on the basis of the interaction of the electrical field E of the photon rotor with the electrical charge eZ_p of the atomic nucleus during its capture by the rotor (here Z_p is the number of protons in the nucleus).

In fact, the electrical field of the photon rotor polarises the quantised space-time. If the atom nucleus is situated in the electrically polarised field, the atom charge will be subjected to the effect of a force from the side of this field, i.e., from the side of the quantised space-time. The atom (molecule) in photon emission is not repulsed from the photon and instead is repulsed from the electrical field of the quantised space-time induced by the photon. In particular, the quantised space-time electrically polarised by the photon 'ejects' the atom (molecule) ensuring their recoil during photon emission.

Figure 8.2 shows the scheme of the effect of the electrical field **E** of the photon rotor on the charge eZ_p of the atom nucleus with the force **F** when the atom nucleus is captured by the electrical rotor. The vector of the force **F** is directed along the vector **E**. The actual value of the strength **E** of the electrical field in the rotors of the infrared photon with a frequency $2.3 \cdot 10^{14}$ Hz (wavelength $\lambda = 1.3 \cdot 10^{-16}$ m) from the Paschen series is determined using equation (6.42) from [2] for $\varphi_e = 0.511 \cdot 10^6$ V and the mean length ℓ of the line of force of the photon

$$E = \frac{\varphi_e}{\ell} = \frac{2\varphi_e}{\pi\lambda} = 2.5 \cdot 10^{11} \frac{\text{V}}{\text{m}} \tag{8.6}$$

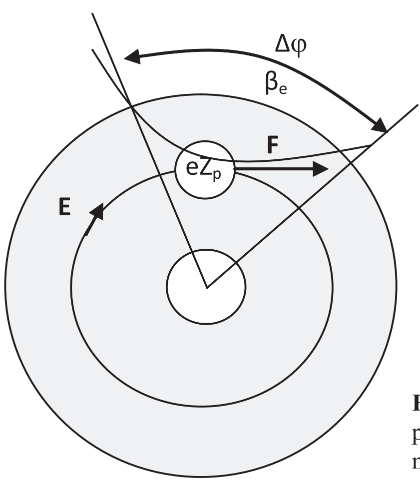

Fig. 8.2. Effect of electrical field **E** of the photon rotor on the charge eZ_p of the atom nucleus with force **F**.

Further, we estimate the actual value of force F on the electrical charge eZ_p of the atom in the electrical field of the rotor E:

$$F = EeZ_p \quad (8.7)$$

The duration t of the effect of the force F (8.7) is estimated on the basis of the half-period 0.5 T and the coefficient k_t of simultaneous interaction between the photon and the atomic nucleus which determines more accurately the duration of the effect of t as part of the half period:

$$\tau = k_\tau 0.5T = \frac{k_\tau}{2\nu} \quad (8.8)$$

From (8.7) and (8.8) we determine the momentum $F\tau$ and equate its value to the amount of motion of the hydrogen molecule with mass $2m_p$, taking into account that the force F (129???), acting on a single atom for $Z_p = 1$, also acts on the entire hydrogen molecule

$$Ee\frac{k_t}{2\nu} = 2m_p v \quad (8.9)$$

From (8.9) we determine the thermal speed of the molecule v:

$$v = \frac{k_t}{4}\frac{Ee}{m_p\nu} \quad (8.10)$$

In contrast to (8.5), in the equation (8.8) for the thermal speed of the molecule n, frequency n is included in the denominator. This corresponds to the observations assuming that only the low-energy photons are capable of carrying out the thermal effect on the molecules. As already mentioned, the thermal mean speed of the hydrogen atom at temperature t = 0°C is ~1800 m/s. Consequently, from (8.10) we determine the value of simultaneity coefficient k_τ for the infrared photon with a frequency of $2.3 \cdot 10^{14}$ Hz

$$k_\tau = \frac{4m_p\nu v}{Ee} = 0.07 \quad (8.11)$$

Equation (8.2) shows that a short-term momentum of 0.035T (8.8) is sufficient for the electrical field of the rotor of the infrared photon to accelerate the hydrogen atom to the required speed of thermal motion of ~1800 m/s. Consequently, we can estimate the momentum p received by the hydrogen atom in capture of the photon by the rotor

$$p = F\tau = \frac{k_\tau Ee}{2\nu} \quad (8.12)$$

Thus, even very approximate calculation show that the source of thermal motion of the molecules can be only photons or, more accurately, low-energy thermal photons. As indicated by (8.12), the value of the momentum p is inversely proportional to the frequency of the emitted photon and, correspondingly, inversely proportional to its energy. This is in agreement with the observed facts.

We can calculate more accurately the force F (8.7) and momentum p (8.20), taking into account the distribution of the strength of the electrical field E both inside the photon rotor and with respect to time [2], and also the duration of combined interaction between the photon and the atom nucleus. However, this greatly complicates the mathematical equations and only slightly improves the accuracy of the calculations without changing in principle the nature of the problem. It is more important to show the reasons for which the moments (8.3) and (8.1) differ so greatly from each other, both in respect of the magnitude and nature.

Equation (8.3) was derived under the false condition in which the photon was regarded as an isolated (closed) particle (matter in itself). In fact, as shown in [2], the photon is an open quantum mechanics system, being the compound part of the quantised space-time. The Superunification theory is the quantum theory of open quantum mechanics systems. In this case, the vector of the strength $\mathbf{E}$ of the electrical field belongs to both the photon rotor and the quantised medium (Fig. 8.2). Therefore, the momentum of atom (molecule) recoil is not connected with the photon as an isolated particles and it is connected with the photon as part of the quantised stationary system. Atom (molecule) recoil in interaction with the photon takes place during repulsion from the quantised medium which is stationary. The result (8.12) corresponds to the true interaction between the photon and the atom as an open quantum mechanics systems, where the result of (8.12) is affected by the interaction with the quantised medium through the superstrong electromagnetic interaction (SEI) which is not taken into account in (8.3). The effect of the magnetic field of the rotor and radial fields of the photon on the recoil can be analysed [2]. However, this is the subject of a separate investigation which should supplement information on the random nature of the given processes and the statistical scatter of the parameters of the recoil momentum, both with respect to magnitude and direction.

8.4. Energy balance of the atom in photon emission

Only slight interest of the investigators in the processes of thermal recoil of atoms (molecules) in interaction with thermal photons is also caused by the fact that, from the classic viewpoint, the energy of the emitted photon is considerably smaller than the kinetic energy of the thermal motion of the molecule as a result of the effect of the recoil momentum. It would appear that this is the clear violation of the law of conservation when the energy balance is not maintained. The kinetic energy of thermal motion of the molecule $0.5mv^2$ is considerably higher than the energy $\hbar\nu$ of the emitted photon, and as a result of recoil in photon emission, the molecule receives the speed v

$$\frac{1}{2}mv^2 \gg \hbar\nu \tag{8.13}$$

In fact, the laws of energy conservation are not violated, taking into account the fact that the only source of energy in the universe is the quantised space-time, being the carrier of superstrong electromagnetic interaction. The photon is only a 'trigger', activating the mechanism of release of the energy of SEI. This is also found in the electron accelerators where a small amount of energy controls a powerful energy flux. A source of powerful energy is required in this case. The energy of SEI is such a powerful source here.

To determine the actual amount of the energy transferred by the quantised medium to the atom (molecule) as a result of photon emission, it is necessary to look for the kinetic energy of recoil in the interaction with the quantised medium and not link it with the photon emission energy. The photon is a relativistic particle – wave as a result of electromagnetic polarisation of the quantised medium. Therefore, the recoil momentum takes place from the polarised quantised medium and not from the photon. Consequently, the molecule is accelerated to the speed v (8.10) which also determines the kinetic energy W_k of the hydrogen molecule:

$$W_k = \frac{1}{2}(2m_p)v^2 = m_p\left(\frac{k_t}{4}\frac{Ee}{m_p\nu}\right)^2 = \frac{1}{16m_p}\left(\frac{k_t Ee}{\nu}\right)^2 \tag{8.14}$$

The total energy of interaction of the atoms (molecules) with the quantised medium, taking SEI into account, is determined by the work carried out in the transfer of the atomic nucleus in the electrical field of the photon rotor which should be equivalent to the kinetic energy of thermal motion but not to the photon emission energy. These are different energy parameters of the open quantum mechanics system. The work W in the transfer of the atomic nucleus in the electrical field E of the rotor along the path $\Delta\ell$, can be described taking into account force **F** (8.7) and angle α between the direction of the force **F** (vector of the strength of the field **E**) and the direction of the trajectory along the path $\Delta\ell$, in the photon rotor (Fig. 8.3)

$$W = \int F\cos\alpha d\ell = \int EeZ_p\cos\alpha d\ell \tag{8.15}$$

In order to solve (8.15), it is necessary to know the function of distribution of at least strength **E** of the field along the path $\Delta\ell$. The function of the strength **E** was determined in [2] but the trajectory of the path $\Delta\ell$, which is random, was not determined. The problem is greatly simplified if the work is estimated on the basis of the maximum difference of the electrical potentials $\Delta\varphi_{max}$ travelled by the atom nucleus in the electrical field of the photon rotor, irrespective of the form of the trajectory.

Taking into account that the rotor electrical potential φ_e of the photon is known and equals $\varphi_e = 0.511\cdot10^6$ V [2], the difference of the electrical potentials $\Delta\varphi$ is determined by the angle β_e (in radians)

$$\Delta\varphi = \frac{\beta_e}{2\pi}\varphi_e \tag{8.16}$$

To determine the work for the transfer of the atomic nucleus in the electrical field with a difference of the electrical potentials of the rotors $\Delta\varphi$, it is sufficient to know the coordinates of entry and exit of the nucleus in the rotor which defined the angle β_e

$$W = \Delta\varphi eZ_p = \frac{\beta_e}{2\pi}\varphi_e eZ_p \tag{8.17}$$

The work W (8.17) determines the kinetic energy $W_k = 0.5\, m_m v^2$ of the thermal motion of the molecule with the mass m_m as a result of interaction with the photon through one of the atoms

$$\frac{\beta_e}{2\pi}\varphi_e eZ_p = \frac{1}{2}m_m v^2 \tag{8.18}$$

From (8.18), we determine the speed of thermal motion of the molecule:

$$v = \sqrt{\frac{\beta_e\varphi_e eZ_p}{\pi m_m}} \tag{8.19}$$

Attention should be given to the fact that the speeds of thermal motion

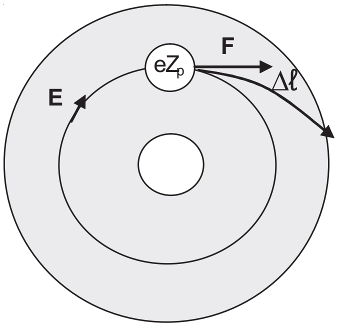

Fig. 8.3. Calculation of the work of transfer of the nucleus in the electrical field **E** of the photon rotor with the effect of the atom nucleus with the force **F** on the charge eZ_p.

of the molecules determined from the equations (8.8) and (8.19) are equivalent because they take into account the effect of superstrong electromagnetic interaction with the photon recoil of the molecules. Kinetic energy W_k (8.14) ensures the energy balance in atom (molecule) recoil at the moment of photon emission.

8.5. Nature of thermal oscillations

The parameters of pressure p and volume V, linked together and with temperature T, show that an increase of the temperature increases the speed of random oscillations of the molecules and atoms in the gas medium (including plasma) or in solids [3]. However, the random movements of the molecules and atoms with increasing temperature are determined by their recoil as a result of photon emission by the orbital electron. This means that the thermal oscillations of the molecules and the atoms are only a consequence caused by the concentration of the photons which can be characterised as thermal photons.

In fact, heating of a solid is associated with an increase of the concentration of thermal photons in the solid which have been many times re-emitted on the atoms and molecules, generating recoil momenta leading to temperature oscillations. Part of the thermal photons leave the heated solid and a thermodynamic equilibrium is established under specific conditions in which the concentration of the thermal photons is stabilised, stabilising the temperature of the solid.

Therefore, it is more logical to link the temperature of the solid (gas) with the concentration of the thermal photons in the solid (gas). It is necessary to determine the radiation spectrum and the spectrum of absorption of thermal photons, linking the concentration of thermal photons with the spectrum on the basis of the integral features. In the final analysis, this integral approach makes it possible to characterise the temperature as a spectral concentration (taking into account the energy with the thermal photon) of the thermal photons in the unit volume or mass of the matter, taking into account the non-linear form of these dependences. Actually, in rapid compression of the gas (by a factor of two), the concentration of thermal photons in the volume is doubled whereas temperature is not doubled and in calculations is linked with the absolute temperature.

Therefore, the absolute temperature zero can be represented by the state of matter in complete absence of the thermal photons in it when the atoms and molecules do not emit and do not re-emit photons.

Consequently, it may be concluded that the heat and temperature are determined by the concentration of thermal photons in the unit volume or mass of the matter, of course, with the frequency distribution taken into account.

Naturally, the development of quantum thermodynamics requires a considerable effort by theoreticians and is time consuming. It is therefore important to mention the main directions of development of quantum thermodynamics and determine the concept of temperature in the initial stage. Regardless of the fact that temperature as a physical parameter is one of the main parameters in molecular ceramics, current ceramics does not have an exact definition of the concept of temperature [3]. The definition of temperature T as a derivative of internal energy U with respect to entropy S does not reflect the physical nature of temperature

$$T = \frac{\partial U}{\partial S} \tag{8.20}$$

The molecular–kinetic interpretation of temperature is linked with the mean kinetic energy of gas molecules or the energy of thermal oscillations of the centres of the solid lattice. However, this is the external side of the thermal phenomena. It is necessary to determine the reasons for thermal oscillations of the molecules. Investigations of photon emission in the present book and also of the two-rotor structure of the photons and their interaction with atoms in [2] indicate that the reason for thermal oscillations of the atoms and molecules are in particular photons, but not all the photons, only thermal ones.

As shown, the complicated nature of the theoretical investigations in this direction encounters contradictions associated with the photon energy. It would appear that as the photon energy increases, the strength of the effect of the photon on the molecule also increases and the photon emits an atom in the composition of the molecule and is many times re-admitted. In this case, the recoil momentum should be determined by the photon energy. However, it appears that the photon energy is not linked with the intensity of thermal oscillations of the molecules and the high-energy photons do not have any significant thermal effect on the molecules. Only a specific group of the low-energy photons is capable of ensuring thermal oscillations of the molecules. This group must be placed in the group of thermal photons. Consequently, the parameters such as: temperature, heat capacity, heat conductivity, energy recoil of fuel, are determined more accurately.

If the temperature is regarded as the spectral concentration of thermal photons in the unit volume of matter, then the heat capacity must be linked with the capacity of matter to retain thermal photons and its conductivity with the speed of movement of the flux of thermal photons in matter. These are quantum approaches to the thermodynamics in which the continuous thermal fields are determined by the effect of discrete and random fields of thermal photons.

The aim of development of quantum energetics is also to increase the efficiency of the conventional types of fuel. The energy output of chemical fuel is determined by its capacity to produce thermal photons as a result of the mass defect of valence electrons in chemical reactions during changes in the molecular bonds. If conditions are created in which there is a directional (not random) emission of thermal photons, the recoil of the molecules o the blades of a turbine increases many times, increasing the efficiency of utilisation of fuel and of its conversion into mechanical and electrical energy.

8.6. High temperature superconductivity

The current theories of heat conductivity are based on a phenomenological description of a certain hypothesis because the superconductivity problems cannot be solved without knowing the reasons for emission of a conductivity electron in a conductor, knowing the structure of the electron (Fig. 7.1) in the space-time and the effect of the gravitational potential well (Fig. 7.6) of the atomic nucleus on the movement of a conduction electron in a strong electrical field of the nucleus.

Moving inside any conductor, the conduction electron emits energy into the surrounding space and its energy losses determine the electrical resistance of the conductor. In fact, any conductor in movement of electricity carriers in it is a generator of radiation, a peculiar converter of direct alternating current into thermal and optical radiation. If the radiation of the conductor or, more accurately, of conduction electrons in the conductor is interrupted, the conductor transfers to the superconducting state because there are no losses through irradiation into the surrounding medium.

The theory of Superunification supplements the theory of emission of the conduction electron by its structure in the space-time and by the strong effect of the gravitational well of the atomic nucleus on electron emission. In fact, in movement in a conductor the conduction electron is forced to interact with the atoms of the matter crammed with nuclei with gravitational wells and strong electrical fields, and it is very difficult for the electron to bypass them. An effect is also exerted by induced magnetic fields. In movement in such a complicated structure, the electron is subjected to the effect of strong alternating accelerations resulting in the exchange of orbital electrons with conduction electrons.

The conduction electrons, subjected to strong acceleration, and the orbital electrons, whose excitation takes place as a result of exchange with the conduction electron, represent sources of radiation in the conductor. In particular, the structure of the material of the conductor determines its electrical resistance with the conductor playing the role of a peculiar generator of electromagnetic radiation whose source are primary conduction electrons. As shown by the theory of Superunification, electron emission is possible only as a result of its mass defect which is manifested in jumps (very strong acceleration) inside the gravitational the well of the atomic nucleus in the region of relativistic speeds. The mass defect of the electron results in the production of thermal photons whose spectral concentration determines the temperature of the conductor. This process is cyclic because the mass defect of the electron is replaced by the restoration of the mass defect at exit of the electron from the gravitational well of the atomic nucleus. This cyclic nature of the energy processes in the conductor results in the loss of energy through radiation (production of thermal photons) and, in the final analysis, in heating of the conductor and determines its electrical resistance. The compensation of energy through the losses in the conductor takes place by means of the energy of the electrical field of the power source.

If the emission the direction electron inside the conductor is interrupted, we obtain ideal superconductivity. An ideal superconductor is the quantised space-time free from matter, i.e., the physical vacuum. Once accelerated, the electron moves in it without radiation and with no resistance to movement, i.e., electrical resistance. It would appear that it is sufficient to take a hollow isolated tube in a vacuum and we obtain a very cheap superconductor, working in the widest temperature range.

However, the problem of vacuum superconductors is not reduced to the problem of formation of superconductivity; instead, it is reduced to the problem of introducing electricity carriers in vacuum and withdrawing them from it. This is the problem of the work function of the electrons from the cathode material, and the problem of reception of carriers by the anode which is in fact a target. Bombardment of a target with the electrons results in bremsstrahlung with a wide spectrum which is used partially for heating the anode and in the final analysis is completely scattered in space. In particular, the losses through the work function of the electrons and acceleration of the electrons in vacuum, and also the energy losses by the electrons in interaction with the anode, determine the electrical resistance of the system, although the main vacuum section is in fact an ideal superconductor.

Discussing the solid state high-temperature superconductors, the problems associated with the search for structures characterised by the formation of conduction bands similar to vacuum bands become evident. It is necessary to produce conduction bands with the minimum depth of the gravitational wells and the maximum distance between the atomic centres, having a lesser effect on conduction electrons. On the other hand, a superconducting material should have a rigid structure (of the ceramic type) with a smaller external thermal effect which interfere with the movement of electricity carriers. At the moment, I do not know how to develop such structures. Evidently, we are concerned with laminated structures, possibly with the longitudinal orientation of the layers between which a vacuum-like condition is produced.

To eliminate the resistance of the conductor it is necessary to stop jump-like movement of the conduction electrons in the conductor. In a smooth (without jumps) movement of the electron in the gravitation well of the atomic nucleus, it's energy remains constant because the increase of the electrical component is completely compensated by the gravitational component. When the temperature of the conductor drops to very low values the thermal oscillations of the crystal lattice of the conductor and of the conduction electrons are terminated. This prevents the jump-like movement of the conduction electron which is the source of electron emission.

In any case, the theory of Superunification provides a powerful tool for analysis of the superconducting state of matter and a new direction for theoretical and experimental investigations in the area of development of superconducting materials.

8.7. Leonov's task

In April 2000 I posted on the Internet a study in which it was proposed to the physicists to test their forces in solving the problem of atom recoil including photon emission. Nobody replied for more than one year. Here, I present the full text of the Leonov task.

In the 17th century, the French mathematician Piette de Fermat threw a challenge to all mathematicians for many centuries ahead by formulating his outstanding theory which he solved and subsequently destroyed. For me, this precedent is a clear example of the proof of the superiority of the scientific mind over dogmas which always existed and in large numbers. However, history shows that the numerical majority has no meaning in fundamental science and the fundamental discoveries are made by lone persons subjected to several pressure from dogma tests.

There are many examples. Newton was brought to the stress state and temporary loss of reasoning, Boltzmann committed suicide, Einstein became an outcast in his native country Germany, Vavilov was murdered, and there are many similar examples. The dogmatists can be flawed by many means that do not take any convincing reasoning because they regard themselves as true scientists and everything which does not fit in the narrow framework of the limited thinking is regarded as force science. In Russia, this phenomenon has acquired the hypertrophied form, expressed in the development of the anti-constitutional commission 'Fight with pseudoscience and falsification of the scientific investigations by the Presidium of the Russian Academy of Sciences (RAS) under the leadership of the atomic physicist Academician E. Kruglyakov who is the main inquisitor of the country. It is strange that this medieval formation inside the Russian Academy of Sciences includes Nobel Prize Laureate for Physics V.L. Ginzburg (now deceased) and the well-know populiser of science Prof. S.P. Kapitsa.

In science it is accepted that any new scientific concept, without being disproved, has the right to live together with the established views. If you cannot refute the new scientific concept, then you do not have the moral right to attempt to destroy, regardless of whether you agree with the new concept or not. This is the normal form of existence and development of science when at the point of change old concepts are replaced by new ones. But this conventional standard of the development of science is rejected by Kruglyakov's commission, reflecting the reactionary position of the RAS as a whole. I am not a specialist in the area of torsional fields, but as theoretical physicist, who created the theory of the Superunification of fundamental interactions - main physical theory, I cannot accept when Kruglyakov's commission brings into question the existence of torsional oscillations and also rejects antigravity and much more.

I entered physics in 1996, when after many years of meditation I discovered almost immediately the quantum of space-time (quanton) and superstrong electromagnetic interaction (SEI) whose existence was predicted by the genius Einstein in the form of the unified field. He spent more than 30 years of life searching for this without success. SEI unites the known interactions (electromagnetism, gravity, nuclear and electroweak forces) in the theory of Superunification.

Within several years I solved the very difficult tasks of theoretical physics, whose solution was put aside for at least a century. The structure of the quantised space-time, nature of gravity, antigravity and nuclear forces were determined. The quanton is the physical carrier of time, assigning the rate to electromagnetic processes and uniting space and time into the united substance. The limiting parameters of elementary particles were determioned, preventing infinite solutions. A two-component solution of the Poisson gravitational equation was obtained – fundamental equation of gravity, which determines mass as the result of the deformation (distortion according to Einstein) of the quantised space-time. The wave equation of elementary particles was analytically derived and the structure of the electron, positron, proton, neutron, neutrino, photon described. It has been proven that the law of relativity is the fundamental property of the quantised space-time. The joint principle of relativity and quantum theory, which embarked on the path of deterministic development, were united.

I could mention many other solved tasks in the theory of Superunification, but I destroyed the solution of one fundamental problem of quantum theory and I propose to repeat its solution to all physicists. I am confident that now no one will be able to do this. I address this call to those physicists who fan cheeks from their importance and occupy leading posts in the RAS. Only in this manner is it possible to show their scientific insolvency and to simultaneously draw to the problem young people who are the future of Russian science. Before formulating the essence of task, it is necessary to make some explanations.

I was forced to make this step by the years irreconcilable and long-standing fight with the grayness, corruption and the scientific incompetence of the management of the RAS. This leads to the degradation of the academic system. You will never defend your thesis if your scientific work exceeds the level of members of the Russian Academy of Science. You can become a member of the Academy if you stand in a long que without allowing scientific dissent in order not to be excluded from the que. It is necessary to wait for death of a member of the RAS in order to occupy his/her place, or more precisely place on the elite cemetery. This is amoral in its basis. You will not be able to publish an article in an academic periodical, without being toady, without having acquaintances and support of members of the RAS, even if you are ‘on the Einstein level’. Today no unknown patent inventor Einstein could publish his first and fundamental articles in a Russian academic periodical.

Such examples can be found quire easily. In the three editorial boards of the leading physical academic periodicals: Journal of Experimental and Theoretical Physics (chied editor Academician of RAS A.F. Andreev), Uspekhi Fizicheskikh Nauk (chief editor was Academician of RAS V.L. Ginsburg (now deceased)), periodical Theoretical and Mathematical Physics (chief editor Academician of RAS A.A. Logunov) there are 13 fundamental theoretical articles concerning Superunification with the total volume of more than 500 pages. In spite of all my urgent requests, specialists of the RAS cannot prepare the articles for review. The matter is down to the complete marasmus - they do not publish articles without a review, but there is no one write a since the RAS has no experts on superunification. There is a criminal suppression of new fundamental discoveries in addition to the violation of the current legislation and constitution of the Russian Federation.

Gentlemen, the chief theorists of the RAS! In order to determine “Who is Who” in contemporary physics, I am sending you this challenge to solve Leonov’s task which obviously is not to your liking. It has been solved by me. This is one of the primary task of quantum theory. I would like to mention that the formation of quantum theory at the beginning of 20th century was the result of the contradictions detected by Planck in the study of black body radiation, when the intensity of emission proved to be proportional to the frequency of the electromagnetic field. This contradicted the classical electrodynamics, in accordance with which the intensity of electromagnetic radiation is determined by the field strength and not by its frequency. The presence of such serious contradictions led in physics ton the discovery of the quantum of radiation (photon) – the particle transferring the energy of electromagnetic radiation in specific portions (discretely) in proportion to the field frequency.

Leonov’s task

Today contradictions in quantum theory lie between temperature and atom recoil with the emission (absorption) of photon. It would seem that as the energy of the emitted photon increases, the recoil of the photon on the atoms becomes greater and the intensity of the temperature variations of atoms (molecules) also increases. In practice everything appears reversed, the largest recoil is produced by the low-energy infrared photon (thermal photon). The physical task of Leonov is thus formulated. It is necessary to mathematically prove that the thermal recoil of the atom (molecule) is inversely proportional to energy of the radiated photon.

Thus, gentlemen down to work! You became accustomed that the recoil of a gun is proportional to the pulse of the ejected bullet. It is now necessary to prove the reverse. These are the paradoxes of quantum theory. I will continue the criticism of the activity of the atomic physicits E. Kruglyakov who, after being absorbed in fighting pseudoscience, dedicated his entire life to the creation of anti-science such as the false concept of controlled thermonuclear fusion (CTF). One agrees that the temperature concept of CTF was not formulated by Kruglyakov but by founders of thermonuclear physics A.D. Sakharov, etc. But they also were not insured against errors.

More than four decades with the participation E. Kruglyakov we were told that the future of power engineering is controlled thermonuclear fusion (CTF), clowing down other directions of studies. With the aid of CTF they promised us to solve all energy problems of humanity by the year 2000, after spending enormous sums of money. Time has gone past, energy problems not only have not been solved but the situation is now in a critical state. A new international project ITER costing 10 billion US$ (with Russia contributing $1 billion) has been proposed instead of inoperative CTF systems of the Tokamak type.

I openly declare that the ITER project is a grandious scientific adventure and will taxpayers money on antiscientific and futile studies as was the case with Tokamaks. CTF is based on the false temperature concept of synthesis. It was originally considered that it would be sufficient to heat the hydrogen-forming plasma in a magnetic trap to a temperature of 15 million degrees to start CTF of helium with the release of energy as a result of the mass defect of nuclei. The temperature in the plasma has already reached 70 million degrees, but CTF does not take place. The temperature concept of nuclear fusion does not work. Kruglyakov and his associates lead the government of the country and scientific community into a dead end.

It is now necessary to scientifically explain the reasons for the aforesaid. But I before advise Kruglyakov as an atomic scientist in the region of CTF, instead of becoming a flimsy inquisitor, he should study my work in the physics of the atomic nucleus and elementary particles, for example 'Electrical nature of nuclear forces' and others. Ignorance of the structure of nucleons and of the nature of nuclear forces resulted in the antiscientific concept CTF based erroneously on high temperature. I shall also show to Mr E. Kruglyakov that in interaction of nucleons inside the nucleus the zones of antigravity repulsion are opened and they stabilise nucleons and atomic nuclei. Antigravity is also widespread in nature, like gravity. It turns out that the physicist-atomic scientist, E. Kruglyakov, Academician of the RAS does not understand the nature of nuclear physics, but he attempts to stick the labels of antiscience to others.

Now, when the nature of nuclear forces in theory of Superunification is known, it is difficult to find a way of including the temperature factor in the CTF concept as a factor of overcoming the electrostatic repulsion of protons (hydrogen nuclei). The temperature concept of CTF was based on the positive experience with the explosion of the H-bomb, where the detonator was a preliminary nuclear explosion accompanied by the release of colossal energy. But in this case the temperature is one the factors of energy release. The high pressures and the accelerations, which 'press' proton nuclei onto each other to the distances of the action of nuclear forces (the electric forces of the alternating shells of nucleons), overcoming the electrostatic repulsion of nuclei, are other factors.

Purely because of technical reasons it is not possible to produce colossal pressures and particle accelerations under the action of nuclear explosion inside the thermonuclear reactors under laboratory conditions. Heating of plasma in the magnetic trap of Tokamaks is irrelevant. Knowing the values of nuclear forces and cross sections of their action, it is not difficult to calculate pressures and forces which must be overcome for the nucleons to come closer together in spite of their electrostatic repulsion. For this purpose the proton nuclei of light elements must be squeezed by the accelerated fragments of the atomic nuclei of heavy elements (uranium, plutonium and others) transferring a force momentum to splinters, as is done in the thermonuclear bomb. The acceleration of the splinters of heavy nuclei occurs as a result of their strongest electrostatic repulsion with splitting at the moment of nuclear explosion. The conditions for the natural acceleration of the splinters of nuclei are thus created.

As a result we obtain a nuclear press, when light nuclei are squeezed between the accelerated fragments of heavy nuclei and the quantized space-time, which presents the elastic quantized medium (EQM) which acts as a wall (anvil). The strength of this anvil increases with an increase in the strength of the effect of acceleration and the momenta of splinters on the anvil. This factor of the quantised medium, which possesses the properties of superhardness under the influence of colossal accelerations and forces from the side of the second required factor – accelerated fragments of heavy nuclei, was never examined in the nuclear fusion theory. Without the two factors indicated, which play the basic role in the explosion of a thermonuclear bomb it will not be possible to start CTF.

On the other hand, I wanted to verify by calculations how the temperature concept of thermonuclear fusion is related to nuclear fusion. I could not find in the literature any sources describing the calculations linking nuclear forces with temperature. Of course, they could not be there. In order to calculate these forces it is necessary to have a clear idea about the temperature not as a parameter on the scale of a thermometer or photon energy, but as a thermal power engineering factror. But also here, as already mentioned, present quantum theory gives failures. It occurs, the higher the photon energy, the less the return down the atom it produces. The greatest return produces the low-energy infrared photon (thermal photon), which is not capable to ensure the recoil momentum of atomic nucleus for overcoming the electrostatic barrier between the nuclei of light elements.

I specially focused attention on this energy paradox, since temperature we connect for the sake of the temperature variations of atoms and molecules as a result of return with the emission (re-emission) of photon. Before its time the development of quantum theory also began based on the energy paradox, when was revealed discrete nature of the emission of atom and dependence of photon energy beyond its frequency, but not from the intensity of emission. This contradicted classical electrodynamics. Today such contradictions to quantum theory lie between temperature and atom recoil during the emission (absorption) of the photon when it is not possible to overcome the force of the electrostatic repulsion of atomic nuclei when attempting their synthesis. The temperature concept of CTF is antiscientific in its basis and it does not have any prospects for further development in power engineering.

Thus, the solution of the Leonov's problem is not only of purely theoretical interest but it also represents the colossal applied value for the processes generating thermal energy in the new power cycles of quantum power engineering. This refers to a number of new experimental effects with the liberation of excess heat, including the Usherenko effect (effect of the ultradeep penetration of microparticles into solid targets). If in CTF they still search for the effect of positive heat liberation, then in the Usherenko effect this release of energy exceeds $10^2 \ldots 10^4$ times the kinetic energy of the accelerated particles–strikers. However, this only one of many facts which experimentally confirm the prospects for the development of quantum power engineering as the basis of power engineering in the 21st century. By the way, quantum power engineering is a more general concept which also includes nuclear reactions which, in the final analysis, are only one of the methods of the extraction of energy of superstrong electromagnetic interaction (SEI). This completely corresponds to the theory of Superunification and the Einstein's concept of the unified field.

More details on new fundamental discoveries and the project 'Quantum Energetics' can be found at www.kvanton.land.ru.

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9
Gravitational waves
Wave equations

The Superunification theory has unified electromagnetism and gravitation through the superstrong electromagnetic interaction. The nature of gravitation and electromagnetism has been determined. If electromagnetism the result of electromagnetic polarisation of the quantised space-time, gravitation is caused by its deformation (distortion). Deformation changes the quantum density of the medium (the concentration of quantons in the volume), whereas in electromagnetic polarisation the quantum density of the medium remains unchanged. This is the large difference between gravitation and electromagnetism. Electromagnetic waves are transverse polarisation oscillations of the quantised medium. From the source of gravitational perturbation, gravity is transferred through the longitudinal deformation of the quantised space-time. Therefore, long-term search for gravitational waves, regarded as transverse waves, was a procedural error. It has been shown that gravitational waves are the longitudinal oscillations of the deformation of the quantised space-time. In August 2006, I generated and sent into the cosmic space a longitudinal gravitational wave with the power of the order of 100 W.

Chapter 9 is based, with small corrections, on the study: V.S. Leonov, *Discovery of Gravitational Waves by Prof. Veinik*, Agrokonsalt, Moscow, 2001.

9.1. Introduction

In 1991, a monograph 'Thermodynamics of Real Processes' by Prof. A.I. Veinik, Corresponding Member of The Academy of Sciences of Belarus was published in Minsk. In the book, Prof. Veinik described a number of interesting experiments, associated with the recording of previously unknown radiation on the basis of the variation of the resonance frequency of oscillations of a quartz sheet. Radiation was generated from different objects at the moment of changes of their deformation state as a result of the effect of a force on the specimen and the removal of the load from the specimen, or the fracture of the specimen itself, and also at the moment of the phase transition of the objects from one state to another, for example, in melting or solidification of metallurgical castings, and in a number of other cases. Radiation was not recorded by electromagnetic methods and was not screened [1].

For example, Fig. 9.1 shows the experimental dependence of the variation of the frequency of a quartz sheet under the effect of radiation at the moment of removal of deformation stress from a pre-loaded ceramic tube. The change of frequency was approximately 200 Hz at the resonance frequency of quartz of 10 MHz.

Veinik himself explained his experiments by the presence of chronal radiation in objects because the course of time in space changed at the moment of the change of the deformation state of the object. According to Veinik, the particle transferring chronal radiation was a hypothetical particle, 'chronon' [1, 2].

When analysing Veinik's experiments, I always believed that his theoretical explanation of the experimental results on the basis of the chronon

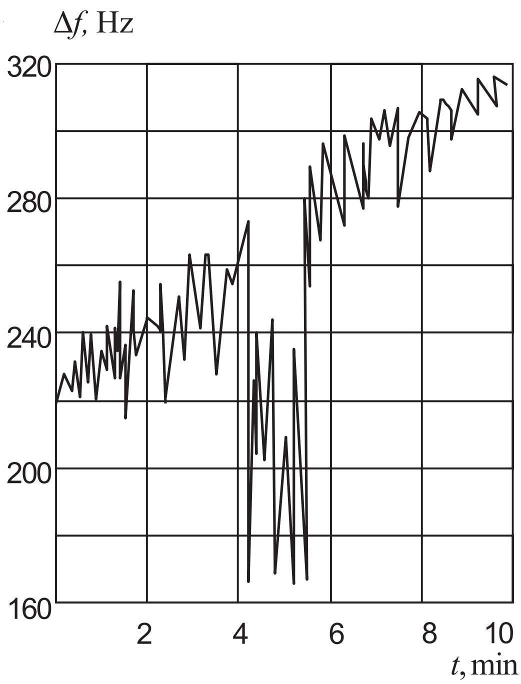

Fig. 9.1. Variation of frequency Δf of a quartz sheet under the effect of gravitational radiation as a result of a change of deformation stresses in the specimen (ceramic tube) [1, 2].

particles (time carriers) is simply invented because it did not fit the Einstein concepts of space-time. The uniqueness of space and time was not doubted and, naturally, the chronon fluxes interfered with the views of physicists. We realise that new discoveries change our views on the nature of phenomena. However, they should not break the fundamental assumptions of physics which include the uniqueness space and time.

So, how can we explain the results of Veinik's experiments? Disregarding the fact that Einstein links the unity of space and time with gravitation, I have attempted to justify the discovery by Veinik of longitudinal gravitational waves emitted by matter at the moment of deformation of the latter. This logical conclusion was reached on the basis of the analysis of the state of gravitation theory as a theory of distorted (deformed) space-time originated by Lorentz, Poincaré, Einstein and Minkovskii. At that time there was already a large amount of practical experience with the application of electromagnetic waves with the longitudinal nature of the oscillations in accordance with the Maxwell equations for the electromagnetic field in the quantised space-time.

9.2. State of the space-time theory

The unity of time and space was proposed by the mathematicians Poincaré and Minkovskii at the beginning of the 20th century, who purely formally combined the Cartesian coordinates (x, y, z) of space and time t through their increments into a single mathematical expression of the quadratic form referred to as the four-dimensional interval ds [3, 4]:

$$ds^2 = c^2dt^2 - (dx^2 + dy^2 + dz^2) \tag{9.1}$$

where $c \approx 3 \cdot 10^8$ m/s is the speed of light in quantised space-time (c = const).

Equation (9.1) is nothing else but another form of writing the Lorentz transformations [4] which show that the course of time t in space depends on the speed of movement v of the body (particle) in space in relation to the initial time t_0 with the relativistic factor γ taken into account:

$$t = t_0\gamma = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{9.2}$$

However, the equations (9.1) and (9.2) do not take into account the effect on the course of time of the mass of the moving body which is a reason for the distortion of the space-time, without mentioning the movement of the mass in the distorted space-time with a different perturbing mass. In order to link the distorted space-time with the gravitational source, i.e., with the mass and its speed, Einstein introduced the concept of the energy–pulse, which determines the dependence of the effect $S(R)$ of space-time on its curvature R (R is the invariant of the Ricci tensor, g_i is the determinant) [5]

$$S(R) = -\frac{1}{16\pi G}\int (dx)\sqrt{-g_i}\ R \tag{9.3}$$

where $G = 6.67\cdot 10^{-11}$ Nm^2/kg^2 is the gravitational constant.

Academician Sakharov criticised this Einstein's approach, saying that: 'the presence of the effect (9.3) results in the metric elasticity of space, i.e., in the formation of a generalising force, preventing distortion of space' [5]. However, this is not directly reflected in (9.3). Identical criticism was also made of the classic approach to gravitation described in the statics by the Poisson gravitational equation for the gravitational potential φ [6] because the known solutions of the Poisson equation also do not contain the component preventing distortion of space

$$\rho_m = \frac{1}{4\pi G}\text{div grad}(\varphi) \tag{9.4}$$

$$\text{div grad}(\varphi) = \frac{\partial^2\varphi}{\partial x^2} + \frac{\partial^2\varphi}{\partial y^2} + \frac{\partial^2\varphi}{\partial z^2} \tag{9.5}$$

Here ρ_m is the density of the matter of the perturbing mass, kg/m^3.

If the density of matter ρ_m is concentrated in a limited volume, then outside its volume under the condition $\rho_m = 0$ the Poisson equation changes to the Laplace equation.

The absence in the solutions of the equations (9.3) and (9.4) of a second component preventing distortion of space should result in the instability of space-time, i.e. in its collapse. However, this has not been observed in experiments. The space-time is a very stable substance. This is possible only if the force preventing the distortion of space to which Sakharov referred to does really exist. However, the existence of such a force can be associated only with the existence of elastic properties of the space determined by its real structure, and taking this structure into account we can introduce the second component, preventing distortion of space, into the solution of the equations.

At the same time, it is necessary to give credit to Einstein who in the general theory of relativity developed the four-dimensional consideration, combining the space and time into a single substance whose distortion is the basis of gravitation.

9 .2. Main static equations of the deformed quantised space-time

The authors of [7, 8] proposed a method of electromagnetic quantisation of space within the framework of the stationary Lorenz absolutely elastic structure, treating the physical vacuum as a continuous medium in the form of specific quantised space-time having ideal (without friction and plasticity) elasticity [9].

The solution of the stationary problems of the formation in the elasticity theory and continuum mechanics is determined by the classic Poisson equation (9.4), and in this case we examine the situation in the replacement of the gravitational potential φ by the quantum density of the elastic continuum (particle/m^3) which characterises the number of particles (space quanta) in the unit volume of the elastic medium

$$\rho_m = k_0 \text{div grad}(\rho) \tag{9.6}$$

$$\frac{1}{k_0} = 4\pi G \frac{\rho_0}{C_0^2} \tag{9.7}$$

$$\rho = \varphi \frac{\rho_0}{C_0^2} = C^2 \frac{\rho_0}{C_0^2} \tag{9.8}$$

where $1/k_0 = 3.3 \cdot 10^{49}$ particle/kg m^2 is the constant of the quantised space-time unperturbed by deformation; C_0^2 = 8.99 10^{16} J/kg (m^2/s^2) is the gravitational potential of the unperturbed quantised space-time (C_0^2 = const); C^2 is the gravitational potential of the quantised space-time perturbed by gravitation; m^2/s^2 ($C^2 \neq$ const); $\rho_0 = 3.55 \cdot 10^{75}$ particle/m^3 is the quantum density of the unperturbed quantised space-time (ρ_0 = const) [7].

The space-time quanta form the quantised space-time. Equation (9.6) characterises the state of the elastic quantised space-time deformed by the perturbing gravitational mass m, and its solution makes it possible to find the distribution of the quantum density of the vacuum medium for both the external region ρ_1 of the deformed space-time and for the internal region ρ_2, in relation to the gravitational interface in the quantised medium. For the case of spherical deformation of the quantised space-time, as a result of integration of (9.6) we obtain the exact solution of the distribution of the quantum density of the medium in the form of a system of two equations in the statics:

$$\begin{cases} \rho_1 = \rho_0\left(1 - \dfrac{R_g}{r}\right) \\ \rho_2 = \rho_0\left(1 + \dfrac{R_g}{R_s}\right) \end{cases} \tag{9.9}$$

where r is the distance from the centre of the source of gravitation ($r > R_s$) m; R_s is the radius of the source of gravitation with mass m (gravitational interface in the elastic quantised medium), m; R_g is the gravitational radius of the source of gravitation (without multiplier 2), m

$$R_g = \frac{Gm}{C_0^2} \tag{9.10}$$

The gravitational radius for the elementary particles and for non-collapsing objects is a purely calculation parameter.

Solution of (9.9) makes it possible to estimate the elasticity of the quantised space-time, for example, on the basis of compression of the quantised density of the medium ρ_2 inside the surface with a radius for the gravitational interface of the Earth, the Sun and a black hole:

- for the Earth at $R_S = 6.37 \cdot 10^6 \text{m}, \; R_g = 4.45 \cdot 10^{-3} \text{m}$

$$\rho_2 = 1.0000000007 \; \rho_0$$

- for the Sun at $R_S = 6.96 \cdot 10^8 \text{m}, \; R_g = 1.48 \cdot 10^3 \text{m}$

$$\rho_2 = 1.000002 \; \rho_0$$

- for the black hole $R_g = R_S \rightarrow \rho_2 = 2\rho_0$

If the Sun collapses, its matter would be compressed $1.27 \cdot 10^{16}$ times, whereas the space quantum is compressed only $\sqrt[3]{2} = 1.26$ times. In fact, here we are concerned with the quantised space-time as a superelastic medium with no analogues with the media known to science.

Taking into account that the quantum density of the medium as a parameter of the scalar field determines the distribution of the gravitational potential in the quantised space-time, we improve the accuracy of the solution of the classic Poisson equation (9.4) for the gravitational potential. By analogy with the solution (9.9) we determine the distribution of the gravitational potentials φ_1 and φ_2 for the spherically deformed quantised space-time with respect to the gravitational interface:

$$\begin{cases} \varphi_1 = C_1^2 = C_0^2 \left(1 - \dfrac{R_g}{r}\right) \\ \varphi_2 = C_2^2 = C_0^2 \left(1 + \dfrac{R_g}{R_s}\right) \end{cases} \tag{9.11}$$

Thus, the new solutions (9.9) and (9.11) of the static Poisson equation (9.4) and (9.6) for the quantised space-time include the second internal components ρ_2 and φ_2 which prevent distortion of space and balance the external deformation (distortion) of the quantised space-time, determined by the parameters ρ_1 and φ_1. This approach makes it possible to avoid the collapse of space and make it stable.

In fact, if we specify some boundary in the quantised space-time and then compress this boundary uniformly to radius R_s together with the medium, the internal compression region increases the quantum density of the medium as a result of tensile loading of the external region, balancing the absolutely elastic system. This process is described by the Poisson equation as the divergence of the gradient of the quantum density of the medium or gravitational potential.

Naturally, the reason for gravity is the disruption of symmetry and of the established equilibrium of the colossal tension of the elastic quantised space-time determined by the distortion of space-time (its deformation). The Newton law of universal gravitation for the force $\mathbf{F}_n$ of two gravitating masses m_1 and m_2 originates from the first external component φ_1 of the solution (9.11) with (9.8) taken into account ($\mathbf{1}_r$ is the unit vector):

$$\mathbf{F}_n = m_2 \mathrm{grad}\varphi_1 = m_2 \mathrm{grad} C_0^2 \left(1 - \frac{R_g}{\mathbf{r}}\right) = G\frac{m_2 m_1}{r^2}\mathbf{1}_r \tag{9.12}$$

On the other hand, the presence of an intrinsic gravitational potential C_0^2 of the non-deformed quantised space-time enables us to determine the rest energy of the particle W_1 during its formation in the quantised space-time by the work of transfer of mass m_0 from infinity to the region of the potential C_0^2, determining the rest energy as the consequent energy of spherical deformation of the quantised space-time by the generated particle:

$$W_0 = \int_0^{C_0^2} m_0 d\varphi = m_0 C_0^2 \tag{9.13}$$

Equation (9.13) is the simplest and most convincing conclusion of the equivalence of mass and energy as an electromagnetic substance.

9.4. The balance of gravitational potentials in quantised space-time

The solutions of the Poisson equations (9.9) and (9.9) can be used to produce the exact balance of the quantum density of the medium and gravitational potentials for the external region of the deformed quantised space-time at $\rho_1 = \rho$ and $\varphi_1 = C_1^2 = C^2$ (to simplify equations)

$$\rho_0 = \rho + \rho_n \tag{9.14}$$

$$C_0^2 = C^2 + \varphi_n \tag{9.15}$$

where ρ_n is the quantum density of the medium, determined by the Newton gravitational potential φ_n, particle/m^3; φ_n is the Newton gravitational potential for the mass m, m^2/s

$$\varphi_n = \frac{Gm}{r} \tag{9.16}$$

The four-dimensional interval (1) is easily reduced to the balance of the gravitational potentials which differs from (15), assuming that the speed of light in the unperturbed (by gravitation) quantised space-time is constant, $c^2 = C_0^2$ = const, and here $c^2 \neq C^2$, where c^2 from (1), and C^2 and C_0^2 from (15)

$$\frac{ds^2}{dt^2} =| C_0^2 - \frac{(dx^2 + dy^2 + dz^2)}{dt^2} \tag{9.17}$$

from which

$$C^2 = C_0^2 - v^2 \tag{9.18}$$

$$C^2 = \frac{ds^2}{dt^2} = \varphi; \qquad v^2 = \frac{(dx^2 + dy^2 + dz^2)}{dt^2} \tag{9.19}$$

As indicated by (9.17), the four-dimensional interval (9.0) determines the gravitational potential $\varphi = C^2$ of the gravitation-perturbed quantised space-time and formally determines the approximate balance of the gravitational potentials (9.18) in the perturbed quantised space-time which can be obtained from (9.15) by incorrect replacement of the perturbing Newton potential φ_n by the square of speed v^2

$$C_0^2 = C^2 + v^2 \tag{9.20}$$

If the balance (9.15) of the gravitational potentials in the quantised space-time is the exact solution (9.11) of the Poisson equation for the deformed (distorted) quantised space-time, then the balance (9.20), reflecting Lorenz transformations, is the approximate equation for the quantised space-time. However, the balance (9.15) describes the statics and (9.20) the kinematics. In order to introduce the speed of movement into the exact solution (9.11), it is necessary to link the dynamic increase of the mass with the spectrum speed and, correspondingly, the perturbing Newton potential, through the normalised relativistic factor γ_n [7]

$$\begin{cases} \varphi_1 = C^2 = C_0^2\left(1 - \frac{R_g\gamma_n}{r}\right) = C_0^2\left(1 - \frac{\varphi_n\gamma_n}{C_0^2}\right) \\ \varphi_2 = C_0^2\left(1 + \frac{R_g\gamma_n}{r}\right) \end{cases} \tag{9.21}$$

From (9.21) we obtain the dynamic balance of gravitational potentials for the particle (body) moving in the entire speed range, including the speed of light

$$C_0^2 = C^2 + \varphi_n\gamma_n \tag{9.22}$$

where γ_n is the normalised relativistic factor

$$\gamma_n = \frac{1}{\sqrt{1 - \left(1 - \frac{R_g^2}{R_s^2}\right)\frac{v^2}{C_0^2}}} \tag{9.23}$$

The balance of the gravitational potentials (9.22) is determined by the general Poisson equation which describes the distribution of the gravitational potential C^2 in the deformed quantised space-time for the spherically symmetric system taking into account the speed of the solid (particle) through the normalised factor γ_n

$$\rho_m = \frac{1}{4\pi G}\text{div grad}C^2 = \frac{1}{4\pi G}\text{div grad}(C_0^2 - \varphi_n\gamma_n) \tag{9.24}$$

The solution of (9.24) is (9.21).

Fig. 9.2 see Fig. 3.11. Gravitational diagram of the distribution of t he quantum density of the medium and gravitational potential in the external ($\rho_1 = \rho$, C^2) and internal (ρ_2, C_2^2) regions of the spherically deformed (distorted) quantised space-time as a result of gravitational perturbation of the quantised space-tme by a particle (a body).

Fig. 9.2 (Fig. 3.11) shows the gravitational diagram in the form of the curve of distribution of the quantum density of the medium and gravitational potentials in the statics in accordance with the solutions (9.9) and (9.11), determining the balance of the quantum density of the medium and the gravitational potentials. As indicated, at the gravitational interface $r = R_s$ there is a jump of the quantum density $\Delta\rho$ of the medium and the gravitational potential $\Delta\varphi$, forming a gravitational well in the medium

$$\Delta\rho = 2\rho_{ns} \qquad \Delta\varphi = 2\varphi_{ns} \tag{9.25}$$

where φ_{ns} is the Newton gravitational potential at the gravitational interface R_s in the medium determined by the decrease of the quantum density of the medium ρ_{ns} on the external side of the gravitational interface in spherical deformation of the quantised space-time, m^2/s^2.

The presence of the multiplier 2 in (9.25) is determined by the physical model – the presence of two components ensuring stability of the quantised space-time as a result of its simultaneous compression and tensioning the elastic medium due to gravitational interactions. Multiplier 2 is excluded from the gravitational radius (9.8) which was erroneously introduced by Schwartzschild because the physical model of the gravitational deformation of quantised space-time was not available. The fundamental role in gravitational interactions is played by the gravitational interface R_s of the medium whose property and structure for the nucleons and the electron (positron) are described in [10].

In the dynamics, the curve in Fig. 9.2 differs from the static only by the fact that it is not determined by the static balance (9.15) of the gravitational potentials and is instead determined by the dynamic balance (9.22), retaining the spherical symmetry of the system. This greatly simplified calculations in the theory of gravity by reducing them to the principle of superposition of the fields in solving the many-body (particle) problem and in the majority of cases is not necessary to use complicated calculation apparatus with tensor analysis.

In the presence of a large number of elementary particles in a single conglomerate of the body, every particle inside the radius of its gravitational interface compresses vacuum as an elastic medium as a result of its ??? on the external side, with gravitation on the elementary level. The effect of the principle of superposition of the fields is determined. Therefore, the resultant solutions are valid not only for elementary particles but also for cosmological objects.

In fact, the mass of any cosmological object (planet, star) is formed from quantons which the mass acquires from the external region of space surrounding the given object and restricted by its volume. On the other hand, the mechanism of redistribution of the quantum density of the medium for cosmological objects operates through the elementary particles, included in the composition of the object. Each of the elementary particles forms its mass as a result of additional inclusion of quantons from the surrounding space. Since the principle of conservation of the total number of the quantons operates in the quantised space-time, the increase of the number of the quantons inside the gravitational interface by a specific number is possible only as a result of reducing the same number of the quantons outside the gravitational interface, determining the principle of superposition of the fields. Naturally, for the cosmological objects, their radius is the conventional interface R_s of the medium.

9.5. Limiting mass and energy of relativistic particles

The normalised relativistic factor (9.23) restrict the limiting mass of the particle when the particle speed reaches the speed of light. The factor results from (9.15) on the condition that the Newton potential (9.16) of the relativistic particle at its gravitational interface R_s in the limiting case cannot exceed $\varphi_n < C_0^2$. Consequently, from (9.16) we obtain that the maximum mass m_{max} of the relativistic particle cannot exceed the values (at $\varphi_n = C_0^2$ and $r = R_s$):

$$m_{max} = \frac{C_0^2}{G} R_s \tag{9.26}$$

and its limiting energy W_{max} is

$$W_{max} = \frac{C_0^4}{G} R_s \tag{9.27}$$

Thus, the establishment of the balance of the gravitational potentials in the deformed quantised space-time has made it possible to solve one of the most difficult problems of theoretical physics – determination of the limiting parameters of relativistic particles. For example, the gravitational interface of a relativistic proton is determined by its known radius $R_s = 0.81 \cdot 10^{-15}$ m, and the limiting mass in accordance with (9.26) is only 10^{12} kg. This is a higher value but is not infinite and corresponds to an iron asteroid with a diameter of the order of 1 km. In the determination of the limiting parameters for the relativistic electron whose radius does not have any distinctive gravitational interface it is necessary to take into account the dimensions of the proton with some modification [7].

It is interesting that the presence of the limiting mass (9.26) of the relativistic particles makes it possible to produce the energy balance for the particle in the entire range of the speeds, using the dynamic balance (9.22) of gravitational potentials, multiplying (9.22) by (9.26)

$$C_0^2 \frac{C_0^2}{G} R_s = C^2 \frac{C_0^2}{G} R_s + \varphi_n \gamma_n \frac{C_0^2}{G} R_s \tag{9.28}$$

It can be seen that the left-hand part of (9.28) is the limiting energy (9.27) of the particle (body). The right-hand part includes the latent energy W_v of the quantised space-time and the total energy W_s of the particle (body). Energy W_s is determined by the sum of the rest energy W_0 and the kinetic energy W_k, having the form of the sum of the energy of the spherical deformation of the quantised space-time of the gravitational interface of the medium R_s (at $R_s = r$)

$$W_v = C^2 \frac{C_0^2}{G} R_s; \qquad W_s = \varphi_n \gamma_n \frac{C_0^2}{G} R_s = m_0 C_0^2 \gamma_n \tag{9.29}$$

Taking (9.29) into account, the energy balance (9.28) can be presented conveniently in the following form, using the latent energy W_v of the quantised space-time

$$W_v = W_{\max} - m_0 C_0^2 \gamma_n \tag{9.30}$$

The energy balance (9.30) shows that the only source of energy of the particle (body) within the limits of the gravitational interface of the medium is the colossal energy, hidden in the quantised space-time. The latent energy exhausts itself completely $W_v = 0$ in the objects of the type of black hole and determines the maximum energy (9.27) of deformation of the quantised space-time by a black hole. In fact, balance (9.30) is the generalised Lagrange function which determines the energy parameters of the moving particle (body) in the quantised space-time deformed by the particle.

Equation (9.30) can be used to determine the latent force F_{vT} of the surface tension of the quantised space-time inside the particle determined by the spherical deformation of the quantised space-time. Force F_{vT} is determined as the derivative with respect to the gravitational interface R_s with (9.27) taken into account, expressing the mass in (9.30) through the density of matter ρ_m

$$F_{vT} = \frac{dW_v}{dR_s} = \frac{C_0^4}{G} - 4\pi R_s^2 \rho_m C_0^2 \gamma_n \tag{9.31}$$

Equation (9.31) includes the maximum force F_{Tmax} of tensioning of the quantised space-time reached on the surface of the black hole and acting on the entire surface of the black hole:

$$F_{T\max} = \frac{dW_{\max}}{dR_s} = \frac{C_0^2}{G} = 1.2 \cdot 10^{44}\,\text{N} \tag{9.32}$$

The force $1.2 \cdot 10^{44}$ N (9.32) is a limiting force which can be reached in nature as a result of deformation of the quantised space-time.

From equation (9.31) we determine the value of the tensor of surface tension $\mathbf{T}_n$ determined by the effect in the quantised space-time of the perturbing mass with the density of matter ρ_m. The surface tension tensor $\mathbf{T}_n$ acts on the unit surface of the spherical gravitational interface R_s ($\mathbf{1}_n$ is the unit vector which is normal to the spherical surface)

$$\mathbf{T}_n = \rho_m C_0^2 \gamma_n \mathbf{1}_n \tag{9.33}$$

As indicated by (9.33), surface tension tensor $\mathbf{T}_n$ depends on the density of matter of the particle (body) and the speed of movement of the particle in the quantised space-time. For example, at a mean density of matter of ρ_m = 5518 kg/m^3, the value of the tension tensor of the quantised space-time on the Earth surface reaches a gigantic value of $5 \cdot 10^{20}$ N/m^2, determining the colossal deformation tension of the quantised space-time. The mean density of the Sun is lower than the mean density of the Earth and, therefore, the tension tensor on the surface of the Sun is lower in comparison with that on the Earth, but the total tension force of the quantised space-time on the entire side surface should be considerably higher than that on the Earth.

Attention should be given to the fact that in the EQM theory the dimension of the gravitational potential of the quantised space-time C_0^2 and C^{23} is determined as J/kg defining at the same time the energy aspect of the quantised space-time. The dimensions J/kg and m^2/s^2 are equivalent to each other. Since there is no unique term for the unit of measurement of the gravitational potential, it is permissible to use either of these dimensions.

Thus, analysis of the balance of the gravitational potentials makes it not only possible to determine the limiting parameters of the particle (body) in the deformed quantised space-time but also find their intermediate values in the entire range of the speed, including the speed equal to the speed of light.

9.6. Fundamentals of the physics of black holes

Undoubtedly, the new results of calculation of the deformed quantised space-time can be used to determine more accurately the parameters of the objects of the type of black holes. In particular, this relates to the physical model of the black hole. The curve of the quantum density and gravitational potentials is represented by the gravitational diagram in Fig. 9.3 (Fig. 3.12). As a result of collapse of matter, the quantum density inside the gravitational radius of the black hole reaches the limiting value equal to $2\rho_0$. This takes place as a result of extension of the medium on the external side to the zero level $\rho = 0$. The black hole is characterised by the limiting parameters of deformation of the quantised space-time.

Fig. 9.3. Refer to Fig. 3.12. Gravitational diagram of the black hole

The main property of the black holes is the disruption of continuity of the quantised space-time as a light-bearing medium, determined by the discontinuities of the quantised space-time at the gravitational interface of the black hole and the quantised space-time. The disruption of the continuity of the light-bearing medium causes that the light is not capable of both penetrating into the black hole or leaving the black hole, making the black hole completely invisible. However, the strong gravitational field of the black hole should be detected by astronomical observations.

At the gravitational interface R_s of the black hole and the medium, equal to its gravitational radius R_g (9.10) there is a 'jump' of the gravitational potential $\Delta\varphi = 2C_0^2$ (R_g (9.10) without the multiplier 2 at $R_g = R_s$). The Newton potential on the external side of the medium on the surface of the gravitational interface has the limiting value C_0^2. The same value of the Newton potential is found also on the internal side of the gravitational interface in relation to the gravitational potential C_0^2 of the non-deformed quantised space-time.

Equations (9.26) and (9.27) can be used to determine the mass and energy of the black hole as the limiting parameters of deformation of the quantised space-time at $R_s = R_g$. Equation (9.32) can be used to determine the total force of limiting tension acting on the surface of the black hole and restricted by its gravitational radius and independent of the gravitational radius.

Attention should be given to the fact that the black holes can be of three types: static, dynamic and relativistic. Static black holes are determined by collapse in the region of low speeds of movement in the quantised space-time.

An increase of speed increases the mass of the body as a result of intensifying spherical deformation of the quantised space-time pushing the system to a critical unstable state. When the system reaches a specific critical speed, accretion of matter to the centre of the system is induced followed by its collapse into a dynamic black hole.

Finally, when the particle is accelerated to the speed of light, the particle transfers into a black relativistic microhole. This black microhole has no electromagnetic radiation but carries the gravitational field which reaches the colossal strength **a** of the gravitational field on the surface of the gravitational radius (**a** is freefall acceleration – strength of the field), m/s^2, at $R_g = R_s$)

$$\mathbf{a} = \frac{C_0^2}{R_s}\mathbf{1}_r \tag{9.34}$$

For example, when the proton reaches the speed of light, it transfers into a black relativistic microhole with the strength of the gravitational field of 10^{32} m/s^2 (9.34) on the surface of the microhole whose radius is R_s. Naturally, we are now concerned with the black holes as hypothetical objects, including black microholes, and information on their physical properties will promote a more efficient search for them.

9.7. Deformation vector of quantised space-time

The balance of gravitational potentials (9.22) is an exact equation of state of quantised space-time for an elementary particle having a mass, and takes into account the effect on vacuum not only of the mass of the moving particle but also describes the movement of the mass in the quantised space-time as transfer of the deformation vector **D** of the quantised space-time [7]

$$\mathbf{D} = \mathrm{grad}(\rho) \tag{9.35}$$

The deformation vector (9.35) can be written through the Newton gravitational potential φ_n with (9.8) and (9.7) taken into account for a spherically symmetric system

$$\mathbf{D} = \frac{\rho_0}{C_0^2}\mathrm{grad}(C_0^2 - \varphi_n\gamma_n) = -\frac{\rho_0}{C_0^2}\mathrm{grad}(\varphi_n\gamma_n) = \frac{1}{4\pi k_0}\frac{m_0\gamma_n}{r^2}\mathbf{1}_r \tag{9.36}$$

As indicated by (9.36), deformation vector **D** is an analogue of the strength of the gravitational field but is expressed in different measurement units (particle/m^4). The deformation vector has a physical meaning which actually describes the deformation of the quantised space-time as a result of the gravitational interaction as real distortion of the space-time.

9.8. Derivation of the equation for the speed of light

The plot in Fig. 9.2 gives information on the distribution of the quantum density of the medium and gravitational potential in the form of spherical quantised space-time with spherical symmetry. Evidently, in movement of an elementary particle (solid) in the quantised space-time, the plot in Fig. 9.2 will be transferred and the spherical symmetry of the field will not change. The moving particle (body) transfers its entire mass in space and also its gravitational field. This transfer of the gravitational field in space is not taken into account by any of the gravitational theories. Conservation of the spherical symmetry of the field results in a fundamental principle of spherical invariance which shows that the relativity principle is the fundamental property of the quantised space-time [8].

The transfer of the gravitational field in the quantised space-time is taken into account by the equation of balance of gravitational potentials (9.22). The transfer of the gravitational field during movement of a body is associated with the complicated processes in the space-time. Naturally, the leading front of the moving gravitational field carries out deformation (distortion) of quantised space-time and the trailing front removes this deformation [7]. For this reason, the speed of light, as the wave manifestation of elastic oscillations of the quantised space-time in the direction of movement of the body and in the opposite direction, ensures that it is constant in accordance with the principle of spherical invariance [8]. This has been confirmed by the experiments carried out by Michaelson and Morley. The elastic quantised space-time behaves as a spherical quantised medium, with no analogues with the known media.

This spherically symmetric model which takes into account the actual deformation of the quantised space-time during movement of the mass in it greatly simplifies all the gravitational calculations and describes the actual speed of light in the quantised space-time by the value of the gravitational potential from the balance (22)

$$C = \sqrt{\varphi} = C_0\sqrt{1 - \frac{\varphi_n \gamma_n}{C_0^2}} \qquad (9.37)$$

Equation (9.37) determines the speed of light in the perturbed quantised space-time in the vicinity of the moving body (particle) and shows that with an increase of the mass of the body and its speed, the speed of light in the perturbed quantised space-time decreases. This corresponds to the experimental observations of the distortion of the trajectory of the light beam in a strong nonuniform gravitational field. In a limiting case, the light is completely arrested on the surface of a black hole at $\varphi_n \gamma_n = C_0^2$ and the black hole becomes invisible (Fig. 9.3). This is determined by the discontinuities in the quantised space-time as a light-baring medium on the surface of the black hole (its gravitational boundary).

Thus, the solution of the general Poisson equation (9.24) in the form of the balance of gravitational potentials (9.22) in the quantised space-time determines the principle of spherical invariance of space which is reflected in the fact that the speed of light (9.37) is independent in direction from the light source, moving in space together with the mass which perturbs the vacuum. In particular, the independence of the speed of light in the directions enabled Einstein to start investigations in the area of the theory of relativity and consider the concept of the unified field which is represented by the quantised space-time and is also a carrier of superstrong electromagnetic interaction (SEI).

9 .9. Distribution of time in space in the form of a chronal field

The solution of the general Poisson equation (9.24) for the deformed quantised space-time message is used to calculate the course of time in space and the distribution of this course in space in the form of a chronal field. For this purpose, we determine the limiting frequency f_0 of the natural oscillations of the elementary non-deformed space-time quantum as the elastic element defining the course of time T_0 in space and unifying space and time into a single substance:

$$f_0 = \frac{C_0}{L_{q0}} = \frac{3 \cdot 10^8}{0.74 \cdot 10^{-25}} = 4 \cdot 10^{33}\,\text{Hz} \tag{9.38}$$

$$T_0 = \frac{1}{f_0} = \frac{L_{q0}}{C_0} = 2.5 \cdot 10^{-34}\,\text{s} \tag{9.39}$$

where $L_{q0} = 0.74 \cdot 10^{-25}$ m are the dimensions of the non-deformed elementary elastic quantum of space-time (quanton) [7].

As indicated by (9.39), the minimum period T_0 is defined by the duration of passage of a wave perturbation as a result of elastic excitation of the quanton. Evidently, (9.38) determines the limiting frequency of the wave perturbations in the quantised space-time. The time is quantised and its passage is a multiple of T_0.

Equation (9.38) makes it possible to link the parameters of space-time in the form of the ratio L_{q0}/T_0 with the gravitational potential of the unperturbed quantised space-time C_0^2 or, in a general case, can be used to link the ratio of the parameters L_q/T with the gravitational potential C^2 of the quantised space-time perturbed by deformation:

$$\varphi = C^2 = \left(\frac{L_q}{T}\right)^2 \tag{9.40}$$

Substituting (9.39) into (9.24), we obtain the Poisson equation describing the field of the parameters L_q/T of space-time

$$\rho_m = \frac{1}{4\pi G}\text{div grad}\left(\frac{L_q}{T}\right)^2 \tag{9.41}$$

Equation (9.41) shows that the course of time in the quantised space-time, perturbed by gravitation, is distributed nonuniformly and depends on the deformation (distortion) of space-time.

Integration of (9.41) with respect to time T in the spherically deformed quantised space-time taking into account the deformation of the quanton gives the solution in the form of the distribution of the course of time in space in relation to the mass and the speed of its movement for the external T_1 and internal T_2 regions of the gravitational interface:

$$\begin{cases} T_1 = T_0\left(1 - \dfrac{R_g \gamma_n}{r}\right)^{-\frac{5}{6}} \\ T_2 = T_0\left(1 + \dfrac{R_g \gamma_n}{R_s}\right)^{-\frac{5}{6}} \end{cases} \tag{9.42}$$

The distribution of time (9.42) in space describes the real chronal field. Time T_1 in the external gravitational field slows down with the increase of mass and the speed of movement of the body. Time is completely arrested on the surface of the black hole on the external side of the gravitational interface at $r = R_s = R_g\gamma_n$. Time T_2 is accelerated inside the gravitational interface R_s. The exponent 5/6 = 0.833 in (9.42) is close to unity so that in the rough approximation the distribution of time in space is close to the distribution of the gravitational potentials (9.21).

As can be seen the physical nature of the space-time is hidden in the actual elasticity of the space-time and its elementary quantum – quanton which specifies the natural course of time in relation to the deformation state of the quantised space-time. The quanton is a volume elastic resonator fulfilling also the role of an ideal electronic clock with the period of the passage of time (9.39).

For this reason, the physical time should not be regarded as some vector, having only the forward direction. Time is a metronome which determines the rate of occurrence of some physical (including biological) processes. The clock is an integrator summing up time periods and, as an integrator, the clock has no reverse motion.

9.10. Antimatter and ideal gravitational oscillator

Thus, the variation of the course of time in space is linked with gravitation, i.e., with the distortion of space-time (its deformation), described by the Poisson equation (9.41). To change periodically the deformation vector

(9.35) of the quantised space-time and, at the same time, induce deformation oscillations of the quantised space-time, we examine an ideal gravitational oscillator which is a source of gravitational waves.

If an ideal electromagnetic oscillator could be represented by the electrical charge q_0 with the variable value of the charge q, for example, changing in accordance with the harmonic law (ω is the cyclic frequency):

$$q = q_0 \sin \omega t \tag{9.42}$$

then by analogy with the electromagnetic oscillator (9.42) the gravitational charge q_0 in the gravitational oscillator should be represented by the mass m_0 in (9.36) with the variable value m:

$$m = m_0 \sin \omega t \tag{9.43}$$

Naturally, in nature there is no charge with the variable value (9.42) but if a high-frequency current is supplied to an antenna produced in the form of a wire section, such an antenna should be regarded as an electrode with the variable charge (9.42), exciting electromagnetic waves in the quantised space-time. In radio engineering, there is a more complicated case in which the antenna is regarded as a dipole whose oscillations excite the electromagnetic field. However, in an elementary case, a charge of variable magnitude is suitable for excitation of electromagnetic radiation (9.42).

Thus, in order to induce electromagnetic waves in space, it is necessary to change periodically the polarity of the electrical charge. To excite gravitational waves in space, the polarity of the gravitational charge, i.e., mass, must be varied periodically. However, the concept of the minus mass is associated with antimatter whose presence in the balance of the gravitational potentials (22) is taken into account by the minus sign in front of the Newton potential:

$$C_0^2 = C^2 - \varphi_n \gamma_n \tag{9.44}$$

The equation (9.44) which describes the balance of the gravitational potentials for the antimatter is related to completely different physics of the formation of antiparticles from antimatter in comparison with conventional matter. If in the case of the matter the presence of the Newton potential determines the presence of the gravitational well in the external region of the quantised space-time (Fig. 2), then in the case of antimatte the Newton potential leads to an increase of the gravitational potential C^2 in the external region of space:

$$C^2 = C_0^2 + \varphi_n \gamma_n \tag{9.45}$$

which determines the distribution of the gravitational potential, both in the external region of space and inside the gravitational interface of the medium, which differs from (9.21) by the signs (+) and (-)

$$\begin{cases} \varphi \; = C^2 = C_0^2\left(1+\dfrac{R_g\gamma_n}{r}\right) \\ \varphi_2 = C_2^2 = C_0^2\left(1-\dfrac{R_g\gamma_n}{R_s}\right) \end{cases} \tag{9.46}$$

This approach also relates to the quantum density of the medium in the formation of an antiparticle in the quantised space-time

$$\begin{cases} \rho_1 = \rho_0\left(1+\dfrac{R_g\gamma_n}{r}\right) \\ \rho_2 = \rho_0\left(1-\dfrac{R_g\gamma_n}{R_s}\right) \end{cases} \tag{9.47}$$

Figure 9.4 (Fig. 3.19) shows the gravitation diagram (plot) of the distribution of the quantum density of the medium (9.47) and the gravitational potential (9.46) for the antiparticle. At the interface of the medium there is a 'jump' of the quantum density of the medium and the gravitational potential (9.24) as in the case of the particle. However, in contrast to the particle, the antiparticle forms as a result of ejection of the quanta (quantons) from the internal region of the gravitational interface to the external region increasing, in the external region, the quantum density of the medium and the value of the gravitational potential.

Fig. 9.4. See Fig. 3.90. Gravitational diagram of the antiparticle (antibody) in the form of the plot of the distribution of the quantum density of the medium and the gravitational potential.

Naturally, the fundamental role in all the processes of the formation of particles in antiparticles in the quantised space-time is played by the gravitational interface. For the particle, the gravitational interface should ensure spherical compression of the quantised space-time to some centre, pulling together the quantised space-time inside the gravitational interface. For the antiparticle, on the other hand, the mechanism of its formation is associated with maintaining the external tensile stresses of the quantised space-time, reducing the extent of compression of the quantons inside the gravitational boundary.

Evidently, a situation may form in the quantised space-time in which the external tension of the medium may result in local disruption of the space and the latter can be kept in the stable condition only by the gravitational interface characterised by the constriction property, e.g., representing a shell of alternating charges [7]. In this case, the jump of the gravitational potential at the interface reaches the value $2C_0^2$ describing the given formation as an antihole.

As regards all the parameters, this antihole in the form of a cosmological objects is an excellent reflector of electromagnetic radiation capable of greatly changing its trajectory and should be recorded by the appropriate astronomical devices. On the other hand, this antihole should have antigravitational properties instead of repulsive properties, like some anomalies in the universe. The presence of the antihole in the centre of our universe, possible from the viewpoint of experiments, explains the accelerated recession of the galaxies.

As regards the elementary antiparticles, analysis of the plot in Fig. 9.4 shows that the antiparticle is in a less stable state in comparison with the particle (Fig. 9.2) where the presence of the gravitational well in the external region of the quantised space-time makes this particle a relatively stable formation. In any case, analysis of the possible formation of gravitational oscillators using antiparticles should result in a completely different approach to the problem of generation of gravitational waves.

9.11. Electromagnetic quantisation of space-time

The investigations show convincingly that the vacuum space-time has an elastic structure and consists of a large number of the smallest particles – quantons – which can not be divided any further. To describe the structure of the elementary quantum of space-time, we use the Maxwell equations for the quantised space-time, writing the density of the currents of electrical $\mathbf{j}_e$ and magnetic $\mathbf{j}_m$ displacement in polarisation of the quantised space-time by the electromagnetic wave in the form of the variation of the strength of the electrical **E** and magnetic **H** fields with respect to time [10]:

$$\mathbf{j}_e = \text{rot}\mathbf{H} = \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t} \tag{9.48}$$

$$\mathbf{j}_m = \frac{1}{\mu_0}\text{rot}\mathbf{E} = -\frac{\partial \mathbf{H}}{\partial t} \tag{9.49}$$

where $\varepsilon_0 = 8.85 \cdot 10^{-12}$ F/m is the electrical constant; $\mu_0 = 1.26 \cdot 10^{-6}$ H/m is the magnetic constant.

Because of the symmetry of the electromagnetic wave, the densities of the currents of electrical and magnetic displacement in the quantised space-time are equivalent in relation to each other as regards the absolute value (modulus)

$$j_m = C_0 j_e \tag{9.50}$$

In (9.50) the densities of the displacement currents are connected together by a multiplier equal to the speed of light C_0 for the quantised space-time unperturbed by gravitation, or C for the quantised space-time perturbed by gravitation. This is caused by the fact that in the SI measurement system the densities of the electrical and magnetic displacement currents have different dimensions. If the dimension for the electrical displacement current is $C/\text{m}^2\text{s} = \text{A/m}^2$, then in the case of the magnetic displacement current there are problems with the dimension, because the elementary magnetic charge g is not specified.

In fact, the densities of the displacement currents can be expressed through the speed of displacement **v** of massless free elementary electrical e and magnetic g charges and the quantum density of the medium ρ_0:

$$\mathbf{j}_e = 2e\rho_0\mathbf{v} \tag{9.51}$$

$$\mathbf{j}_m = 2g\rho_0\mathbf{v} \tag{9.52}$$

The multiplier 2 is included in (9.51) and (9.52) because the charges e and g are included in the composition of the quanton in pairs with the sign (+) and (–), forming on the whole a neutral particle.

Substituting (9.51) and (9.52) into (9.50), we obtain a relationship between the elementary electrical and magnetic charges

$$g = C_0 e = 4.8\cdot 10^{-11}\,\text{A}\cdot\text{m (or Dc)} \tag{9.53}$$

where $e = 1.6\cdot 10^{-19}$ C is the elementary electrical charge.

Thus, the elementary magnetic charge (9.53) in the SI system has the value $4.8\cdot 10^{-11}$ A m in the dimension expressed in Diracs (Dc) which has not as yet been officially included in the SI system. In theoretical physics, the elementary magnetic charge (Diracs monopole) is measured in coulombs by analogy with the electrical charge [11]. This causes confusion because the magnetic quantities in electrical engineering are determined by the derivatives of electrical current, and if the dimension of the magnetic moment is $\text{A}\cdot\text{m}^2$, the magnetic charge is determined by the dimension A · m = Dc, and not C.

Thus, analysis of the Maxwell equations shows that the condition for polarisation the quantised space-time by the electromagnetic wave is the presence of electrical and magnetic displacement currents for massless electrical and magnetic charges included in the composition of the quanton.

Therefore, the quanton as an elementary quantum of the space-time should itself include four elementary charges: two electrical charges ($+1e$ and $-1e$) and two magnetic charges ($+1g$ and $-1g$) representing a static electromagnetic quadrupole which has not been studied at all in electrodynamics. We shall therefore refer to massless elementary charges as monopoles (electrical and magnetic).

In fact, in order to define the elementary volume in space on the basis of geometrical minimisation we require only four marking points. The first point is simply a point, two points form a line, three points form a surface, and only four points can be used to define the volume in space. These four points have been planned by nature itself in the form of the previously mentioned four monopoles, forming the structure of the quanton. On the whole, the quantum is an electrically neutral and massless particle having electrical and magnetic properties which become evident in polarisation of the quantised space-time in the electromagnetic wave.

Naturally, the properties of the quanton can be investigated on the basis of the analogy with the properties of the known elementary particles, for example, such as the electron which has a mass and is at the same time the carrier of the elementary electrical charge. From the viewpoint of classic electrodynamics, the four different monopoles in the quanton should collapse into a point under the effect of colossal attraction forces. However, this has not been observed. The quantised space-time is a very stable substance. This means that the monopoles, included in the quanton, have finite dimensions and determine the diameter L_q of the quanton [7]

$$L_q = \left(\frac{4}{3}k_3\frac{G}{\varepsilon_0}\right)^{\frac{1}{4}}\frac{\sqrt{eR_s}}{C_0} = 0.74\cdot 10^{-25}\,\text{m} \tag{9.54}$$

where $k_3 = 1.44$ is the filling coefficient of the quantised space-time by spherical quantons; $R_s = 0.18\cdot 10^{-15}$ m is the radius of the proton (neutron).

The equation (9.54) was derived on the basis of the conditions of tensioning of the quantised space-time as a result of the interaction of the quantons with each other during the generation of the elementary particle (proton, neutron) from the quantised space-time as a result of its spherical deformation. Radius R_s is the elementary gravitational interface in the quantised medium for these elementary particles.

Figure 9.5 shows the most probable structure of the electrical and magnetic monopole. Evidently, for the monopole to satisfy the conditions of the elastic state of the quantised space-time it should have the form of a two-phase particle, consisting of the central nucleus 1, surrounded by the elastic atmosphere 2 and referred to as protoplasma (Fig. 2.3). In particular,

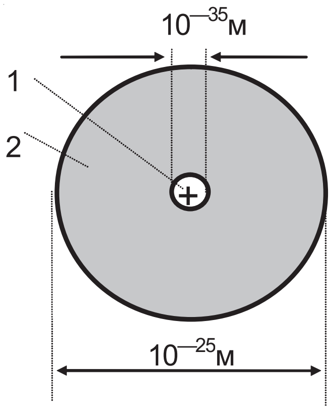

Fig. 9.5. Structure of the electrical (magnetic) monopole. 1) the nucleus of the charge, 2) the atmosphere.

the nucleus 1 is the source of the field (electrical or magnetic) in the form of a charge. It may be assumed that the nucleus of the monopole is determined by the Planck length of 10^{-35} m, and the dimensions of the monopole are of the order of 10^{-25} m [7]. The physical nature of the monopole charges and the structure of the elastic atmosphere are still unknown. It can only be assumed that the elastic atmosphere of the monopoles determines the electrical and magnetic properties of the quantised space-time and is characterised by the constants in the form ε_0 and μ_0, linking together the electrical and magnetic matter inside the quanton.

Therefore, on the basis of the physical model of the monopole charges we can analyse the process of formation of the quantum shown in Fig. 9.6 (Fig. 2.2a). Four elastic spheres–monopoles form a figure with the distribution of the nuclei in the tips of the tetrahedron resulting in the orthogonality of the electrical and magnetic axes of the neutral quanton. However, the quanton cannot remain in this state.

Naturally, the colossal forces of electromagnetic compression should deform the quadrupole consisting of the monopoles into a spherical particle, shown in Fig. 9.7 (, Fig. 2.2b) retaining its integrity as the single particle and also retaining the orthogonality of the electrical and magnetic axes. In this case, the nuclei of the monopoles in the investigated model of the spherical quanton also remain situated at the tips of the tetrahedron inserted into the quanton. This leads to the equivalence of the electrical and magnetic effects of the fields which is determined by the equality of the Coulomb forces for the electrical F_e and magnetic F_m charges acting at the distance r equal to the face of the tetrahedron inside the quanton (on the condition $F_e = F_m$)

$$\begin{cases} F_e = \dfrac{1}{4\pi\varepsilon_0}\dfrac{e^2}{r^2} \\ F_m = \dfrac{\mu_0}{4\pi}\dfrac{g^2}{r^2} \end{cases} \tag{9.55}$$

Fig. 9.6. See Fig. 2.2a. Formation of the space quantum (quanton) for four monopole charges with the tetrahedral model of distribution of the nuclei (top view).
Fig. 9 .7. See Fig. 2.2b. Formation of the spherical form of the quanton as a result of electromagnetic compression of the monopoles into a single quadrupole (figure is rotated).

From equation (9.54) we obtain a relationship linking the electrical and magnetic monopoles:

$$\frac{e^2}{\varepsilon_0} = \mu_0 g^2 \tag{9.56}$$

Taking into account the fact that in the SI system we have the relationship

$$\varepsilon_0 \mu_0 C_0^2 = 1$$

from (9.56) we obtain the required relationship between the magnetic and electrical elementary charges, corresponding to (9.53)

$$g = C_0 e$$

However, (9.56) was derived using a different procedure in comparison with (9.53). This indicates the accurate result in the calculations of parameters of the quantised space-time. The speed of light is determined by the actual quantisation of the quantised space-time by the electrical and magnetic monopoles, included in the composition of the quantons:

$$C_0 = \frac{g}{e} \tag{9.57}$$

Equation (9.57) again confirms that the light is an electromagnetic process in the quantised space-time which is a light-bearing medium.

The process of electromagnetic quantisation of a large volume of space is linked with its filling by the quantons. Because of the natural capacity for linking the charges with opposite signs, the quantons, linking with each other, form a quantised elastic medium. The tetrahedral form of the arrangement of the monopole nuclei in the quantons introduces an element of chaos into the linking of the quantons, resulting in a random orientation of the electrical and magnetic axes in space. Any preferred orientation of the axes is excluded and this results in the formation of an electrically and magnetically neutral homogeneous and isotropic medium characterised by the electrical and magnetic properties in the form of a static electromagnetic field [12–14] referred to as the quantised space-time in the EQM theory.

Fig. 9.8. See Fig. 2.4a. Simplified scheme of the interaction of four quantons in the local region of the quantised space-time presented in lines of force.

Of course, it is not possible to show the actual pattern of the static electrical and magnetic fields of the quantised medium in projection onto the plane. Figure 9.8 (Fig. 2.4a) shows a simplified model of a flat local region of the quantised space-time for four quantons in projection on a plane in the form of the lines of force of the electrical and magnetic fields. Naturally, the quantised space-time can be regarded as a discrete mesh with a discreteness of the order of 10^{-25} m consisting of the lines of force of the static electrical and magnetic fields placed on the entire universe and linking all the objects together. We live in the electromagnetic universe.

Evidently, because of the small dimensions of the quanton, the effect of the electromagnetic forces inside the quanton between the monopole charges is so strong that there are no forces in nature capable of splitting the quantum into individual monopoles. Experimentally, this is confirmed by the absence in nature of free magnetic charges, regardless of long-term search for them [11]. Some excess of the electrical charges of the positive and negative polarity is caused by the electrical asymmetry of the universe. However, in particular, this excess of electrical charges is a source of generation, from the quantised space-time, of elementary particles and of all real matter [7].

9 .12. Derivation of the Maxwell equations and electromagnetic waves

It is assumed that the electromagnetic wave is a derivative of the electrical and magnetic fields, has no intrinsic carrier and is not linked with gravitation. However, all this is only a consequence based on the laws of electromagnetic induction in which magnetism is generated from electricity through the unexplained topology of space. The electromagnetic interactions results from the disruption of the equilibrium of the discrete static electromagnetic quantised space-time which has an intrinsic carrier in the form of the elementary quantum of the space-time – the quanton, connecting together electricity and magnetism.

Evidently, the transfer of electromagnetic energy in the quantised space-time in the form of the electromagnetic wave takes place as a result of electromagnetic polarisation of the quantised space-time due to the disruption

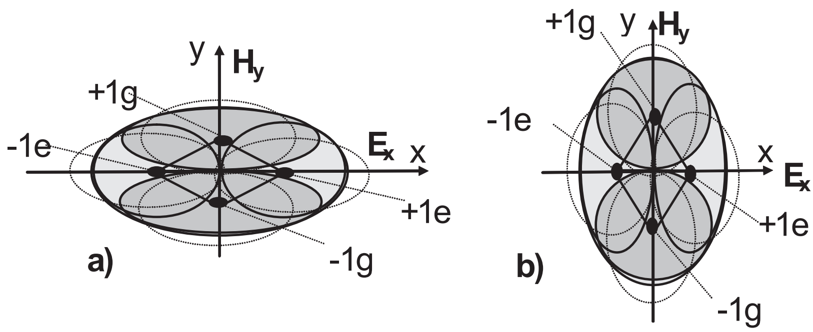

Fig. 9.9. Polarisation of an individual quanton under the effect of the electromagnetic wave on the quanton in the quantised space-time.

of electromagnetic equilibrium of the quantised medium. The quanton is only a carrier of electromagnetic radiation ensuring constancy of intrinsic energy. This has been determined by experiments on the basis of the absence of excess energy in the electromagnetic wave which does not lead to any release of the additional energy from the quantised space-time. For this reason, the polarisation of the quanton along the electrical axis is associated with the unique tensioning of the quanton along the electrical axis and with compression along the magnetic axis and, vice versa, and the internal energy of bonding between the charges remains constant (Fig. 9.9).

Since the electrical and magnetic axes of the quanton are orthogonal to each other, they are placed in the rectangular coordinate system along the axes x and y, respectively, assuming that the distance x and y between the charges inside the quanton is equal to the faces of the tetrahedron, i.e., $r = x = y$. Consequently, the binding energy of the charges interacting inside the quanton is determined by the energy of the electrical W_e and magnetic W_g:

$$W_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{x} \tag{9.58}$$

$$W_g = \frac{\mu_0}{4\pi}\frac{g^2}{y} \tag{9.59}$$

The condition of passage of the electromagnetic wave causing polarisation excitation of the quantised space-time, is determined by the constancy of the total electromagnetic energy W_q of the quanton which is the carrier of wave excitation:

$$W_q = W_e + W_g = \text{const} \tag{9.60}$$

The condition of constancy of energy (9.60) is fulfilled as a result of the fact that during polarisation of the quanton the latter is tensioned along the electrical axis (Fig. 9a) and is also compressed along the magnetic axis (Fig. 9b). The increase of the distances between the electrical charges inside the quanton reduces its electrical energy and results in an equivalent and simultaneous increase of its magnetic energy as a result of a decrease of the distance between the magnetic charges. The polarisation processes in the quantised space-time are associated with the very small displacement of the charges inside the quanton because of its superhigh elasticity. Consequently, the variation of energy during the variation of the small distance between the charges can be expressed by means of the appropriate derivatives of (9.58) and (9.59):

$$\frac{\partial W_e}{\partial x} = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{x^2} \tag{9.61}$$

$$\frac{\partial W_g}{\partial y} = \frac{\mu_0}{4\pi}\frac{g^2}{y^2} \tag{9.62}$$

The minus sign in equation (9.61) means that the energy of the electrical field of the quantum decreases, and the plus sign in (9.62) indicates that the energy of the magnetic field increases, and vice versa. The variation of the strength of the field from one charge in the region of another charge with a small change of the distance between them (small displacement) is taken into account by means of the appropriate derivatives which are determined from the field of the elementary charge ($\mathbf{1}_x$ and $\mathbf{1}_y$ are unit vectors):

$$\frac{\partial \mathbf{E}}{\partial x} = -\frac{\mathbf{1}_x}{2\pi\varepsilon_0}\frac{e}{x^3} \tag{9.63}$$

$$\frac{\partial \mathbf{H}}{\partial y} = -\frac{\mathbf{1}_y}{2\pi}\frac{g}{y^3} \tag{9.64}$$

Substituting (9.63) and (9.64) into (9.61) and (9.62) respectively, gives

$$\frac{\partial W_e}{\partial x} = \frac{1}{2}\text{ex}\frac{\partial \mathbf{E}}{\partial x} \tag{9.65}$$

$$\frac{\partial W_g}{\partial y} = -\frac{1}{2}\mu_0 g y\frac{\partial \mathbf{H}}{\partial y} \tag{9.66}$$

Taking into account that the condition (9.60) is fulfilled as a result of the equality of the variation of the energies (9.65) and (9.6) we obtain the required relationship linking together the mutual variation of the strength of the electrical and magnetic fields in the electromagnetic wave in the conditions of a small polarisation displacement of the charges in the quanton (at $x = y$):

$$e\frac{\partial \mathbf{E}}{\partial x} = -\mu_0 g\frac{\partial \mathbf{H}}{\partial y} \tag{9.67}$$

Taking into account (9.41) and the condition $\mu_0 C_0 = (\varepsilon_0 C_0)^{-1}$, from (9.67) we obtain:

$$C_0\varepsilon_0\frac{\partial \mathbf{E}}{\partial x} = -\frac{\partial \mathbf{H}}{\partial y} \tag{9.68}$$

Equations (9.68) is transformed to the form in which the variation of the strength of the fields is detected during time t and the speed of displacement of the charges v inside the quantons is expressed by the appropriate derivatives:

$$v = \frac{\partial x}{\partial t} = \frac{\partial y}{\partial t} \tag{9.69}$$

Taking (9.69) into account, from (9.68) we obtain the required relationship of the parameters of the field for the electromagnetic wave:

$$C_0\varepsilon_0\frac{\partial \mathbf{E}}{\partial t} = -\frac{\partial \mathbf{H}}{\partial t} \tag{9.70}$$

Or, taking into account the orthogonality of the vectors $\mathbf{E}\perp\mathbf{H}$, equation (9.70) is expressed through the appropriate indexes x and y (or the unit vectors):

$$C_0\varepsilon_0\frac{\partial \mathbf{E_x}}{\partial t} = -\frac{\partial \mathbf{H_y}}{\partial t} \tag{9.71}$$

Comparing (9.71) with (9.48) and (9.49), we obtain a relationship identical with (9.50) for the vectors of the density of the displacement currents with the appropriate indexes, taking their orthogonality into account

$$\mathbf{j}_{my} = C_0\mathbf{j}_{ex} \tag{9.72}$$

Further, the relationship (9.72) is reduced to the form (2.60)

$$\left[C_0\mathbf{j}_e\right] = -\mathbf{j}_g$$

The variation of the electrical parameters of the quanton by the effect of the electromagnetic wave was analysed by taking into account changes of the field inside the quanton. However, since the quantised space-time, as a medium being in a neutral equilibrium state, leaves this state when the electromagnetic equilibrium of the quanton is disrupted, the resultant expressions also hold for the quantised space-time as a whole in electromagnetic polarisation of a set of quantons entering the region of the wave.

Thus, we have obtained rotorless equations (9.70), (9.71), (9.72) linking the electrical and magnetic parameters of the field of the electromagnetic wave in the quantised space-time and they determine the effect in the quantised space-time of laws of electromagnetic induction according to which the variation of the electrical component is accompanied by the appearance of the magnetic component, and vice versa.

Integration of (9.71) gives a relationship linking the strength of the electrical and magnetic fields in the electromagnetic wave in the quantised space-time which change in accordance with the harmonic law (with a dot):

$$C_0\varepsilon_0\dot{\mathbf{E}}_x = -\dot{\mathbf{H}}_y \tag{9.73}$$

Taking into account that the speed of light C_0 in (9.73) determines the direction of the electromagnetic wave and is the vector $\mathbf{C}_0$, the equation (9.73) can be presented in a more convenient form of the vector product

$$\varepsilon_0\left[\mathbf{C}_0\dot{\mathbf{E}}_x\right] = -\dot{\mathbf{H}}_y \tag{9.74}$$

Equation (9.74) shows that all the three vectors $\mathbf{E}_x$, $\mathbf{H}_y$, $\mathbf{C}_0$ are orthogonal in relation to each other. This means that the vectors $\mathbf{E}_x$ and $\mathbf{H}_y$ are situated in the plane normal to the speed vector $\mathbf{C}_0$ and determine the electromagnetic wave as the wave of transverse polarisation of the quantised space-time (Fig. 9.10). Attention should be given to the fact that the vectors $\mathbf{E}_x$ and $\mathbf{H}_y$ exist simultaneously in the electromagnetic wave. This eliminates one of the old mistakes regarding the nature of the electromagnetic wave, i.e., that the rotor of the electrical field generates the rotor of the magnetic field, and vice versa. Rotors have not been found in the flat electromagnetic wave in the quantised space-time in experiments.

The simultaneous existence of $\mathbf{E}_x$ and $\mathbf{H}_y$ rules out the rotor hypothesis

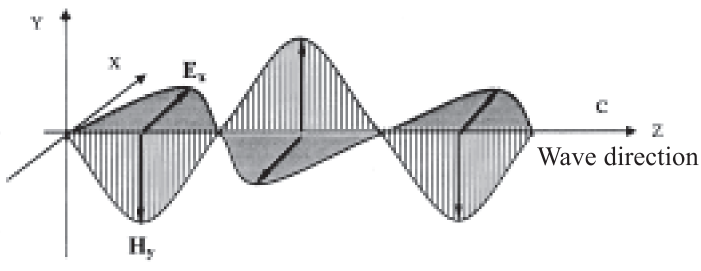

Fig. 9.10. Electromagnetic wave with transverse polarisation of the quantised space-time.

of propagation of electromagnetic wave in the quantised space-time. Only the electromagnetic polarisation of the quantons provides accurate explanation of the presence of electromagnetic field in the quantised space-time whose carrier is the quantised space-time. This fact is that the experimental confirmation of the conclusion that the vacuum has the structure in the form of quantised space-time. Consequently, it was possible for the first time to derive analytically the Maxwell equations which were written by Maxwell in the purely empirical form. For the quantised space-time, the relationship between the strength of the electrical and magnetic fields is reduced to only one equation (9.74) confirming the symmetry between electricity and magnetism in the quantised space-time.

For the gravitation-perturbed quantised space-time, the vector of the speed of light $\mathbf{C}_0$ in (9.74) transforms to the vector $\mathbf{C}$ from (9. 37). The nature of formation of the rotors of the strength of the electrical and magnetic fields in the quantised space-time is associated with the orientation polarisation of the quantons and has been investigated in [7, 8] for increasing distance from the radiation source. However, these rotors are secondary and do not explain the nature of the electromagnetic wave. Rotors are also found in the region of the emitting antenna in the form of a section of a conductor through which a high-frequency current passes. However, this is a line with the distributed parameters. The rotors are found in transformers, by the electromagnetic field of the transformer is not the electromagnetic field in the quantised space-time.

Naturally, polarisation of the quantised space-time is associated with both the deformation and orientation polarisation of the quantons themselves which are a carrier of the electromagnetic field and the electromagnetic energy of the emitting antenna. On the whole, the electromagnetic wave forms as a result of the disruption of the equilibrium of the quantised space-time caused by the electromagnetic polarisation of the quantons ensuring that they retain their intrinsic energy and, the same time, the effect of the laws of electromagnetic induction in the quantised space-time. However, the rotorless nature of electromagnetic induction for the electromagnetic wave in the quantised space-time differs, as shown, from the rotor nature of the electromagnetic induction for a transformer

9.13. Equivalence of electromagnetic and gravitational energies

In order to understand the energetics of the wave processes taking place in the quantised space-time, when, it would appear, the identical phenomena are associated, for example, with a mass defect, in one case we are concerned with electromagnetic radiation and in another case with gravitational waves, it is necessary to remove one of the paradoxes of theoretical physics permitting the simultaneous existence of two, it would appear, mutually excluding types of principles.

On the one hand, it is the principle of equivalence of electromagnetic energy and mass, determined by expression (9.13). However, as confirmed previously, the mass of a particle (a body) is a gravitational charge, i.e., it is a parameter of the gravitational field whose energy is determined by the energy of the spherical deformation of quantised space-time (9.13). Thus, the principle of equivalence of mass and energy determines the equivalence of the energy of the electromagnetic and gravitational fields.

On the other hand, in the theory of gravitation in has been believed that the energy of the gravitational field of, for example, an electron, is incommensurably smaller in comparison with its electrical energy. In fact, the standard equations for the energy of the gravitational W_m and electrical W_e (9.58) fields of the electron can be used to determine their ratio:

$$W_m = \frac{Gm_e^2}{r} \tag{9.75}$$

$$W_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r} \tag{9.76}$$

where $m_e = 0.91 \cdot 10^{-30}$ kg is the rest mass of the electron.

Dividing (9.76) by (9.75), we obtain the sought relationship:

$$\frac{W_e}{W_m} = \frac{1}{4\pi\varepsilon_0 G}\left(\frac{e}{m_e}\right)^2 = 4.2 \cdot 10^{42} \tag{9.77}$$

In general, equation (9.77) is inaccurate in its basis and is based on the forces of electrical interaction being considerably greater than the gravitational forces. However, the force acting on a free electron in the quantised space-time must be regarded as a derivative of energy (9.31). Consequently, the force integral gives the required value of energy which, if the integration constant is correctly selected, differs from (9.75). In calculations, no account is made of the gravitational energy of the deformation of the quantised space-time by the electron and, consequently, the integration constant was inaccurately determined resulting in the incorrect derivation of (9.77).

In fact, the energy of the gravitational field of the free electron is determined by the energy of spherical deformation of the quantised space-time because only the presence of spherical deformation of the quantised space-time by the particle is the reason for gravitation. On the other hand, the energy of the electrical field of the electron is determined by the energy of electrical polarisation of the spherically deformed quantised space-time. These interactions can be taken into account by the method of mirror imaging on a sphere in which the energy of interaction of the electron with the vacuum field is taken into account by the interaction with the second electron with mass m_e, imaged on a sphere, with the charge e. In this case, the main electron perturbing the vacuum generates in the quantised space-time the gravitational potential $\varphi = C^2$ from (9.15) and the electrical potential φ_e which also determines the energy of the gravitational and electrical fields of the electron

$$W_m = \int_0^{C^2} m_e d\varphi = m_e C^2 = m_e C_0^2 - m_e \varphi_n = m_e C_0^2 - \frac{Gm_e^2}{r} \quad (9.78)$$

$$W_e = \int_0^{\varphi_e} e d\varphi_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r} \quad (9.79)$$

Equation (9.17) was derived by the method of re-normalisation of the gravitational potential where the fictitious Newton potential is replaced by the actual gravitational potential C^2 (the action potential) of the spherically deformed quantised space-time (Fig. 9.2).

As shown by (9.78) the equation for the energy of the gravitational field of the electron with the spherical deformation of the quantised space-time taking into account greatly differs from the well-known expression (9.75), and the energy of the electrical field (9.79) coincides completely with (9.76). A paradox is that the energy of the gravitational field, like the energy of the electrical field, is determined by the value of the potential which in the case of the gravitational field decreases on approach to the gravitational interface of the medium (Fig. 9.2). The Newton potential plays the role of a fictitious potential, and the actual potential of the quantised space-time is defined as C^2.

However, the equations (9.78) and (9.79) are already comparable in the magnitude of energy and have a common point of intersection of the dependences on the distance, accepted as the classic radius of the electron r_e where the energy of the gravitational field is fully balanced with the energy of the electrical field of the free electron in the quantised space-time, i.e. $W_m = W_e$

$$m_e C_0^2 - \frac{Gm_e^2}{r_e} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_e} \quad (9.80)$$

From (9.80) we obtain the exact value of the classic electron radius r_e

$$r_e = \frac{\dfrac{e^2}{4\pi\varepsilon_0} + Gm_e^2}{m_e C_0^2} = \frac{e^2}{4\pi\varepsilon_0 m_e C_0^2} + \frac{Gm_e}{C_0^2} \tag{9.81}$$

The second component included in the solution (9.81) determines the gravitational radius R_g of the electron (9.10) which was previously not taken into account in physical calculations in determination of r_e. However, R_g is incommensurably small in comparison with r_e. For this reason, the classic electron radius r_e can be determined by the well-known equation, albeit approximate

$$r_e = \frac{e^2}{4\pi\varepsilon_0 m_e C_0^2} = 2.8\cdot 10^{-15}\,\mathrm{m} \tag{9.82}$$

In fact, the gravitational potential C_0^2 of the quantised space-time has the role of the calibration potential in (9.80) and balances the energy of the gravitational and electrical fields of the electron. Still, in all previously mentioned considerations there is a certain indeterminacy with respect to the physics of the phenomenon and not mathematics. The energy of the gravitational field of the electron in accordance with (9.78) is almost completely independent of the distance to the electron and at infinity is equal to $m_e C_0^2$. This is incorrect because the effect of the gravitational field of the electron cannot extend to infinity without attenuation.

This shortcoming of the theory is eliminated as a result of the further application of the method of renormalisation of the gravitational potential. Taking into account the equivalence of the energies of the gravitational (9.78) and electrical (9.79) fields, we determine the equality taking into account the actual gravitational potential C^2 which satisfies the condition of equivalence of the energy of the gravitational and electrical fields of the electron:

$$m_e C^2 = e\varphi_e \tag{9.83}$$

Taking (9.82) into account, from (9.83) we determine the distribution of the actual gravitational potential C^2 of the electron, represented by the ratio r_e/r

$$C^2 = \frac{e\varphi_e}{m_e} = C_0^2 \frac{r_e}{r} \tag{9.84}$$

Taking into account (9.84), from (9.78) we determine the actual energy of the gravitational field of the electron equivalent to its electrical energy (9.76)

$$W_m = \int_0^{C^2} m_e d\varphi = m_e C_0^2 \frac{r_e}{r} \tag{9.85}$$

Equation (9.85) determines the distribution of the gravitational energy of the electron in the quantised space-time. As indicated by (9.85), within the limits of the boundary of the classic electron radius at $r = r_e$, its gravitational energy corresponds to the rest energy meC_0^2, and with increase of the distance from the electron the energy of its gravitational field weakens in inverse proportion to the distance, like the energy of the electrical field.

In this respect, the classic electron radius r_e has the function of the gravitational interface of the medium R_S (Fig. 9.2). In a general case, the distribution of the energy of the gravitational field of the elementary particle (or a body) can be expressed by the ratio R_S/r and the rest energy

$$W_m = m_0 C_0^2 \frac{R_s}{r} \tag{9.86}$$

9.14. Electron structure

Naturally, the calculations of the equivalence of the energy of the gravitational and electrical fields of the electron with the electromagnetic structure of the quantised space-time taken into account help to describe the electron structure. This is important for understanding the processes of emission by the electron of not only photon electromagnetic radiation but also for understanding the difference between the electromagnetic and gravitational waves in the quantised space-time.

As shown, the quantised space-time is a static electromagnetic field fully filled with quantons with a discreteness of the order of 10^{-25} m (Fig. 9.8). It is now assumed that an elementary massless electrical monopole charge with negative polarity (–1*e*) is introduced into the quantised space-time. The situation actually forms in the generation of a pair of particles – electron and positron – in the quantised space-time. Of course, the quantised space-time reacts to the introduction of the electrical monopole, mostly by electrical polarisation of the quantons.

Actually, the radial electromagnetic field of the monopole charge tries to unfold the quantons by the electrical axis along the line of force of the radial electrical field of the monopole (–*e*) and 'stretch' the quanton along the electrical axis, carrying out the processes of orientational and deformation polarisation (Fig. 9.11). It may be seen that in the immediate vicinity of the central monopole charge, in the region of the very strong electrical fields,

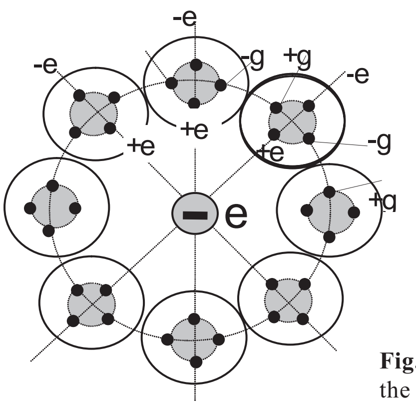

Fig. 9.11. Induction of the spherical magnetic field of the electron by its radial electrical field.

the quantons are oriented by their electrical axis in the direction of the radial field of the monopole charge. Since the magnetic axis of the quanton is normal to its electrical axis, then a group of quantons around the central monopole charge (–1*e*) forms a magnetic field closed on the sphere which is similar to a rotor although there are some differences.

Calculation show that the nonuniform electrical field of the monopole charge produces the gradient force $\mathbf{F}_e$ acting on the quanton and directed along the radius of the centre of the monopole charge (–*e*):

$$\mathbf{F}_e = \frac{1}{6\pi\varepsilon_0} \frac{e^2}{r^2} \left(\frac{L_q}{r} \right)^3 \mathbf{1}_r \tag{9.87}$$

The magnetic field, closed on the sphere, also acts on the quantons, pulling them to the centre of the monopole charge (–*e*) with force N_g:

$$\mathbf{N}_g = \frac{\mu_0}{8} \frac{g^2}{r^2} \frac{L_q}{r} \mathbf{1}_r \tag{9.88}$$

Dividing (9.88) by (9.87) and taking into account (9.53), we obtain an equation which shows that the dominant factor in pulling the quantons to the centre of the monopole charge is the induced magnetic field, closed on the sphere at $r = r_e$ (9.82)

$$\frac{N_g}{F_e} = \frac{3}{4}\pi \left(\frac{L_q}{r_e} \right)^2 = 3.6 \cdot 10^{20} \tag{9.89}$$

Later, the relationship (9.89) was made more accurate in (4.154)

$$\frac{F_{qg}}{F_{qe}} = \frac{\pi}{2} \left(\frac{r_e}{L_{q0}} \right)^2 = \frac{\pi}{2} \left(\frac{r_e}{L_{q0}} \right)^2 = 2.3 \cdot 10^{21} \tag{4.154}$$

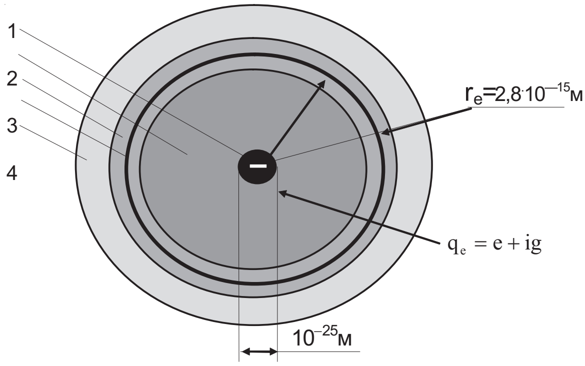

Fig. 9.12. The structure of the electron in the quantised space-time. 1) the electron nucleus (electrical monopole with negative polarity), 2) the region of compression of the quantised space-time by the spherical magnetic field, 3) transition region, 4) conventional interface (classic electron radius), 5) the region of ??? the quantised space-time.

Thus, the induced magnetic field, closed on the sphere, carries out spherical deformation of the quantised space-time, forming the electron mass whose structure is shown in Fig. 9.12 (more accurately in Fig. 4.3). The centre of the electron contains a nucleus in the form of a central monopole charge. Around the monopole charge there is a region of spherical deformation of the quantised space-time whose gravitational interface does not have any distinctive boundary with the quantised medium and appears to be 'blurred' in relation to the classic electron radius forming a transition region. This is followed by the region of extension of the quantised space-time.

The spherically closed magnetic field of the electron is a physical analogue of spin (similar to the anapole moment, only more complicated), giving to the electron both electrical and magnetic properties which can be expressed by a complex charge q_e (i is the imaginary unit)

$$q_e = e + ig \tag{9.90}$$

Equation (9.19) can be used to calculate the electrical and magnetic parameters of the fields of the electron in the appropriate measurement units, regarding the magnetic component as imaginary. The measurement unit (9.90) can be reduced to the unique value by means of (9.53). In any case, vector analysis in the field theory should be supplemented by new functions, describing the spherically closed fields (spher$\mathbf{A}_1$), induced by radial fields (rad$\mathbf{A}_2$), linked by specific relations together (here $\mathbf{A}$ is the vector of the strength of the field).

In this case, the electron field can be described by the complex strength $\mathbf{E} + i\mathbf{H}$, whose parameters are connected together by the relationship:

$$\text{rad}\mathbf{E} = -C_0\mu_0\text{spher}(i\mathbf{H}) \tag{9.91}$$

The imaginary unit in (9.91) indicates that the vector **H** is orthogonal to vector **E**, i.e., **H**⊥**E**. From (9.90) or (9.91) we determine the imaginary value of the strength of the spherical magnetic field of the electron

$$iH = \frac{1}{4\pi}\frac{g}{r^2} \tag{9.92}$$

The difference between the radial electrical field of the electron and its spherical magnetic field is that the electrical field disrupts the electrical equilibrium of the quantised space-time and is manifested externally (can be measured), whereas the spherical magnetic field does not disrupt the magnetic equilibrium of the medium and results only in changes of the quantised space-time forming a spherically closed magnetically ordered system.

During the lattice movement of the electron in the external magnetic field the spherical symmetry of its magnetic field is disrupted and the field transforms to a rotor field (9.48). It may be assumed that accelerated movement of the electron (and movement by jumps) disrupts the spherical symmetry of the magnetic field of the electron. During uniform movement of the electron in the quantised space-time unperturbed by other fields, the disruption of the spherical symmetry of the magnetic field of the electron should not take place and the situation is governed by the principle of spherical invariance. The relativity theory provides for visible elliptical compression of the field in the direction of movement in relation to a stationary observer. However, this is a paradox of relative measurements and does not relate to the actual position of the spherical field in the quantised space-time.

Naturally, the movement of the electron in the space is associated with the transfer of its monopole charge and transfer of fields: electrical, magnetic, gravitational. The energies of these fields are equivalent to each other, and their summation is not permitted. Each of the energies is the manifestation of the unified electromagnetic essence of the quantised space-time. For the electron, this uniqueness is reflected in the primary electrical polarisation of the quantised space-time and the secondary induction of the spherical magnetic field. The result of these effects is the formation of spherical deformation of the quantised space-time and the formation of a gravitational field. In particular, this secondary gravitational field of the deformed quantised space-time is regarded as the electron mass. The mass is the secondary manifestation of electromagnetism in quantised space-time.

In fact, the EQM theory includes the law of gravitational–electromagnetic induction, with the result of this induction being the generation of the electron mass from electromagnetism in the quantised space-time. This can be expressed in the form of a sequence of operations in the quantised space-time:

1. Formation of a radial electrical field **E** under the effect of a central monopole charge (–1*e*) on the quantised space-time;
2. Formation of a spherically closed magnetic field **H** (9.91);
3. Formation of the electron mass m_e as the function of the spherical deformation of the quantised space-time **D**:

$$\mathbf{E} \rightarrow i\mathbf{H} \rightarrow m_e(\mathbf{D}) \tag{9.93}$$

Evidently, as the speed of the electron in the quantised space-time increases, the monopole charge starts to interact with larger and larger numbers of the quantons, intensifying the processes of polarisation of the quantised space-time and, consequently, intensifying its spherical deformation and, in the final analysis, increasing the electron mass.

In [7] attention was given to the behaviour of an orbital electron in a gravitational well on a stationary elliptical orbit with no electron emission and also at the moment of emission of a photon as a result of its mass defect, and the structure of the positron and nucleons was also investigated.

9.15. Gravitational waves in quantised space-time

Returning to the analysis of the gravitational waves, it is assumed that they greatly differ by their properties from the additional transverse electromagnetic waves. However, these waves are of the same nature associated with the wave manifestation of quantised space-time. It may be assumed that the variation of time in space in Veinik's experiments is not associated with the effect of the flux of hypothetical chronons to a quartz sheet but it is caused by the deformation of the quantised space-time. This can take place as a result of the deformation of matter when the mechanical stresses in the matter change, and can also take place during phase transitions from one state of matter to another leading to the generation, in the quantised space-time, of longitudinal oscillations representing gravitational waves.

As already shown, the structure of the matter is linked inseparably with the structure of the quantised space-time. The generation of mass m is determined by spherical deformation of the quantised space-time, starting with elementary particles. This conclusion results from the Poisson equation (9.6) with (9.35) taken into account. In transition to the Gauss theorem, we determine the mass by the flow of the deformation vector (9.35) which penetrates the surface S in the spherically deformed quantised space-time

(where m_0 is the rest mass of the particle, kb)

$$m = m_0\gamma_n = k_0 \oint_S \mathbf{D}dS \tag{9.94}$$

Experiments have confirmed that the mass of the specimen also changes slightly in the static deformation of the specimen of matter [21]. The deformation vector of the quantised space-time **D** is directed along the radius from the centre of mass of every elementary particle in the specimen of matter and, on the whole, is determined by the superposition principle, which adds up the effect of the entire set of the particles. For this reason, the variation of the mass of the specimen in deformation of matter results in a change of vector $\Delta\mathbf{D}_a$ (perturbation amplitude) of the quantised space-time outside the specimen, changing the total longitudinal flow Ψ of the deformation vector of the perturbed quantised space-time penetrating the closed surface around the specimen. These changes can be expressed by, for example, the harmonic law

$$\Psi = \oint_S (\mathbf{D}+\Delta\mathbf{D}\sin\omega t)dS = \frac{1}{k_0}\left[m_0\gamma_n + \Delta(m_0\gamma_n)\sin\omega t\right] \tag{9.95}$$

For the excitation in the quantised space-time of longitudinal oscillations of the quantum density of the medium, as the change of the flow of the deformation vector (9.95), it is necessary to change periodically the perturbation component $\Delta(m_0\gamma_n)$. Evidently, this can be carried out by changing the mass of the specimen and/or the direction and magnitude of its speed included in the normalised relativistic vector γ_n (9.32). The main factor for the excitation of the longitudinal oscillations of the quantised space-time in the region of non-relativistic speeds is the variation of the mass Δm of the specimen which, in a general case, can be described by the periodic law as the variation of the amplitude Δm_a, accepting in this manner a solid with a variable mass as a source of gravitational waves (9.43):

$$\Delta m = \Delta m_a \sin\omega t \tag{9.96}$$

This approach makes it possible to write the wave equation of the gravitational wave through the quantum density of the medium ρ in the quantised space-time, regarding the gravitational waves as the moving areas of longitudinal compression and the decrease of the quantum density of the medium in the quantised space-time from the source (9.96) with speed C (3.146):

$$\frac{\partial^2\rho}{\partial t^2} = C^2\left(\frac{\partial^2\rho}{\partial x^2} + \frac{\partial^2\rho}{\partial y^2} + \frac{\partial^2\rho}{\partial z^2}\right) \tag{9.97}$$

The solution of equation (9.97) can be presented conveniently in the form of the variation of the magnitude and direction of the instantaneous value of the longitudinal deformation vector $\mathbf{D}_r$ of the quantised space-time at the distance **r** from the radiation source for the amplitude $\mathbf{D}_a$, for example, in accordance with the harmonic law (θ is the phase shift):

$$\mathbf{D}_r = \mathbf{D}_a \sin(\omega t - \theta) \quad (9.98)$$

Naturally, in the ideal case the gravitational waves should not be generated by the source (9.95) and should be generated by some other source in accordance with the EQM theory, forming a communication channel on the gravitational waves (Fig. 9.13). However, this task requires a technical solution. This communication channel will not have any electromagnetic screening and electromagnetic interference.

Evidently, in deformation of the specimen in Veinik's experiments, small changes of the mass of the specimen resulted in excitation in the quantised space-time of longitudinal oscillations of the medium in the form of gravitational waves which were also recorded on the basis of the variation of the frequency of oscillations of a quartz sheet as a change of time. Taking into account the nonuniformity of the material of the specimen, it can be assumed that in deformation loading of the specimen a large number of local zones (dislocations) form inside the specimen and they are capable of exciting gravitational waves forming their spectrum attenuating with time. Evidently, the electromagnetic radiation spectrum should also be detected in this case at the same time.

As indicated by the decrease of the frequency of quartz in the experiment in Fig. 9.1, the effect of the gravitational wave results in the formation of a specific asymmetry determined evidently by the anisotropic susceptibility of quartz to part of the wave with the reduced quantum density of the medium. The instability of the results of measurements of frequency of the quartz is evidently explained by the impact effect of the gravitational wave, excited by the non-periodic variation of the deformation state of the specimen. An effect is also exerted by the random phase shift between the oscillations which should result in a stochastic 'wobbling' of the frequency but at the moment it is not possible to determine the exact frequency of the gravitational wave and we can determine only the duration of restoration

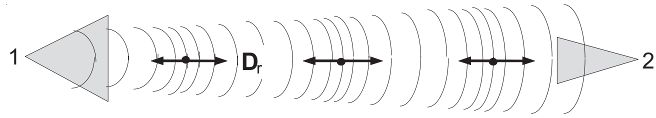

Fig. 9.13. Scheme of a possible communication channel on longitudinal gravitational waves in quantised space-time: 1) radiation source, 2) receiver.

of the deformation equilibrium of the specimen after removing the load. It can be assumed that the frequency of gravitational radiation is in the radio-frequency range and in the Veinik's experiments it was in the frequency range smaller than 10 MHz.

Evidently, the first scientist to predicted gravitational waves as early as in 1905 was French mathematician Poincaré. The possibility of formation of gravitational waves in the quantised space-time was subsequently investigated by Einstein in 1918 who erroneously assumed that by analogy with electromagnetic waves the gravitational waves are transverse waves and lead to acceleration of the solid [15]. A large number of attempts was made in the 20th century to detect experimentally the transverse gravitational waves. These experiments were not successful, regardless of the considerable effort applied to them [16]. Veinik recorded longitudinal gravitational waves of elastic deformation of the quantised space-time which did not fit the well-known Einstein concepts. For this reason, Veinik's discovery could not be understood for more than 10 years.

Actually, the source of the gravitational wave is the perturbation component $\Delta(m_0\gamma_n)$ in (9.95) inside which the acceleration factor is determined by the variation of speed in γ_n (9.23). This factor may prove to be significant if the solid acquires rapidly the speed close to the speed of light and also rapidly slows down in the reverse direction, repeating cyclically the process. No natural objects have as yet been detected in nature and they cannot be produced artificially. The bremsstrahlung of the relativistic electrons is well known but this phenomenon occurs in the region of the electromagnetic range of x-ray and gamma radiation.

As shown by analysis, the oscillating mass may be a source of gravitational waves (9.95). These oscillations inside the quantised space-time may be caused by periodic oscillations of the mass. The defect of variable mass, detected in this case, is found in the frequency range considerably lower than the frequency of quantum manifestations of electromagnetic radiation. For this reason, the oscillating mass in the gravitational radiation regime does not emit photon radiation which is detected, for example, as a result of the mass defect of the orbital electron in transition to a stationary orbit in the atom, determining the equivalence of the gravitational and electromagnetic energy [7].

Evidently, Veinik's discovery have something in common with a discovery by astrophysicist N. Kozyrev who also recorded the radiation of unknown nature of originating from stars which was then reliably reproduced in investigations by other scientists [17]. It should be noted that Kozyrev's radiation is considerably faster (according to the author) than the speed of light. I have two hypotheses in this case:

The first hypothesis: Kozyrev discovered fluxes of neutral particles – tachions of the electronic neutrino type not connected with the wave properties with the quantised space-time because these particles have no mass and their movement in space does not require transfer, together with the particle, of spherical deformation of the quantised space-time as a single wave, for example, of the soliton type. The speed of tachions, as particles not associated with the way properties of the quantised space-time, can greatly exceed the speed of light. The speed of light itself is a wave function in the quantised space-time for transversely polarised waves and is connected with the quantum density of the medium (gravitational potential C^2). Unfortunately, because of the absence of experimental procedures and appropriate equipment, we do not know the distribution of these neutral particles (of the electronic neutrino type) with respect to concentration, speed and direction of the flows.

In fact, the EQM theory regards the structure of the electronic neutrino in the form of an electrical dipole consisting of massless charges of positive and negative polarity with the distances between them considerably smaller than the classic electron radius. At these distances between the charges in the quantised space-time it is not possible to ensure the spherical deformation of the quantised space-time around the charges and form some mass. For this reason, the electronic neutrino does not have any mass [7].

The second: Kozyrev discovered gravitational radiation from stars whose speed is determined by the wave speed of perturbation of the quantised space-time and its magnitude coincides with the speed of light (or is close to it). Consequently, the results showing that the new radiation and the light emitted by the stars are recorded on the celestial sphere with different coordinates, can be explained by different trajectories of gravitational and light radiation of the stars determined by the curvature of the space-time. This curvature determines the topology of space, for example, by analogy with the distortion of the quantised space-time by the spherical magnetic field of the electron (Fig. 9.9). In this case, the trajectories of propagation of the longitudinal gravitational and transverse electromagnetic radiations do not coincide and in observations they appear as the radiation emitted by different objects.

However, this is possible only if the space of our universe is not flat but is convex (distorted). This disputable question requires extensive investigations, both theoretical and experimental, of a peculiar region of cosmology. In fact, the topology of the cosmic space with its quantised structure taken into account has not been examined.

In a general case, the presence of the elastic static electromagnetic structure of the quantised space-time shows that it contains three types of wave perturbations and their combinations:

1. Transverse oscillations. This type of oscillation in the quantised space-time is manifested in the form of an electromagnetic wave determined by the electrical and magnetic polarisation of the quantised space-time (electrical and magnetic displacement currents). Since the electromagnetic waves do not change the quantum density of the medium, these waves appear only as transverse waves.

2. Longitudinal oscillations. This type of oscillation is manifested in the form of a gravitational wave in the quantised space-time and is described by the wave equation (9.97). The solution of (9.97) can be conveniently presented in the form of the harmonic function (9.98) of the variation of the magnitude and direction of the instantaneous value of the longitudinal deformation vector $\mathbf{D}_r$ of the quantised space-time:

$$\mathbf{D}_r = \mathbf{D}_a \sin(\omega t - \theta)$$

3. Torsional oscillations. This complicated and insufficiently examined type of oscillation in the quantised space-time is sometimes referred to as torsional radiation and evidently contains the main tangential (transverse) components, forming the rotor of the deformation vector rot**D** in the medium in combination with the radial (longitudinal) component representing the variety of the gravitational wave.

As regards the torsional oscillations in the quantised space-time (torsional radiation), I do not support attempts to present the theory of these oscillations from the general theory of relativity (GTR) in a study by G. Shipov [18] because they do not consider in the calculations the structure of the quantised space-time and complicate physical understanding of the actual processes. Shipov, rejecting GTR, proposed a geometrical theory of absolute parallelism. It was proposed that two parallel lines never intersect in space but they are capable of twisting along a helical line. However, in the EQM theory, the torsional component of the longitudinal gravitational wave is taken into account by the tangential component of the deformation vector in (9.98). Taking into account that the torsional oscillations take place, I highly value the studies by G. Shipov and his colleague A. Akimov who devoted a considerable effort to the development of the new direction and its defence the scientific world.

All types of oscillations in the quantised space-time can be regarded as quantum fluctuations of the balanced static quantised space-time as a result of disruption of the steady equilibrium [5, 19]. In addition to this, I personally, as an experimentator, reproduced part of Veinik's experiments and greatly increased the sensitivity of recording equipment. This enabled me, as a theoretician in this case, to be fully certain about the validity of the EQM theory, also taking into account the fact that the results of Veinik's experiments have been reproduced by other investigators [20, 21]. However, in reproducing Veinik's experiments, there are considerable problems associated with the very small strength of the observed effect and with the effect of electromagnetic component on the results.

9.16. Report by V. Leonov on the generation of a gravitational wave

On August 16, 2006, I managed to send for the first time to the cosmic space a gravitational wave with a power of ~100 W. I greatly treasure my reputation of a scientist who has made fundamental discoveries which would determine the development of science and technology for many years to come. Therefore, I am fully confident about my discovery, taking into account the fact that the method of generation and of reception of gravitational radiation, and also devices used for this purpose, are already protected by a patent with know-how.

The experiment itself is greatly interesting because of the complete coincidence of the theoretical assumptions and the results. A receiver gravitational radiation has not as yet been constructed and it was therefore necessary to record gravitational radiation indirectly. The experiments was based on the following procedure:

The volume of the emitter of the gravitational wave (activator) is very small, no more than 0.2 l (200 cm^3). The emitter is screened with a steel screen and is earthed. This prevents any electromagnetic radiation. Direct current is supplied to the emitter. The DC intensity and voltage determine the power required by the emitter which was approximately 100 W.

Why am I so sure that this energy is used for generating gravitational radiation and is carried with it into the cosmos? The answer is simple. Electromagnetic radiation is screened. If the supplied energy is transformed into the electromagnetic field inside the emitter, the electromagnetic field should heat the emitter. This was not so. The emitter remained cold. This is possible only if the supplied energy inside the emitter is transformed into gravitational radiation and carried into the space without heating the emitter. Initially, the device was constructed as a source of gravitational radiation on the basis of the EQM and Superunification theories..

The observed slight heating of the system is determined by the efficiency of conversion lower than 100% at the required power of the order of 100 W. If a heater with a power of 100 W (soldering iron) is placed instead of the gravitational emitter inside a steel screen with the volume of 0.2 l, the system is rapidly heated. In particular, the gravitational emitter tranfers energy into space without allowing the system to heat.

The first conclusion fully confirms theoretical predictions. **The electromagnetic screen does not screen gravitational radiation.** The gravitational wave is characterised by a colossal penetrating capacity. I did not feel any harm to my health. I assume that around us there is a large number of gravitational waves from different sources and we are simply not capable of recording them, as we could not record electromagnetic radiation in the past. So far I have not constructed a receiver of gravitational waves (but could not do this because of objective reasons) and I have decided not to reveal all the fine details of the experiment for repetition in other laboratories. In fact, they can be repeated quite easily, if one penetrates into the principle of the EQM and Superunification theories (see Russian Federation patent No. 2184384 'Method of generating and receiving gravitational waves and device for this purpose (variants), Bulletin No.18, 2002).

At present, fundamental science has a real possibility of carrying out unique experiments in comparing the speeds of light and gravitational radiation and at the same time stop all the scientific discussions in this problem.

The applied aspects of application of gravitational waves are manysided..

9.17. Conclusions for chapter 9

The nature of gravitational waves can be determined by the theory of the elastic quantised medium (EQM) (or Superunification theory) which at present is the most powerful analytical apparatus for investigating the matter and most complicated physical phenomena. The EQM theory is the theory of the unified field whose principles were predicted by Einstein within the framework of the general theory of relativity (GTR). It has been established that the quantised space-time is governed by the principle of spherical invariance and the relativity principle is the fundamental property of the quantised space-time. The theory represents a further development of the quantum theory and quantum considerations regarding the nature of matter from the viewpoint of electromagnetism. The discovery of the electromagnetic structure of the quantised space-time has enabled us for the first time to determine the superstrong electromagnetic interaction (SEI), i.e., the fifth force, combining gravitation, electromagnetism, nuclear and weak forces.

On the basis of the analysis of the wave oscillations in the elastic quantised medium (quantised space-time) it can be assumed that Veinik recorded for the first time in experiments the longitudinal gravitational waves in the form of moving zones of compression and of the decrease of the quantum density of the vacuum medium emitted at the moment of a change in the deformation-stress state of matter. The Veinik results were reproduced by other investigators. However, the Veinik experiments are characterised by low stability and a low recorded strength of the signal comparable with the level of noise and interference. It is important to develop completely new methods of generating and receiving gravitational waves.

The scientific fundamentals of these developments are provided by the EQM theory which describes for the first time the structure of the quantised space-time regarding it as an elastic quantised medium, being a carrier of wave perturbations in the quantised space-time. Analysis of the wave perturbation of the quantised space-time shows that there are three types of wave oscillations in it: transverse, longitudinal and torsional. All three types of the wave oscillations of the quantised space-time have been observed in experiments.

Transverse oscillations. This type of oscillations in the quantised space-time is manifested in the form of an electromagnetic wave generated by the transverse electrical and magnetic polarisation of the quantised space-time (electrical and magnetic bias currents).

Longitudinal oscillations. These oscillations are manifested in the form of a gravitational wave as longitudinal displacement of the zones of compression and of the decrease of the quantum density of the medium in the quantised space-time.

Torsional oscillations. This complicated, insufficiently examined type of oscillations in the quantised space-time is associated with the formation of torsional oscillations.

Thus, it has been shown for the first time that the gravitational waves are characterised by the longitudinal oscillations of the quantised space-time. Knowledge of the nature of gravitational radiation makes it possible to develop completely new devices for excitation of gravitational waves.

In the area of communications, one can expect the development of completely new and unusual channels for sending and receiving information which differ from the channels based on conventional electromagnetic waves. This expands the range of investigations of matter, including biological systems in medicine and agriculture. Naturally, Veinik's discovery is constantly utilised by astronomers and astrophysicists who have been expecting for a long time the discovery of an effective method of recording gravitational waves.

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10

Superstrong electromagnetic interaction and prospects for the development of quantum energetics in the 21st century

The new fundamental discoveries of the space-time quantum (quanton) and the superstrong electromagnetic interaction (SEI) have made it possible to establish in the Superunification theory that the only source of energy in the universe is the SEI, and the known types of energy (chemical, nuclear, etc) are only methods of extracting the energy of the SEI. The new discoveries explain the unique experimental effects: the Usherenko, Searl and other defects, associated with the generation of excess energy in new energy cycles for the open quantum mechanics systems, where the source of energy is the superstrong electromagnetic interaction. Theoretical and experimental fundamentals now exist for the development of quantum reactors, heat generators and quantum engines of a new generation which will form the basis of the quantum energetics in the 21st century. The quantum reactors are the source of thermal energy and in future they can replace nuclear reactors in nuclear power stations, ensuring that nuclear power engineering will be economically capable of competition and ecologically safe. The quantum engines open prospects for the development of power units for a new generation of ground-based and space transport.

10.1. World economy and scientific and technical revolutions

At the present time, electrical power engineering and thermal engineering is based on the fundamental knowledge obtained in the 19th century and at the beginning of the 20th century. This concerns the discovery of the Faraday law of electromagnetic induction and Maxwell equations which form the basis of electrical power engineering, and subsequent discoveries of the molecular-kinetic theory of heat, the radiation quantum, the structure of the atomic nucleus and radioactivity. In particular, the previously mentioned fundamental discoveries would enable the energy of chemical fuel and the atomic nucleus to be used for generating thermal energy, followed by its conversion into electrical energy and supply of energy to the user.

The new fundamental discoveries of the space-time quantum (quanton) and the superstrong electromagnetic interaction together with the Superunification theory can radically change the principles of generation and conversion of energy and on the background of these new discoveries the old approaches to power engineering will prove to be incapable of competition on the energy services market. The new strategy of reforming power engineering, developed for a specific period of time, should provide for a transition to the completely new methods of generation and conversion of energy and also for increasing the efficiency of conventional energy technologies.

If this is not carried out, we shall be faced with a very dangerous tendency which may result in the next energy crisis which would be unavoidable taking into account the increasing demand for non-renewable natural energy resources. This concerns first of all oil and radioactive fuel whose reserves are being continuously exhausted. If no precautionary measures are taken, the world economy can already collapse after 10 years. If we are discussing reforms in the power engineering, then the reform of the purely economic plan, associated with the de-monopolisation of suppliers of energy services is already late because the leading position at the moment is occupied by the problem of structural rearrangement of power engineering with simultaneous reforming of the control system in the world economy conditions. There should be many suppliers of energy services, and the price and quality of the services be determined by the market only in the presence of healthy competition. Only in this manner is it possible to reduce power consumption in the production costs and the cost of the energy services. The users of the energy services should be able to select from amongst many suppliers of energy services in order to ensure the market regulation of this sphere of economy. The old energy supply system is not suitable for this purpose.

The development of world economy is associated closely with scientific and technical advances which are subject to cyclic processes over a period of several decades [1]. As regards power engineering, then the last cycle of scientific and technical progress was the release of nuclear energy in

1945. We are now concerned with a new cycle of scientific and technical revolution when new fundamental discoveries of the space-time quantum (quanton) and superstrong electromagnetic interaction were made in 1996. Completely new information was obtained in the area of old and new power cycles which have been used as a basis for the development of two fundamental theories: the theory of the elastic quantised medium (EQM) and Superunification theory [2–7]. New knowledge greatly changes all the current views regarding the processes of generation and conversion of energy and determines the development of new energy technologies in the 21st century [8–15]. We cannot compare the start and end of the 20th century as regards the level of knowledge, and also the start and end of the 21st century.

10.2. Scientific errors and new energy concepts

One of the greatest physicists, Albert Einstein, is often alleged to carry out activities which he did not undertake at all, in particular, Einstein, who replaced the unfounded concept of mechanical aether by the concept of the field form of space-time, as the united field, never regarded the space as the absolute emptiness, on the contrary he said that: ‘empty space, i.e., space without field, does not exist. Space-time exists not by itself, it exists only as the structural property of the field. Thus, Descartes was not far from the truth when he assumed that the existence of the empty space must be rejected’ [16]. Unfortunately, despite Einstein’s views, the physics of the 20th century remained on the erroneous positions, regarding the space-time as the absolute void, with no structure. Some of the physicists held this view, but others were supporters of the opposite view, like Einstein.

The well-known English theoretical physicist and science populariser, Paul Davies, in his book Super force claims: ‘entire nature, in the final analysis, is subjected to the effect of some super force, manifested in different hypostases. This force is sufficiently powerful to create our universe and provided it with light, energy, matter and a structure. However, the super force is something greater than simply something generating the origin. In the super force, matter, space-time and interaction merge into an integral harmonic whole, generating such unity of the universe which had not been previously expected [17].

American theoretical physicist Harold Puthoff, in a series of articles in the prestigious scientific journal Physics Review, developing the concept of the super force, also assumes that space-time, which is often referred to as physical vacuum, manifests the electromagnetic and gravitation properties as a result of exiting the equilibrium state, i.e. from the zero state. However, Puthoff went further, assuming that relatively large amounts of energy and heat can be directly extracted from physical vacuum [12]. Undoubtedly, this claim was relatively daring and required experimental confirmation. However, science does develop in this manner, proposing, it would appear, an absurd idea which in the final analysis is actually confirmed.

Einstein's concept [16] of the field structure of space-time as the unfied field, the Davies' concept [17] of the super force and the Puthoff concept [12] of the colossal energy capacity of physical vacuum were realised simultaneously in the theory of the elastic quantised medium (EQM) and the Superunification theory after discovering the space-time quantum (quanton) [2–6].

In chapter 2 concerned with the Superunification theory we consider the process of quantisation of the Einstein space-time. The quantisation process is an energy process associated with filling the space-time with quantons (Fig. 1.3). The quanton (Fig. 1.2 and 2.2) is not an elementary particle and has a complicated structure containing four whole quarks: two electrical ($+1e$ + and $-1e^-$) and two magnetic quarks ($+1g$ + and $-1g^-$) linked by the relationship (2.6):

$$g = C_0 e = 4.8\cdot 10^{-11}\ \mathrm{Dc} \qquad (10.1)$$

The magnetic charge or, as is also referred to, the Dirac monopole is measured in Diracs (Dc): 1 = 1 A · m. This corresponds to the SI system in which the magnetic moment is measured in A · m^2, as the product $g\ell$ of the magnetic charge g by the arm ℓ.

Figure 2.2 shows the individual stages of the formation of the space-time quantum (quanton) from an electromagnetic quadrupole a result of quantisation of the electrical (e^+, e^-) and magnetic (g^+, g^-) monopoles (massless) elementary charges. The centres of the charges inside the quadrupole (Fig. 1a) form a tetrahedron. The electromagnetic compression of the quadrupole results in the formation of a quanton in the form of a spherical particle with the tetrahedral arrangement of the charges, establishing the orthogonality of the electrical and magnetic axes (Fig. 2.2b). Under the effect of the superstrong electromagnetic interaction, the quanton integrates electricity (e^+, e^-) and magnetism (g^+, g^-) and is the only carrier of electromagnetism accumulating electromagnetic energy. On the other hand, the quanton is a volume electromagnetic resonator, the unique 'electronic clock', specifying the rate of time and combining space and time into the united field form of matter – quantised space-time.

Figures 1.3 and 2.4 show the filling of space with the quantons and the local area of the quantised space-time consisting of four quantons in the form of a grid of lines of force. It should immediately be noted that the quantised space-time is the invisible (to us) field form of primary matter, accumulating the colossal amount of energy, and pulled in the form of an electromagnetic grid on the entire universe. The Superunification theory determines the diameter of the quantons of the order of 10^{-25} m (3.179) and their colossal concentration, of the order of 10^{75} quantons/m^3 (3.180). Taking into account the small distances between the centres of the charges inside the quanton, the calculated energy, accumulated by the quanton, is approximately 10^{-2} J (2.17). The energy capacity of the quantised space-time is 10^{73} J/m^3 (2.18). If we activate 1 m^3 of quantised space-time, the released energy will be sufficient for the generation of another universe as a result of a big bang.

In particular, the colossal concentration of energy characterises the superstrong electromagnetic interaction as the fifth force which controls from the unique position four other forces: electromagnetism, gravitation, strong (nuclear) and electroweak interactions. Only the larger force can overcome a smaller force. This golden rule of mechanics forms the basis of the Superunification theory which unites the fundamental interactions [5–9].

The experimental results show that the quantised space-time is the only source of electromagnetic energy in the universe and all other known types of energy are only methods of releasing energy from the quantised space-time. Therefore, when developing energetics, it is necessary to consider the new fundamental knowledge in order to optimise the already known energy cycles and also master the completely new energy technologies of production and conversion of energy.

Before we discuss the new energy technologies, it should be mentioned that the quantised space-time combines electromagnetism and gravitation which are manifested, as assumed by Puthoff [12], as a result of the disruption of electromagnetic or gravitational equilibrium, characterised by the displacement of the charges inside the quanton by the values Δx and Δy from the equilibrium position (2.1):

$$\Delta x = + \Delta y \tag{10.2}$$

Theoretical physicists tried unsuccessfully to find a general equation combining electromagnetism and gravitation although in fact this equation is quite simple (2.1). The minus sign in (2.1) corresponds to electromagnetic interactions when the displacement of the electrical charges to the centre of the quanton results in the simultaneous displacement of the magnetic charges from the centre of the quanton and, conversely, disrupting the electromagnetic equilibrium of the quantised medium. This ensures the validity of the laws of electromagnetic induction when magnetism originates from electricity, and vice versa. In particular, the displacement of the charges inside the quanton determines the realias of the bias currents in the Maxwell equations which describe electromagnetic processes in matter and in vacuum. Electromagnetic interactions are characterised by the constant concentration of the quantons (their quantum density) in the quantised medium.

The plus sign (+) in (2.1) corresponds to the gravitational interactions when the displacement of the electrical charges, for example, to the centre of the quanton results in the simultaneous displacement of the magnetic charges also to the centre of the quanton, compressing out the quanton and changing the gradient concentration of the quantons in the medium. This is accompanied by the change of energy W and the gravitational potential of the quantised medium with $C_0^2 = 9 \cdot 10^{16}$ J/kg (or m^2/s^2) to the value of the potential of action $C_0 < C_0^2$. The gravitational potential C_0^2 is the potential carried by the electromagnetic grid of the quantons (Fig. 2.2). Previously, it was assumed that space has no gravitational potential in the absence of a source of gravitation. However, this contradicts the principle of equivalence of mass and energy when the energy the particle W is determined by the work of transfer of the rest mass m_0 into the range of the gravitational potential $\varphi = C_0^2$ [2–5]:

$$W = \int_0^{C_0^2} m_0 \, d\varphi = m_0 C_0^2 \qquad (10.3)$$

Equation (10.3) is the simplest and most intelligible derivation of Einstein's formula. In fact, the mass is the equivalent of energy only in other measurement units. The equivalence principle (10.3) holds only in the presence of the gravitational potential C_0^2 at the quantised space-time. Previously, it was assumed that C_0^2 is the square of the speed of light. In fact, the speed of light C_0 in the medium is determined by the square root of the gravitational potential of the quantised medium.

To produce elementary particles and form their mass, in addition to the quantons there must be some excess of electrical monopole (massless) elementary charges (e^+ and e^-). In particular, the excess of the charges (e^+ and e^-) determines electrical asymmetry (2.14) of the universe which ensures the generation of primary matter. Consequently, the generation of the mass of the elementary particle, for example, the electron, is associated with the introduction of the electrical monopole charge (e^-) with negative polarity to the quantised medium when under the effect of ponderomotive forces the quantons start to move in the direction of the central perturbing charge, carrying out spherical deformation of the medium or, according to Einstein, distortion of space-time. As a result, the electrical charge assumes a mass and transforms into an electron (Fig. 4.2 and 4.3). If the charge (e^+) with positive polarity is placed in the quantised medium inside of the electrical charge with negative polarity, a positron, i.e., an antiparticle in relation to the electron, forms. The energy of spherical deformation of the medium by the elementary particle is equivalent to its mass in accordance with (10.3) [2–6].

It is well known that the movement of the electron (positron) in the quantised medium which has superelastic properties is connected with the wave transfer of mass and corpuscular tunnelling of the point electrical charge in the channels between the quantons (Fig. 1.3). This ensures the validity of the principle of corpuscular-wave dualism in which the elementary particle shows both wave and corpuscular properties.

Naturally, all the problems of quantum mechanics and ponderable matter as a special form of its electromagnetic energy, cannot be described in a short article. It is important to mention that the presence of electrical asymmetry (e^+ and e^-) inside the quantised space-time forms the entire variety of inanimate and living nature, starting with the formation of elementary particles and ensuring at the same time the realisation of all energy cycles. This construction requires a large number of combinations of only two electrical charges (e^+ and e^-), distributed inside the quantised medium and representing new quarks together with the magnetic charges (g^+ and g–) inside the quanton. Consequently, that the basis of the universe consists of only four elementary charges (e^+, e^-, g^+, g^-) and their numerous combinations.

The discovery of the space-time quantum (quanton) and superstrong electromagnetic interaction enables us to consider the elementary particles as open quantum mechanics systems linked from the viewpoint of energy with the quantised space-time and used for the exchange and extraction of energy from the quantised medium as a result of the mass defect. The knowledge of the reasons for the formation of mass, reasons for electromagnetism and gravitation, and the structure of the elementary particles and the atomic nucleus can be used to optimise the currently known energy cycles and develop completely new energy technologies [6–11]. The new fundamental discoveries provide a basis for the development of a deterministic quantum theory defining the classic approaches to the analysis of the quantum phenomena in quantum energetics where the understanding of the complicated quantum phenomenon has been raised to the engineering level as is the case in electrical power engineering and mechanics. Quantum theory accessible to designers and this is important in the realisation of new energy technologies.

There are three main directions in quantum energetics:

1. Quantum reactors for producing heat
2. Quantum thermal generators for producing heat
3. Quantum engines for producing mechanical work and traction

The quantum reactors, heat generators and engines are based on the experimental effects which had been known long prior to the discovery of the quanton and superstrong electromagnetic interaction but they could not be scientifically explained. The quantum thermal effects of production of excess thermal energy are detected in experiments in the cavitation effect in a fluid [15] and the Usherenko effect of superdeep penetration of particles into solid targets [7]. The Searl effect enables superstrong electromagnetic interaction to be utilised for producing mechanical work and traction in vacuum [9, 13, 14].

10.3. Dependence of the efficiency of the cycle on the energy yield of fuel

In order to evaluate the efficiency of an energy cycle, it is necessary to show the actual efficiency coefficient (EC) in relation to the energy yield of fuel. The energy yield w_f fuel is the amount of heat in J/kg which 1 kg of fuel produces as a result of an energy cycle (reaction). In this case, the total efficiency of the cycle should be related with the limiting energy $m_0 C_0^2$ (10.3) which is accumulated by the fuel in the quantised medium

$$\mathrm{EC} = \frac{W_c}{m_0 C_0^2} 100\% = \frac{w_f}{C_0^2} 100\% \tag{10.4}$$

where W_c is the energy generated in a cycle, J.

As indicated by (10.4), the efficiency of the energy cycle is evaluated by the ratio of energy yield w_f of fuel to the value of the gravitational potential C_0^2 of the quantised space-time, linking the energy cycle with the release of energy in the final analysis from the quantised medium.

Figure 10.1 shows graphically the dependence of the efficiency of the energy cycle on energy yield w_f of fuel. It can be seen that the graph contains three characteristic regions:

I. Chemical fuel. Energy yield $10^7 \ldots 10^8$ J/kg, efficiency ~10^{-7}%. Waste is ~100%. Reserves are limited. The source of energy is the mass defect of valence electrons.

II. Nuclear fuel. Energy yield $10^{13} \ldots 10^{14}$ J/kg, efficiency ~0.1%, radioactive waste ~99.9%. Reserves are limited. This fuel is ecologically

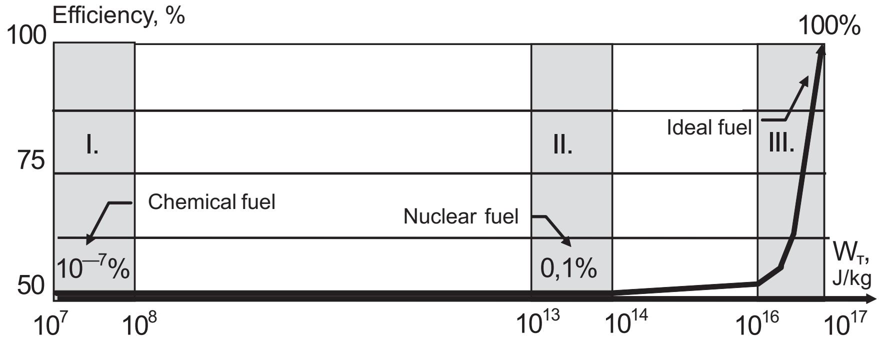


Fig. 10.1. Increase of the efficiency of the energy cycle in relation to the energy yield of fuel.

and economically useless. The source of energy is the mass defect of the atomic nucleus, more accurately, nucleons in the atomic nucleus.

III. Ideal fuel. Energy yield $10^{16}...10^{17}$ J/kg, efficiency up to 100%. There is no waste. The source of energy is matter and antimatter.

The dependence, shown in Fig. 10.1, indicates that the further development of quantum thermal energetics should take place in the direction to producing ideal types of fuel. The efficiency of the energy cycle of this type of fuel should approach 100%. These ideal cycles are offered by binary fuel consisting of two components: matter and antimatter. At the moment, it is not simple to obtain 100% efficiency for the ideal fuel, but it has been established that the Usherenko effect is characterised by electron-positron cycles in which the energy yield in the experiment has already reached $10^9...10^{10}$ J/kg [7, 8]. This is considerably higher than the energy yield of chemical fuel and approaches the energy yield of uranium fuel, taking into account that its energy yield is actually $\sim 10^{12}$ J/kg.

For example, when an RBMK-1000 nuclear reactor is fully loaded with 180 t of fuel only approximately 5 kg is 'combusted'. The efficiency of application of nuclear fuel is only 0.003%, radioactive waste is 99.997%. This does not mean that the old nuclear reactors can be rapidly converted to safe quantum reactors because the development of the latter requires extensive and time-consuming investigations. Therefore, in nuclear power engineering which is the integral part of quantum energetics, there are real prospects for efficient development with a considerable increase in the competition capacity on the energy market.

10.4. Quantum thermal energetics. Usherenko effect

Any generation of heat is ensured by quantum processes, associated with the formation of thermal photons (chapter 8). This includes heating of a conductor with current, chemical and nuclear reactions, and annihilation of matter and antimatter. In the latter cases, it is necessary to apply additional regimes of re-emission of high-energy gamma quanta into thermal photons or create suitable conditions for their emission. In particular, the concentration of the thermal photons in the unit volume of the medium determines the temperature of the medium. Thermal motion of the molecules and atoms, being the basis of the molecular–kinetic theory of heat, is a secondary process observed as a result of the recoil momentum during the re-emission of the photon. The capacity of matter to confine thermal photons determines its heat capacity. The capacity of fuel to produce thermal photons determines the energy yield of fuel. This is therefore a brief explanation of the main assumptions of quantum energetics. It should be added that to maintain the vital activity of the human organism, the organism requires thermal photons and stabilisation of their concentration to maintain the required temperatures.

As mentioned previously, the chemical and nuclear reactions are not ideal for the production of thermal photons because of the low efficiency of the energy cycles and the colossal amount of waste, including radioactive waste, contaminating the environment. The ideal fuel is a binary fuel consisting of two components: matter and antimatter, with the annihilation of these components resulting in the generation of the radiant energy. Analysis shows that the simplest processes are the processes of the annihilation of the electrons and positrons and not of the atomic nuclei and antinuclei. A special feature of the application of antimatter as fuel in energetics is that the production of antimatter requires its immediate use as fuel because there are considerable problems with the storage of antimatter.

Analysis shows that the requirements described above can already be realised by the application of the Usherenko effect. In 1974, the Belarusian scientist Sergei Usherenko (now works in Israel) found that if the channel of a solid target is bombarded with fine-dispersion particles, accelerated to 1 km/s, the process results in the generation of the colossal amount of energy, which is 10^2–10^4 times greater than the kinetic energy of the particles. This ensures burning-through of the channel and superdeep penetration of the particles into the target. Analysis of the experimental results shows that the energy yield of the particle in the channel of the target reaches 10^9–10^{10} J/kg. This is considerably higher than the energy yield of chemical fuel in combustion reactions which is of the order of 10^7–10^8 J/kg. Therefore, the question of chemical nature of energy generation is immediately answered [7].

Measurements of the residual radioactivity in the specimens of spent targets show that this radioactivity is on the level of the natural background. This means that if nuclear transformations take place in the channel of the target, these reactions are not fundamental. On the other hand, the high level of energy generation in the channel of the target indicates that high-energy processes, typical of the physics of elementary particles, take place in the channel.

As a result of the discovery of the structure of the quantised space-time and the structure of elementary particles in the EQM and Superunification theories it has been assumed that the target channel is characterised by the occurrence of vacuum fluctuations, associated with the formation of electron–positron plasma which is also a source of energy. This is indirectly confirmed by the exposure of x-ray film applied to the target at the moment of passage of the particle in the target channel in the superdeep penetration regime. In addition, the film shows a large number of traces of unknown nature with the diameter of the order of 1 μm, whereas the size of the particles was approximately 100 μm. It is therefore justified to assume that the film shows the traces of formations resulting from individual clusters of electron–positron plasma.

The Superunification theory shows that the electron–positron plasma cannot form in pure vacuum. This plasma can be produced only in the presence of a heated gas from the material of the target and the atmosphere which is restricted in space by a spherical shell of the electrons and positrons, forming a shell electron–positron cluster of the type of fullerene C_{60}. The pressure of the gas inside the shell of the cluster prevents destruction of the shell (collapse and annihilation), ensuring the short-term stability of the cluster. It is quite possible that ball lightning is in fact only a giant cluster with the diameter of 10 cm and also consisting of the electron-positron plasma [3].

According to the trace of the film in the Usherenko effect, the diameter of the cluster is approximately 1 μm. The energy of the electron–positron plasma is not used so rapidly as a result of compression of its shell during movement in the target channel. The radiation of the cluster can be detected in a wide spectrum: from soft x-ray to infrared, including thermal photons. In particular, the energy of this radiation from the large number of clusters causes burning of the channel in the target, ensuring the superdeep penetration regime, discovered by Usherenko.

In annihilation of the electron e^-_m and positron e^-_m in vacuum, the mass m of the particles, as the equivalent of the energy of spherical deformation of the quantised medium, transformed to the radiation energy of 0.511 MeV of two gamma quanta γ_k. The monopole charges of the particles e^- and e^+

form an electric dipole ($e^- e^+$) which can be observed as the electron neutrino ν_e, i.e., some bit of information that a pair of particles: electron and positron, existed. Consequently, the reaction of annihilation of the electron and positron in vacuum can be presented in the following form [7]

$$e_m^- + e_m^+ \to \nu_e + 2\gamma_k \text{ (1.022 MeV)} \tag{10.5}$$

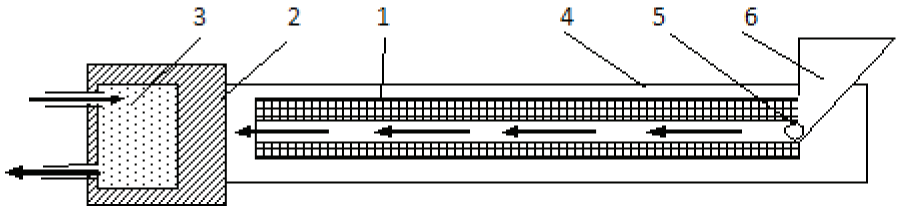
It was previously assumed that the generation of electron–positron pairs from vacuum is possible only under the external effect on the electron neutrino ν_e of a gamma quantum with the energy not lower than 1.022 MeV. The splitting of the neutrino into the electron and the positron, resulting in an energy balance, is only possible in this case. Here the excess energy cannot be generated and the well-known reaction (10.5) of the electron and the positron in vacuum did not attract attention of energy experts.

The unique feature of the Usherenko effect is that as a result of the internal energy, determined by additional deformation of space-time during the deceleration of a fine-dispersion particle in the target channel, the neutrino can split into the electron positron with the generation of excess energy from the electron–positron cluster cycles when the 'fuel' is represented by both matter (electrons) and antimatter (positrons) [7, 8].

10.5. Quantum reactors

Figure 10.2 shows the scheme of the simplest quantum reactor based on the Usherenko effect and including: the particle accelerator 1, heat-generating elements (targets) 2, the heat exchanger 3 and other elements. The initial fine-dispersion material is represented by silica particles (sand). From the hermetic bunker 6 the silica particles travel through the feeder 5 into the accelerator 1 and are accelerated to the required speed. The particle accelerator 1 is placed in the hermetic casing 4, ensuring the required vacuum. The accelerated particles (indicated by the arrows) impact on the heat-generating elements of the target 2 in the superdeep penetration regime. The generated thermal energy is transferred from the target 2 through the heat exchanger 3 in which the working body is represented by any of the currently available heat carriers, including water converted to vapour. Subsequently, the vapour is supplied into a turbine which rotates the rotor of an electric generator. Thus, utilising the Usherenko effect, it is possible to produce electrical energy literally from sand used as fuel.

The specific consumption per hour m_t of the micro-particle powder for the production of $W = 1$ MW·h ($3.6 \cdot 10^9$ J) of thermal energy is determined from energy yield calculations $w_t = 10^{10}$ J/kg



$$m_t == \frac{W}{w_t} = \frac{3.6 \cdot 10^9}{10^{10}} = 0.36 \text{ kg/h} \quad (10.6)$$

The generation of 1 MW·h ($3.6 \cdot 10^9$ J) of energy by the quantum generator requires the consumption of the impacting powder particles of 0.36 kg/h (0.1 g/s). The production of 1000 MW h requires the powder consumption of 0.1 kg/s. These fully realistic numbers indicate that the proposed method of energy generation can compete seriously with the uranium fuel at the power of the energy unit of 1000 MW [8]. However, in any case, these consumption values of the powder represent a difficult technical problem for the accelerator capable of producing the speed flow of the order of 10^6–10^9 particles per second. By optimising the speed of the particles and the dimensions in relation to the material of the powder and the target it is possible to reduce greatly (by an order of magnitude or more) the consumption of the microparticle powder.

Naturally, the development of the quantum generator requires considerable means comparable with the construction of nuclear reactors. However, taking into account the colossal energy market, associated with the replacement of the nuclear reactors of atomic power stations by ecologically clean quantum reactors, the volume of business in this area is also colossal. On the other hand, the transition to the quantum generators will transfer the energy generation from of the crisis condition ensuring that it is capable of competing on the market of energy services.

10.6. Cavitation heating

In 1843 on the basis of the experimental data Joule calculated the mechanical equivalent of heat regarded as a fundamental constant. In the subsequent 150 years these results were not doubted until the start of investigation of more energy consuming and higher speed processes attracted attention. To understand the nature of the mechanical equivalent of heat, it is necessary to return 150 years back and analyse the Joule experiments [7].

Figure 10.2 shows the diagram of the Joule experimental equipment which includes the container 1 with a fluid (water, oil, mercury), with two paddle wheels 3 with brass paddles for mixing the fluid installed on the shaft 2 inside the container. The stationary paddles 5 prevent the rotation of the entire volume of the fluid in the container 1. The paddle wheels 3 are driven by the pulley 4 through the shaft 2, with the cord 8 wound on the pulley and connected with the other end with the load 6 through the block 7. When the weight 7 falls from the height *h*, the drive rotates the paddle wheels and causes mixing of the fluid which is heated. The extent of heating is recorded with a thermometer. Knowing the amount of the fluid, its heat capacity, the increase of temperature and the applied mechanical work, the mechanical equivalent of heat is determined.

It should be mentioned that the speed of rotation of the paddle wheels in the Joule experiment did not exceed 720 rpm. The dependence of the yield of heat on the speed of rotation of the paddle wheels was not determined by Joule. In science, it is accepted that the experimental facts which have not been confirmed cannot be regarded as generally valid. This was not the case with the Joule experiment. The mechanical equivalent of heat determined on the basis of the currently used procedures, was determined at low interaction speeds. Additional investigations are required for higher speeds. According to the analysis results, Joule did not investigate the effect of speed. In physics there is already a precedent according to which

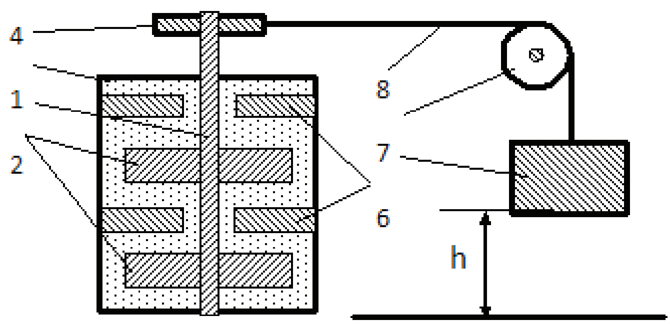


Fig. 10.3. Diagram of Joule equipment for the determination of the mechanical equivalent of heat (simplified scheme): 1) content, 2) the shaft, 3) the paddle wheel, 4) pulley, 5) stationary paddles, 6) the weight, 7) the block, 8) the cord.

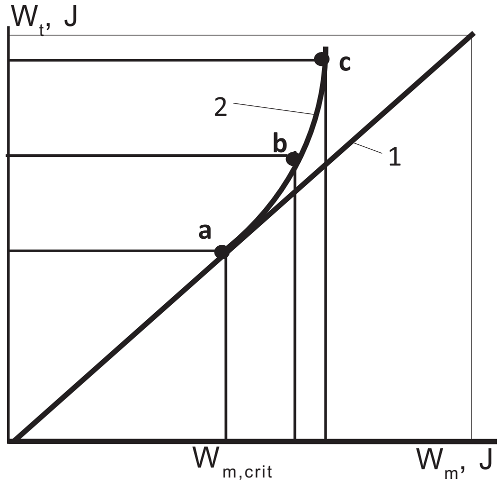


Fig. 10.4. Nonlinear relationship between mechanical work and thermal energy.

the mass of the relativistic particles at high speeds close to the speed of light increases in a non-linear manner from the speed of movement although until recently it was assumed that there should be no mass increase. Mass was regarded as a constant. Nonlinear physics is the main part of current investigations [2].

Figure 10.4 shows the non-linear dependence of the mechanical equivalent (curve 2) for the case in which the mechanical equivalent of heat has the form of the linear coefficient of proportionality irrespective of the speed of interaction (line 1). The nonlinear effects become evident at the speed of rotation of the paddle wheel of approximately 3000 rpm when cavitation starts to appear on the surface of the rotating blades. Cavitation results in the activation of completely different energy mechanisms in the quantised medium, disrupting the linearity of the mechanical equivalent of heat determined by Joule. The nonlinear form of this dependence is represented by the curve 2. Starting at some critical point *a*, the nonlinear region (*b*–*c*) is characterised by a large increase of thermal energy W_t in comparison with the spent mechanical work W_m.

The presence of a large number of cavitation bubbles and their formation and collapse of these bubbles generate specific noise (acoustic field) whose spectrum reaches the ultrasound range of several hundreds of kilohertz. It should be mentioned that the speed of the cavitation processes is very high: the collapse time of cavitation bubbles is only of the order of 10^{-6} s. The pressure inside the cavity reaches 100 MPa (~1000 atm) and temperature ~10 000 K (this temperature is higher than the temperature on the surface of the Sun). It is justified to assume that the collapse of a cavitation bubble is accompanied by the formation of electron–positron plasma in the cavity and this is the source of excess heat, as in the Usherenko effect.

Tens of patents for various devices for heating water using thermal cavitation pumps were granted in the USA only, starting in 1930. All these devices are characterised by the disruption of the linearity of the mechanical equivalent of heat. It appears that the coefficient of transformation of energy (the ratio of the thermal energy supplied by the device to the electrical energy used for driving the hydraulic pump) is >1.2. The most reliable results are those obtained in tests of a thermal cavitation pump of the Yurle company (Belarus), carried out by the Institute of Heat and Mass Transfer of the Academy of Sciences of Belarus (Minsk). The determined conversion coefficient was 0.975–1.15 (without taking into account the heat losses into the surrounding environment) [15].

Analysis of the literature and patent sources shows that no investigations of thermal cavitation pumps which can be regarded as the simplest quantum reactors have been carried out in fundamental science. Until recently, this was the subject of interest of inventors who reported the instability of the effects and the fact that the nature of the phenomenon is not known. New fundamental discoveries of the space-time quantum (quanton) and superstrong electromagnetic interaction (SEI) have made it possible to pay attention to thermal cavitation effects, and detailed investigation of these defects may become the basis for construction of a new family of quantum reactors for thermal power engineering.

10.7. Quantum engines. The Searl effect

At the beginning of the 50s of the previous century, the English inventor John Searl discovered a unique physical effect referred to as the Searl effect [13].

The Searl device (Fig. 10.5) has the form of a roller bearing with the internal ring of the bearing being a permanent magnet made of a ferromagnetic materials. This is the main central magnet 1. The rollers 2 are made of rare-earth magnets. The axes of the rollers are secured in the bearing in the outer ring–guide 3. Untwisting the ring–guide 3, the rollers 2 start to rotate, travelling on the cylindrical surface around the central magnet 1. After reaching some critical speed of the ring–guide 3 with the rollers, the system is transferred to the self-rotation regime without requiring any energy. In addition, the system generates an unbalanced force in the direction normal to the plane of the figure 1.

Naturally, the unique effect, discovered by Searl, contradicted all the knowledge at that time. Firstly, the Searl device already represented a perpetual motion machine with an unknown energy source. Secondly, the

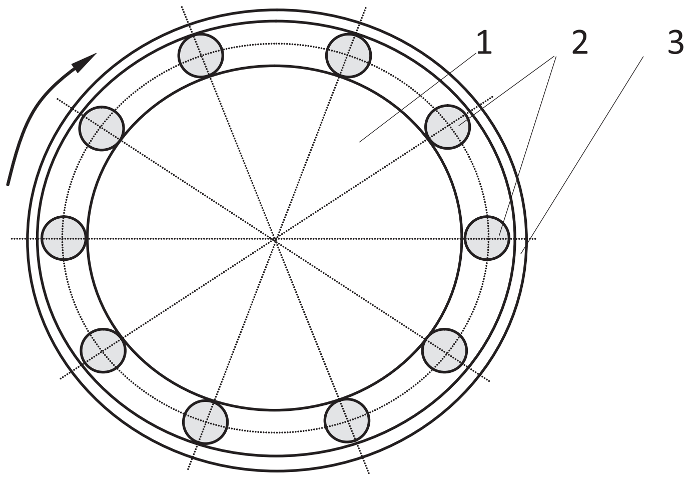


Fig. 10.5. Diagram of the Searl device (top view in section): 1) central magnet, 2) magnetic rollers, 3) outer ring.

Searl device generated a traction force, contradicting classic mechanics.

Actually, in accordance with the laws of classic mechanics, these Searl effects should not be detected in principle. However, this does not relate to quantum mechanics whose laws are not governed by the laws of classic Newton mechanics. Einstein was the first to stress this, showing that Newton mechanics does not work in the area of relativistic speeds, i.e., the speeds close to the speed of light. Further, it was found that classic mechanics is not suitable for describing the behaviour of the orbital electron in the composition of the atom, and for discrete radiation of the energy of the orbital electron by the photons. The new knowledge was placed in a separate region referred to as quantum mechanics.

The problems of perpetual motion do not contradict quantum mechanics. Perpetual motion of the orbital electrons ensures the presence of a substance (atoms, molecules). If the orbital electrons are arrested, the substance (atoms, molecules) breaks up. Radiation of the photon by the orbital electron is associated with the fact that the speed of the photon reaches the speed of light very rapidly and this could not be achieved if the photon had no traction. In this respect, the effects discovered by Searl do not contradict quantum mechanics. However, for many decades, the Searl effect could not be understood by theoreticians. Because of the absence of an appropriate theory the results obtained when the Searl effect was investigated by other researchers were not stable.

Only after the discovery of the space-time quantum (quanton) and the superstrong electromagnetic interaction was it established that the source of energy in the Searl effect is the superstrong electromagnetic interaction. The Searl device (Fig. 10.5) belongs to open quantum-mechanical systems, directly connected with the quantised medium, ensuring exchange energy processes. This has become possible after integrating electromagnetism and gravitation in the Superunification theory and the determination of the reasons for gravitation and inertia as the only equivalent of deformation of the quantised medium [9].

Examples of the simplest open quantum-mechanics systems were also known prior to the discovery of the Searl effect (Fig. 3.16). They included the decrease or increase of the weight of a gyromotor and the reverse gyroscopic effect.

The reverse gyroscopic defect has a significant shortcoming, i.e., the Coriolis forces, acting on the flywheel during its translation movement along the radius compensate each other generating a momentum capable of generating 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 cannot be used to generate the lifting force of aircraft.

In the case of the Searl device (Fig. 10.5) it is possible to change actively not only the direction and magnitude of the Coriolis forces but, as a result of additional electromagnetic effects, generate un unbalanced traction force on the magnetic roller 2 which is directed under the angle, ensuring the effect of horizontal and vertical forces. The horizontal force generates a torque so that the Searl device rotates continuously. The vertical force ensures the lift traction force. The source of energy in the cell divides is the superstrong electromagnetic interaction (SEI).

Experiments with the Searl device were repeated at the Institute of High temperatures of the Russian Academy of Sciences. The tests of the device indicated the generation of the electrical power of 7 kW in the continuous working regime with the additional traction of 120 kg at the diameter of the device of the order of 1 m and the weight of the entire magnetic system of 350 kg [14].

Taking into account the Superunification theory, the Searl effect has been applied in completely new quantum engines [9].

10.8. Practical application of quantum engines

Russian patent No. 2185526 'A method of generating traction in vacuum and a field engine for spaceships' [9]

Regardless of the fact that the name of the patent indicates the field (quantum) engine for spaceships, this method of energy generation and various energy devices based on the method can be used widely in transport and power engineering. The term 'field' initially reflects the energy base of the quantum engines. The source of energy for the quantum engines is the single energy field, represented by superstrong electromagnetic interaction (SEI).

The quantum engines are designed for generating traction and torque:

– generation of traction in vacuum is fundamental for the development of a new generation of aircraft and spaceships;

– generation of torque and the conversion of rotational energy into electrical energy in the quantum engine–generator systems;

– combination of traction and torque in the power systems for ground-based transport.

As the sources of energy and traction, quantum engines can be used widely in transport (automobiles, rail and sea transport, aviation, interplanetary spaceships) and in power engineering (autonomous power sources).

The extraction of the energy of superstrong electromagnetic interaction in the quantum engine takes place as a result of the formation of an unbalanced force (momentum) in deformation of quantised space-time by gradient electromagnetic systems (activators). It is not necessary to use conventional chemical fuel and it is well known that the resources of chemical fuel will soon be exhausted. The principle of operation of the quantum engine is described in detail in the patent No. 2185526.

10.8.1. New generation automobiles

The automobile in the 21st-century will still be the most important mass and easily available transportation means. The application of quantum engines in the cars is the basis of development of a new generation of automobiles, both passenger and cargo automobiles. The wide range of automobiles require quantum engines with the traction F of 1, 2, 5, 10, 20, 40 t or more not associated with the wheel drive. For parking the automobiles, the quantum engine is combined with the electric generator and electric drive of the wheels.

Figure 10.6 shows the diagram of a lorry (tractor) with the quantum engine 1 with horizontal traction **F** not connected with the wheel drive. This ensures increased passability of the vehicle. In addition, chemical fuel is not required for the automobile. The source of energy of the quantum engine is the superstrong electromagnetic interaction. The automobiles with internal combustion engines do not have these characteristics.

Figure 10.7 shows the diagram of a terrain vehicle (jeep) with increased passability. The quantum engine 1 is installed in the tail part of the automobile,

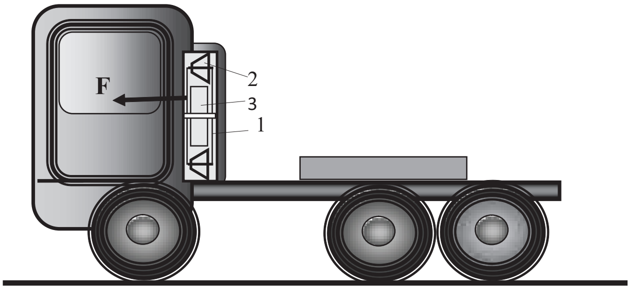


Fig. 10.6. Diagram of a lorry with a quantum engine with a traction of more than 10 t. 1) the quantum engine, 2) the activator, 3) the electric generator-starter.

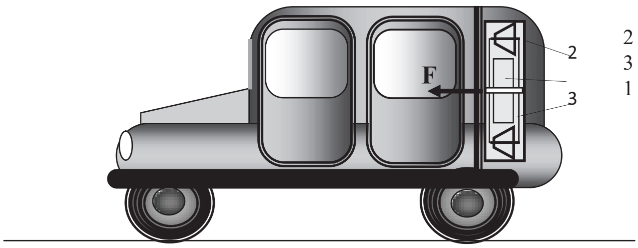


Fig. 10.7. Installation on a terrain vehicle of a quantum engine with horizontal traction **F** of 2 t not connected with the wheel drive, and with the additional electrical power of 20 kW. 1) the quantum engine; 2) electromagnetic activator; 3) the electric generator – starter.

producing the horizontal pushing force **F** of 2 t, not connected with the wheel drive. In addition, the quantum engine 1 rotates the 20 kW electric generator–starter 3 ensuring supply of electricity to the vehicle and the electric wheel drive (not shown in the drawing) for parking the automobile in the garage. The horizontal traction **F** is generated by the electromagnetic activators 2 resulting in deformation of the quantised space-time and control of the traction force. The automobile, weighing 2 t, with the horizontal traction force of the engine of 2 t can accelerate in a straight line with the initial acceleration of the order of 1 g (~10 m/s^2). Taking into account the resistance to movement, the acceleration time of the vehicle to the speed of 100 km/s is approximately 5 s, developing the power of the order of 100 kW (136 hp). The quantum engine 1 is started by the electric generator-starter 3 using an accumulator battery.

The horizontal traction 2 t not connected with the wheel drive for a vehicle weighing 2 t makes the vehicle highly passable in comparison with conventional terrain vehicles. The quantum engine pulls (pushes) like a winch the vehicle on any road. None of the currently available terrain v ehciles has such high passability.

The main advantages of the quantum engine in comparison with the internal combustion engine when used in a vehicle are:

– the quantum engine enables the vehicle to be started with constant traction utilising its power to the maximum extent;

– the quantum engine does not require chemical fuel and does not eject gases contaminated with the atmosphere;

– the internal combustion engines loses up to 80% of power at the start because of the low speed of rotation of the engine at the moment of connection, 50% of power when the clutch is engaged, and in the final analysis only 10% of the power is used when starting the automobile with the internal combustion engine.

At the present time, the cost of the quantum engine can be calculated from the condition of US$1000 per 1 kW of rated power. And engine with a power of 100 kW costs US$100 000. If a million of engines are produced per annum, the price of the engines can be reduced by an order of magnitude, i.e. 10 times.

The terrain vehicle on an anti-gravitation cushion is shown in Fig. 10.8.

Figure 10.8 shows the diagram of a terrain vehicle on the anti-gravitation cushion which can travel on terrain without any roads and also water obstacles (rivers, swamps). The terrain vehicle on the anti-gravitation cushion does not require bridges. In fact, this is the local flying vehicle at a fixed height above the water surface (for example, 10–15 cm). The height of flight through a barrier is stabilised by the automatic system controlled by the radar-scanner 3. The radar–scanner also ensures safe movement of the automobile on the route, preventing collisions with other vehicles. The radar–scanner, fitted with a microprocessor control of the vehicle, is capable of ensuring its movement in the autopilot regime.

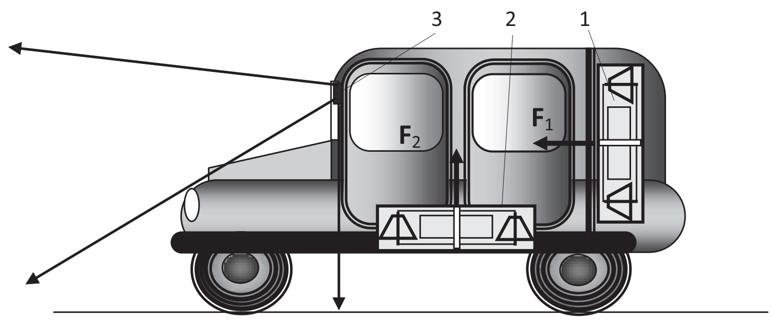


Fig. 10.8. The terrain vehicle on the anti-gravitation cushion with two quantum engines 1 and 2 with horizontal F_1 and vertical F_2 traction and with a scanning radar 3.

It is also possible to construct a flying vehicle without the restrictions regarding altitude but this will no longer be a vehicle but a flying vehicle, requiring special habits in control and permission documents for control.

10.8.2. Spaceships and aircraft

Figure 10.9 shows the diagram of a flying vehicle with quantum engine 1. The control of the electromagnetic system of the activator 2 enables not only regulation of the magnitude of the traction vector **F** but also its control, changing the vertical and horizontal components.

Small flying vehicles (Fig. 10.9) with a quantum engine will gradually replace helicopters and larger ones also aircraft. This may take place in the future. The quantum engines are capable of lifting the flying vehicles to the Earth orbit and maintained them at any altitude.

The construction of an interplanetary spacecraft of a new generation with the quantum engine would make flights to the Moon and Mars realistic. Exploration of planets and space tourism will become a business. For example, the flight to Mars in the years of Mars opposition (55–58 000 000 km from the Earth) in such a spacecraft in the regime of constant acceleration g at halfway with subsequent deceleration would take only 42 hours. The maximum speed will be 740 km/s. The speed of new spaceships of a new generation will be an order of magnitude greater than the speed of rockets.

The construction of new generation spaceship with quantum engines will determine the development of field (quantum) cosmonautics when it will be possible to realise interplanetary communication and colonisation, primarily the Moon and then Mars. Traditional rocket cosmonautics has reached its limit. At the present time, nobody is even thinking of sending a new expedition in a rocket to the moon. The risk is very high.

Figure 10.10 shows the diagram of an interplanetary spaceship of a

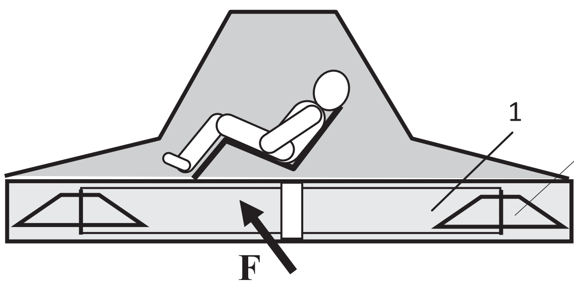


Fig. 10.9. Diagram of a flying system with quantum engine 1. 2) electromagnetic activator, deforming the quantised space-time and generating the regulated traction vector F.

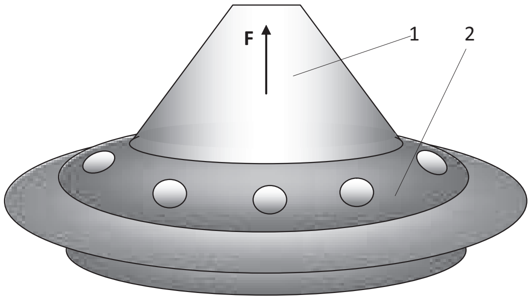


Fig. 10.10. Diagram of an interplanetary spaceship with a quantum engine. 1) quantum engine, 2) the cone.

new generation. The spaceship consists of the quantum engine 1 with the conical working body (activator). In the Russian Federation patent No. 2185526 ‘Method of producing traction in vacuum and a field engine for a spaceship’, the quantum engine contains several conical activators of the quantised space-time. However, with the development and advances in technology it will be possible to produce a single powerful quantum engine because its traction is determined by the volume of the cone of the working body of the activator. The formation of the gradient of the quantum density of the medium in the body of the activator determines the traction of the engine. In particular, the gradient of the quantum density of the medium determines the magnitude and direction of the deformation vector **D** (or distortion according to Einstein) of the quantised space-time and, correspondingly, the direction and force of traction **F**.

To install the quantum engine 1 on the body 2, it is necessary to place additional activators on the periphery of the body (smaller activators) for compensating the torque of the conical rotor of the main engine 1. This is essential for preventing the rotation of the spaceship and stabilisation of the position of its body. Consequently, the external appearance of the spaceship resembles ‘a saucer’.

If the press is to be believed, the US squadron under the leadership of Admiral Richard Byrd was attacked by similar spaceships and 9047 at the the Antarctica coast. The squadron and its aircraft, as stated by one of the pilots, were destroyed in 20 min. The spacecraft were capable of entering and emerging from water. If these were extraterrestrial civilisation spacecraft then this case shows convincingly that we are technologically backward in this respect. New fundamental discoveries and the theory of Superunification would enable this gap to be closed.

Figure 10.9 shows the diagram of a small flying vehicle with a quantum engine. These small flying vehicles for flights above the surface of the moon or Mars can be installed in a large interplanetary spaceship.

Interplanetary communications

Everybody knows that movement of a spaceship by inertia in the interplanetary space does not require any energy sources. For this purpose, it is sufficient to accelerate the spaceship to the required speed with energy consumption. Further movement of the spaceship by inertia is determined by its ballistic trajectory. In order to change the trajectory, it is necessary to activate the engines and generate traction. This requires an additional energy and consumption of fuel.

Naturally, the development of quantum engines breaks all the existing stereotypes in cosmonautics. In particular, the operation of the quantum engine does not require the conventional types of fuel. The energy source is represented by the superstrong electromagnetic interaction (SEI); the carrier of this interaction is the quantised space-time. New cosmic technologies, formed by the application of quantum energetics, make it possible to receive energy continuously for the spaceship directly from space.

This means that the new generation of spaceships will not have the form of a station travelling along the ballistic trajectory by inertia and it will be a controlled system with a constantly working engine and continuous traction. This formulation of the problem changes the very concept of interplanetary cosmonautics. From passive ballistic cosmonautics will change to active traction. This will be a new stage in its development.

Having a quantum engine with continuous traction, it will be possible to generate traction F, corresponding to the force $F = mg$, where m is the mass of the spaceship, $g = 9.8$ m/s^2 is the free fall acceleration on the Earth surface (acceleration is the equivalent of the strength of the gravitation field). The movement of the spaceship with acceleration would have generate inside the aircraft the conditions corresponding to earth gravity. Weightlessness is conquered. In particular, weightlessness is the ‘whip’ of ballistic cosmonautics and has a negative effect on the organism of the cosmonaut.

Let us now imagine that we are travelling to Mars with continuously operating quantum engine whose thrust generates motion with acceleration g. This acceleration creates gravity conditions similar to those on the Earth. If we now sit at a table and drink tea, our state will not differ from that in our working area on the Earth. Active traction cosmonautics will become comfortable. The crew of the space you will experience discomfort only at one point of the trajectory of the flight with acceleration. This is the point of thrust reversal, i.e., the variation of the direction of the thrust vector in the opposite and transfer from the acceleration to deceleration regime g. For this purpose, the spaceship travels half of the distance with acceleration g and the other half with deceleration g.

It should be mentioned that in the deceleration regime, the spaceship releases the kinetic energy accumulated previously during its acceleration, into the quantised space-time. Inertia energy is reversible. This means that in movement with acceleration and subsequent deceleration the energy losses will be compensated for. Or in the language of physics: the energy integral along the path is equal to zero like in the movement along the ballistic trajectory. However, we have gained as regards the travel time.

The movement of the spacecraft with acceleration g and the same subsequent deceleration greatly shortens the flight time t which is determined by the equation:

$$t = 2\sqrt{\frac{x}{g}}$$

where x is the distance between planets along the movement trajectory in metres, time t is in seconds.

For example, an expedition to Mars in the year of its opposition in relation to the Earth (55...58 000 000 km) in the active regime of continuous acceleration followed by deceleration will take only 42 hours. In movement on the ballistic trajectory it takes several months. The difference is obvious.

A flight to the Moon (384 400 km) in the active regime g will take only 3.5 h, and the maximum speed of the spaceship will be of the order of 60 km/s, i.e., five times faster than the currently available rockets.

Colonisation of the Moon

The development of field (quantum) cosmonautics offers realistic possibilities for the colonisation of the Moon and then Mars. Enterprising Americans have already sold plots on the Moon surface. No international agreements have been made regarding this matter. The occupational rights will belong to those who will be the first to land in the specific area of the moon. China is already working actively on the colonisation of the Moon.

The colonisation of the Moon is already of commercial nature due to the fact that settlements of earthlings can be produced in the interior of the moon at a certain depth on the horizon with the temperature of 20 °C. The surface of the moon, illuminated by the sun, is very rapidly heated and in the shadow there is cosmic frost. The discovery of the volcanic activity of the Moon indicates that its interior is heated. It is necessary to transfer to deep horizons with the stable temperature of the order of 20°C suitable for the vital activity of man. In particular, hermetically sealed spaces filled with air can be produced in the Moon interior for inhabitation by people. In addition, these settlements will be protected from meteorite fluxes. There is enough work for underground constructors on the Moon.

The Moon is already attractive because of its interior. Projects are being prepared for the supply of helium-3 to the Earth detected in colossal quantities on the Moon. The unique possibilities of deep vacuum in low gravity of the Moon would make it possible to develop technologies which are extremely expensive in the conditions on the Earth. In addition, production procedures which are dangerous for the ecology on the Earth can be transferred to the Moon. In the conditions of the cosmic vacuum the harmful emissions will be immediately dissolved in the unlimited space.

The rich interior of the moon, its unique technological possibilities in the construction of settlements in the Moon interior are the attractive aspects of the colonisation of the Moon and the development of field (quantum) cosmonautics.

A new type of services will soon be offered, i.e. cosmic tourism.

Cosmic safety of the Earth

A serious danger for the civilisation on the Earth comes from large asteroids with the size larger than 1 km whose impact on the Earth would have the catastrophic effect on the life of the Earth. It is sufficient to examine the surface of the Moon covered with relatively large craters. On the Earth, these craters do not remain because the effect of the atmosphere and vegetation. It may be guessed that large cosmic catastrophes already occurred on the Earth during impact of asteroids. Astronomers predict that in the year 2028, the trajectory of the Earth may intersect with the orbit of a large asteroid. A catastrophe may have global consequences for civilisation.

The proposed methods of preventing the impact of asteroids are basically based on explosions using nuclear charges. However, the most efficient method is the change of the trajectory of the asteroid as a result of the force effect of a group of spaceships with quantum engines (Fig. 10.11). At a large distance from the Earth, a group of spaceships will arrive at the asteroid and apply to it a force for a long period of time, generating a momentum sufficient to change its trajectory away from intersection with the Earth orbit.

This fact already suggests that it is necessary to start immediately the development of a new generation of spaceships with quantum engines, if

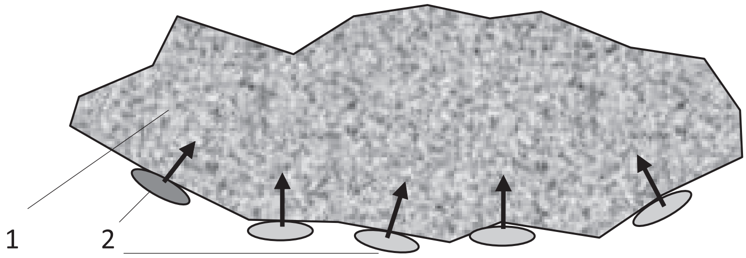


Fig. 10.11. Variation of the trajectory of the large asteroid 1 by the force effect of a group of spaceships 2 with quantum engines.

Fig. 10.12. Dispatch from the Earth 1 towards the Sun 2 of the container 3 with the radioactive waste using the cosmic tug 4 with a quantum engine (the container 3 and tug 4 are magnified for better understanding).

we want to preserve our civilisation.

Radioactive waste disposal

The problem of radioactive waste disposal can be solved most efficiently using the cosmic tug 4 (a spaceship with a quantum engine) which accelerates the container 3 with the radioactive waste towards the sun and subsequently slows down and releases its content (Fig. 10.12). The radioactive waste burns on the sun. The tug with the container returns to the Earth orbit for a new batch of radioactive waste.

Unfortunately, with the exception of unreliable guesses, we do not know anything about extraterrestrial civilisations and the relation to us. At the moment, these relations are neutral. However, if somebody wants to destroy us, the earthlings should also be able to resist. In order to save our civilisation, the rate of development of new cosmic technologies should be increased.

Lifting of satellite antennae to the orbit

A small flying vehicle (Fig. 10.9), capable of lifting satellite communication antennae to the orbit, is considerably cheaper than rockets (Fig. 10.13).

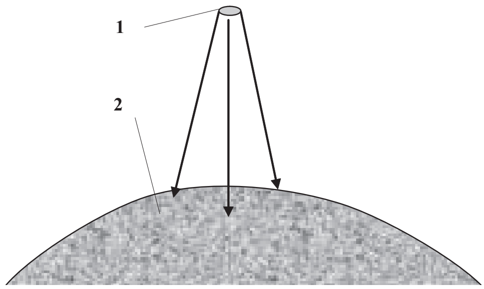


Fig. 10.13. Sending a satellite antenna to the orbit. 1) the satellite antenna, 2) the Earth surface.

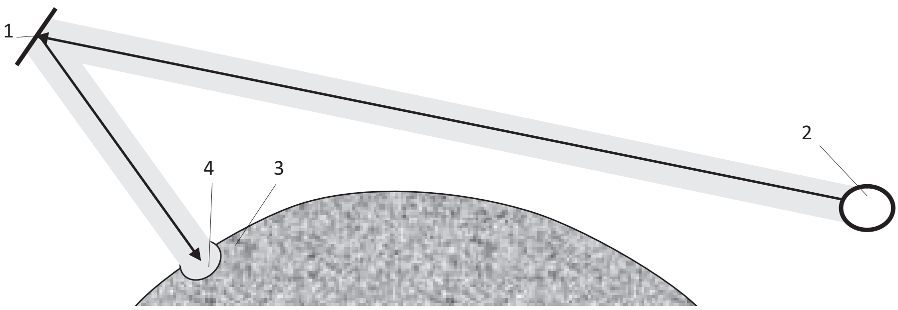


Fig. 10.14. Lifting to the stationary orbit of a film reflecting surface 1 for solar illumination of the surface of the Earth during the night. 1) the film reflecting (mirror) surface; 2) the sun, 3) the Earth surface; 4) the illuminated surface.

Use of sunlight for nocturnal illumination

The direct use of sunlight for illuminating large cities is most economical. The incident flux of the solar energy on the Earth orbit reaches 1.37 kW/m^3. The fraction of the light flux is ~25%. If it is assumed, taking all losses into account, that the energy of the reflected light flux is determined by calculations as 0.1 kW/m^2, the reflecting surface with the size of only 100 × 100 m (area 10 000 m^2) transfers the light flux with a power of 1 MW to the Earth. There can be many reflecting screens distributed in the orbit. Solar illumination from the orbit excludes the need for using a very large number of electrical bulbs and posts for their installation and a dlarge network of cable lines and transformers. A shortcoming of solar illumination is the dependence on the presence of clouds.

The film reflecting surfaces are tensioned by four small flying vehicles 5 with a quantum engine (Fig. 10.15). The same systems ensure orientation of the film reflecting surface in relation to the Sun and the Earth.

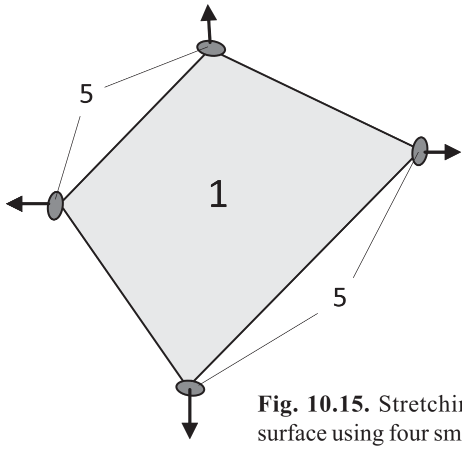


Fig. 10.15. Stretching and orientation of the film reflecting surface using four small flying vehicles 5 with quantum engines.

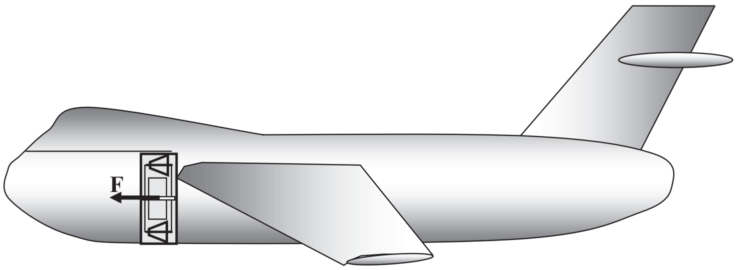


Fig. 10.16. Installation of a thrust quantum engine in the fuselage of aircraft.

The film surface is transported in the assembled form to the orbit by one of the flying vehicles.

The use of solar illumination is one of the projects which cannot be realised without the development of quantum engines and new flying vehicles.

Aviation

Regardless of the fact that the flying systems with quantum engines can fly without wings, wing-based aviation will probably still exist for a long period of time (Fig. 10.16). The quantum engines do not generate any noise like reactive engines and do not require chemical fuel.

Underwater systems

The installation of quantum engines on ships will remove the need for using screw propellers. The quantum engine provides the direct thrust like a sail,

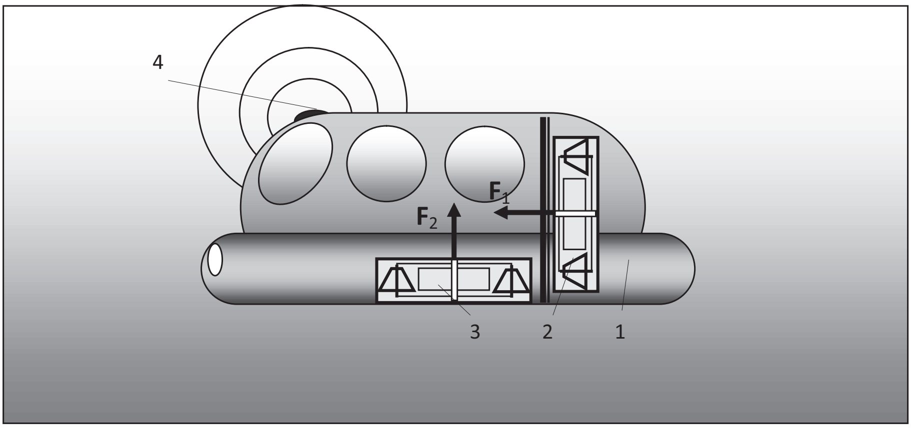


Fig. 10.17. Underwater apparatus 1 with quantum engines 2 and 3 and the gravitational communication system 4.

pushing the ship in the direction of the thrust vector.

As an example of the application of quantum engines on seagoing vessels, Fig. 10.17 shows the diagram of underwater equipment. Placing two quantum engines 2 and 3 with horizontal $\mathbf{F}_1$ and vertical $\mathbf{F}_2$ thrusts results in the unique properties of this equipment.

This underwater equipment does not require any ballast for immersing or floating up. The rate of immersion and floating up is controlled by changing the magnitude and direction of the vertical traction vector $\mathbf{F}_2$ by the quantum engine 2. The quantum engine 1 ensures the horizontal movement of equipment.

The absence of the screw propelles makes the underwater system irreplaceable in recovery operations, preventing winding of nets and ropes onto the screw propellers.

At a sufficiently high power of the quantum engines, the underwater system can leave the water and fly above the water surface in both the atmosphere or in space. The currently available water equipment does not have these characteristics.

The distinguishing special feature of this underwater equipment is the installation of a system for gravitational communication (Russian patent No. 2184384 ‘A method of generation and reception of gravitational waves and a device for its realisation). The gravitational wave like ultrasound freely passes through the water, ensuring stable communication with underwater equipment at any depth.

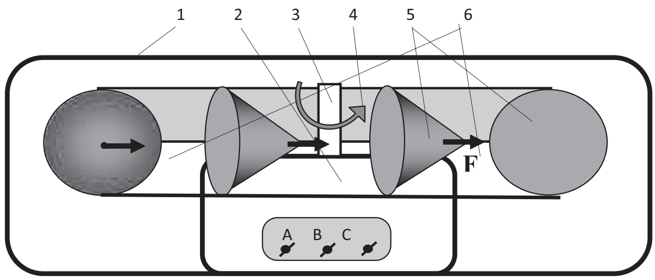


Fig. 10.18. Diagram of a quantum engine–generator for the production of electrical energy. 1) the body of the quantum engine–generator, 2) electric generator, 3) the shaft of the electric generator, 4) the guide, 5) the activators of the quantum engine 6.

10.8.3. Quantum engines–generators

The quantum engine itself cannot directly generate electrical energy because it produces thrust and/or torque. To produce electrical energy, a quantum engine is connected with an electrical generator, forming a quantum engine–generator system. In this case, the quantum engine operates in the regime of the total torque, preventing the formation of the thrust regime.

The main application of the quantum engines–generators are the autonomous systems for electric power supply with extensive application with the power of 10, 25, 50, 100, 250, 501, 1000 kW, and more.

The quantum engine–generator operates as follows (Fig. 10.18). The activators 5 generate thrust **F** in the direction of rotation (indicated by the curved arrow) of the shaft 3 of the electric generator 2. The activators 5 are installed on the guides 4, secured on the shaft 3 of the electric generator 2. The effect of thrust **F** from each activator 5 generates a torque which causes the shaft 3 of the rotor of the electric generator to rotate. This results in the generation of electric energy with the three-phase voltage of 380/220 V, the frequency of 50, 60 or 400 Hz (depending on the country and purpose of current). The electrical voltage of 380/220 V is collected by the terminals A, B, C of the electric generator 2.

The quantum engine–generator is started by another quantum engine-generator, mains or an accumulator battery.

Sintering of constructional materials with current

The generation of cheap energy can be utilised for the efficient application of energy-consuming technologies in constructional engineering. New constructional materials, produced by the method of sintering with electric

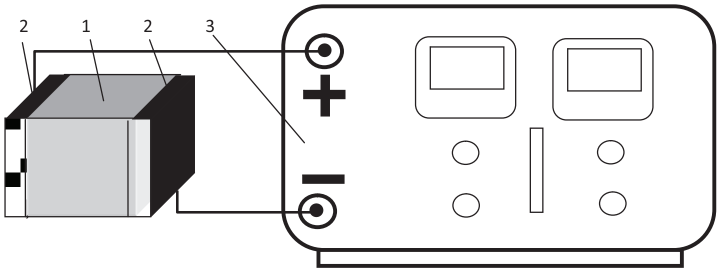


Fig. 10.19. Sintering of material with electric current. 1) material, 2) electrodes, 3) the current source.

current, designed for production without cement of structural materials for a wide range of applications: bricks, blocks, house panels, sidewalk slabs, road surfaces. The material is produced by electric current sintering of silica (sand) and any soil. The technology of electric current sintering of the powder materials is used widely in powder metallurgy.

Figure 10.19 shows the diagram of sintering Elstar material by electric current which includes: material (silica) 1, electrodes 2, current source 3. During the passage of electric current through the material the latter is centre to the required density and represents a completed component which can be used as a constructional material (bricks, etc).

The development of the new industry of constructional materials has made it possible to increase the volumes of building of new houses at a considerably lower price.

Sintering of roadbeds

Figure 10.20 shows a road machine for placing the roadbed by sintering. The road machine includes: the tractor 1, the power plant 2 (quantum engine–generator), equipment 3 for sintering of soil. The machine pulls the roadbed 4 by sintering it from the soil.

Equipment 3 for sintering of soil is installed on the hydraulic suspension in front of tractor 1, which moves on the already along laid roadbead 4. This ensures the uniform motion of the tractor and the necessary adjustment of equipment 3 along the horizontal and vertical lines, making it possible to produce the ideally flat roadbed surface 4.

Power power plant 2 realizes fundamentally new energy technologies.

The new technology of road building will make it possible to solve the problem of roads in Russia. This means large constructional businessed and new work sites. But the main thing is that there will be good roads everywhere.

Power supply of habitable sector

The installation of quantum engine–generator 1 with a power of 100 kW will provide both by electric power and heat to houses (Fig. 10.21). Electric radiators with temperature control will be installed in every room. There will be no need for central hot water heating and connection to the power system. This will make it possible to build low dwellings in any convenient place, without any need for the engineering infrastructure: centralized electric power and heat supply. The prolonged and expensive agreements on connections and permissions will not be necessary.

The cost of a standard quantum engine–generator 1 with a power of 100 kW will be of the order of $100 000, i.e. $1000 per 1 kW of rated power. This is not expensive, taking into account that no further paymenet will be requied for energy carriers, since free ultrapowerful electromagnetic interaction is the energy source in this case.

Autonomous quantum engines–generators will radically alter the structure of contemporary town building. Today the cost of utility networks (electric power and heat supply, water, canalization) is compared with the cost of construction sections, composing 50% of estimate. Taking into account the scarcity of the generating electrical power, large-scale urban building is held in control.

With the development of quantum energetics, centralized heat and power supply in town building will be replaced by remote energy sources. The need for thermal and cable systems and transformer substations is eliminated.

Over the long term it will be possible to solve the problem of constructing ecologically clean houses with the complete processing of the by-products of the vital activity of man.

The major advantages of the quantum engines over any types of

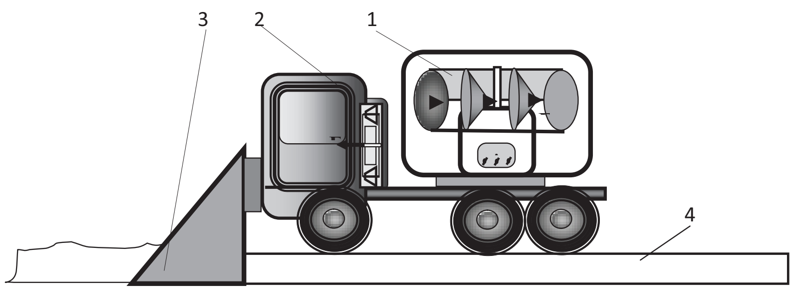


Fig. 10.20. Laying roadbed by sintering. 1) tractor, 2) power plant (quantum engine–generator), 3) equipment for sintering soil; 4) road layer.

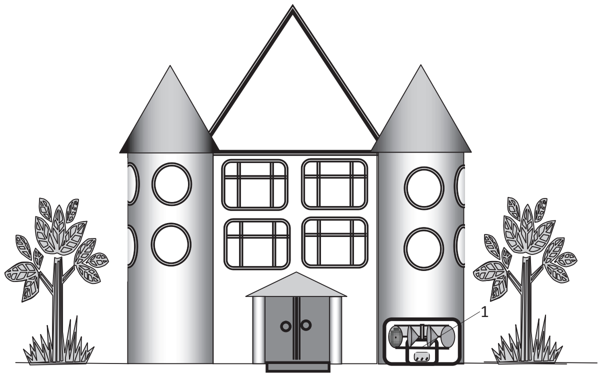


Fig. 10.21. Installation of the autonomous quantum engine–generator 1 for supplying electricity and heat to houses.

the engines which exist at present and the engines being developed at present are:

1) chemical fueld is not required for the operatiuon of the quantum engine;

2) unlimited distance of the movement of transportation means;

3) no need for refueling of transportation means;

4) significant reduction in the material expenditures for the infrastructure, which ensures transport motion (AZS, electric power lines for railroads and municipal transport, etc.);

5) high ecological efficiency and safety.

10.9. Forecast of the development of quantum power engineering in 21 century

This paragraph was written as an addition when the book was already being translated into English. During 2007-2009 experimental studies were carried which confirm the theory of Superunification by new physical effects. Therefore, it became necessary to described, at least briefly, some results of the experimental verification of the theory of Superunification, especially the successful tests of a quantum engine generating thrust application without the ejection of reactive mass.

The theory of Superunification for the first time reveals the electromagnetic nature of gravity and structure of quantised space-time with which it is possible actively to interact, controlling gravity and inertia. This required new knowledge provided by the theory of Superunification which cannot be found in the standard model responsible for the state of contemporary physical knowledge. The standard model does not include gravity, yes even other fundamental interactions are described purely phenomenologically, without revealing their nature.

10.9.1. Results of the tests of a quantum engine for generating thrust without the ejection of reactive mass

Up to now, the reactive method was the only method of producing thrust in vacuum. It is based on the ejection from the nozzle of reactive mass during the combustion of fuel in the jet engine. It is considered that the gas pressure during the combustion of fuel acts on the internal walls of the jet engine and produces thrust. The thrust momentum is proportional to the speed and mass of the fuel ejected from the nozzle.

Numerous attempts have been made to produce thrust without the ejection of reactive mass. These were purely empirical attempts within the framework of the existing knowledge. Without having clear theoretical substantiation, it was impossible to create such an engine. The point is that in accordance with the third Newton's law, when effective force is equal to the counteracting force, thrust is created with repulsion from another mass or body. The wheels of an automobile are repulsed from the road surface. In the jet engine, the thrust is created as a result the ejection of reactive mass, as if being repulsed from this mass. Air and hydraulic screws, screwing into the air and hydraulic medium, reject the mass of this medium, being repulsed from it.

But is it possible to be repulsed from vacuum? The theory of Superunification asserts this is possible by considering space vacuum as the elastic quantised medium (quantised space-time) from which it is possible to be repulsed. This is the unique weightless medium which has not analogs in nature and whose structure is desribed for the first time in the theory of Superunification. It is shown that the weightless quantised space-time penetrates through all ponderable bodies. In this case, all ponderable bodies are the composite and indissoluble part of the weightless quantised space-time. The mass of a body is formed as a result of the spherical deformation (bending according to Einstein) of the weightless quantised space-time by elementary particles which form part of the body. In this case the mass of the body is the component part of the elastic quantised medium, its energy cluster. Mass, as a gravitational charge, is a secondary formation in the quantised space-time.

All known methods of producing thrust are based on the external action with the repulsion from the known media. In this case all known apparatuses for the thrust generation must be treated as closed quantum-mechanical systems. In accordance with the theory of Superunification, the quantum engine is an open quantum-mechanical system when thrust is created inside the body of the operating unit (activator) of the quantum engine. To create thrust without the ejection of reactive mass it is necessary to switch over to the open quantum-mechanical systems. In this case it is possible to be repulsed from the elastic quantised medium actively interacting with time quantised by space??? PLEASE CHECK. In this case, there are no contradictions with third Newton's law, whose fundamentality is thoroughly checked, and is completely confirmed by the theory of Superunification. The reader should refer to the section 3.5.3. Simple quantum-mechanical effects, and also to patent [9].

The very process of creating the thrust inside the operating unit of the quantum engine is connected with Einstein's 'bending' of the quantised space-time. Based on the positions of the theory of Superunification, the Einstein distortion effect of space-time looks like the real deformation of the elastic quantised medium inside the operating unit of the quantum engine [9]. This deformation produces the redistribution of the quantum density of the medium inside the body of the operating unit of the quantum engine. This leads to the appearance of gradient thrust forces inside the operating unit. Thus, for the first time gravity and inertia are controlled. This again confirms the fundamentality of Einstein's theory that against the basis of gravity is the bending of the quantised space-time.

It is natural that the control of gravity on the global scale is not possible at the moment. The perturbinh mass of the Earth is required to obtain the strength of the gravitational field of 1g (acceleration in the terrestrial gravitational field) in pure vacuum. This deformation of the outer space free from the external source is is associated with colossal power consumption.

But here the deformation of the quantised space-time in the local region inside the operating unit (activator) of the quantum engine already corresponds to energy which is spent by the body on its acceleration. In this case the classical law of energy conservation. Deformation of vacuum takes place in the body of the operating unit of the quantum engine which actively interacts with the vacuum medium which penetrates the body. The internal thrust force appears inside the body of the operating unit. This is not external repulsion as in the jet engine, it is internal repulsion. Therefore, without having new knowledge, it was not possible in the pas to analytically predict such processes and effects.

But the theory of Superunification goes further and differs from the classical theory by the fact that it is the very strongly developed quantum theory which operates with the already superstrong electromagnetic interaction (SEI) as the basic, previously unknown energy source in the universe. For comparison, the classical theory forbids motion without the ejection of reactive mass, whilst the theory of Superunification permits this motion. It is gratifying that during motion with acceleration regimes form inside the quantised space-time in which deceleration is observed during enery regeneration. With recuperation the spent energy returns and can be used for the second time. Such regimes are used in the hybrid circuits of automobiles with electric transmission. The kinetic energy of a moving automobile with its braking is restored and returns to the enery accumulator – the storage battery. With the acceleration of the automobile thestored energy is used for the second time. In this case, the fuel consumption in the regimes of frequent acceleration and braking is sharply reduced. Inertia possesses a remarkable property - capability for regeneration.

Inertia regimes with regeneration are used actively in the quantum engine. The capability of the quantum engines for energy regeneration during thrust ensures the most economical power cycles of the quantum engine. It is necessary to compensate the energy losses due to friction in the mechanisms of the engine and ohmic losses in the electrical wires and the windings of the activators. In comparison with the traditional internal combustion engine (ICE) and the jet engine, the efficiency of the quantum engine for the generation of thrust can exceed that of the traditional engines 20 or more times. Let us compare the regimes of motion of an expedition to Mars along the ballistic trajectory as far as the inertia and the trajectories of motion in the regime of acceleration - braking with regeneration are concerned. In both cases, the path integral which determines power consumption for motion, excluding losses, is equal to zero. However, in the case of motion the acceleration-braking regime, using a quantum engine, we repeatedly gain in the duration of the expedition, completely compensating weightlessness [9]. In this case, the quantum engine works in the regime of constant conversion and energy exchange of superstrong electromagnetic interaction (SEI).

It would seem that the patent [9] describes in a simple manner the construction of the operating units (activators) of the quantum engine and the principle of its operation. But this is done only theoretically. The patent does not stipulated the modes of powering the operating units and the materials from which they are made. Even the author of this development had to face serious problems in creating the quantum engine and determining the thrust regimg during operation of the engine. Two years of intense work were required for this. It was encouraging that immediately it was possible to generate a small thrust of 0.1 N, and this thrust was then further increased.

In two years of experimental work it was possible to increase the thrust from 0.1 N to 500 N with the mass of apparatus being 50 kg together with the chassis. The diameter of the apparatus of was 1.5 m, the height 1.05 m together with the chassis. It can be concluded that the earth's gravity was overcome with the aid of the quantum engine. Outwardly the apparatus resembles a small flying saucer (or saucepan), but this does not mean that the apparatus must have the form of a 'plate'. it can be any form. Unusual even for the author was to observe the motion of the apparatus which has no screws, jet nozzle and drive for the wheels. High stability is typical of the work of the quantum engine. The effect of generating thrust without the ejection of reactive mass during the operation of the quantum engine did not disappear even after 6 months in repeated tests. This fundamental effect is always well reproduced. An apparatus with the thrust of 5000 N weighing 100 kg is being prepared for tests. If everything goes without problems, then its flights will be demonstrated at the Moscow Aerospace Salon (MAKS) at Zhukovskiy in the Moscow region. The results of tests and design features of the quantum engine, the procedure for calculation of operating units for the given thrust and the operating modes, will be examined in the second volume of Quantum Energetics.

In principle, there are no special limitations on the thrust of quantum engines. A procedure has been developed for calculation of the design parameters of the quantum engine for any thrusts, including 100 tons (1000 N), 1000 tons (10000 N) and more. High efficiency is the distinctive special feature of the quantum engines since the quantum engines do not use the uneconomical thermodynamic cycles. They use exchange cycles inside the energy-consuming quantised space-time. The construction of interplanetary spacecraft of the new generation with the complete compensation for weightlessness becomes reality. The organization of an international expedition to Mars with the participation of the European Union, USA and Russia and other countries will become possible.

It should be noted that the quantum engine is a relatively complex construction with the complex electronic control system. It is an expensive apparatus and its repeated construction can be ensured only by powerful organizations with the participation of specialists in the region of the theory of Superunification. However, no specialists are being trained in this area at the moment. It is hoped that when this book is published, its content will be accepted the university courses of physics and power engineering, giving new knowledge to future specialists.

On the other hand, the efficiency of the quantum engine is the thorough experimental verification of the theory of Superunification which predicted similar effects and they have been confirmed experimentally. Most importantly, the efficiency of the quantum engine proves that the vacuum has a structure in the form of quantised space-time with which it is possible actively to interact. Prior to starting the series production of quantum engines, it would be desirable for independent laboratories to study of the processes of the interaction of the simplest operating units with the quantised space-time, investigating its elastic properties. This is new knowledge which which will have to be acquired. A simple and inexpensive instrument, which can be repeated in any university laboratory, has be constructed and is proposed for repetition below, or it can be ordered from us.

10.9.2. Simple instrument for studying the elastic properties of quantised space-time

The basic problem of contemporary physics is the structure of the outer space which was a grey area in science prior to the development of the theory of Superunification. The attempts to allot space vacuum the properties of mechanical gas-like aether as some thin ponderable material, were not confirmed in experimentals carried out by of Michaelson and Morley more than a century ago. The motion of the Earth relative to the hypothetical ponderable aether was not discovered.

The theory of Superunification rejects all hypotheses of ponderable aether since they have not been confirmed by experiments, and Einstein was right, assuming that there is no mechanical aether. Instead of mechanical aether Einstein introduced the concept of weightless four-dimensional space-time, attempting on this basis to combine electromagnetism and gravity on the way to the unified field theory within the framework of general theory of relativity (GTR). Complete unification was not achieved, but it was possible to prove that the basis of gravity is the bending of space-time. The problem is not the term itself - aether, it is the understanding of its physical essence. There are no contradictions whatever when discussing the electromagnetic aether as the luminiferous weightless medium which refers to the weightless quantised space-time. However, this unique medium has nothing in common with mechanical gas-like aether.

Only the theory of Superunification has been capable of discovering the quantised structure of Einstein space-time, i.e., vacuum. The elastic quantised medium has no analogs with the known media. Inertial motion in accordance with first Newton's law is possible only in vacuum when the body preserves the state of rest or rectilinear uniform motion. This is not possible with motion in a gas, a liquid or a solid. In this case the vacuum as the quantised space-time reacts by resisting force (inertial force) only to acceleration or deceleration of the body in accordance with the second Newton's law.

Within the framework of the standard model inertia is erroneously attributed to the body itself as a system isolated from the external world. This methodological error is corrected in the theory of Superunification and it is shown that the special nature of the mass of the body is the reason for inertia. It is shown that the mass is formed as a result of the spherical deformation of the quantised space-time for the by elementary particles which form part of the body. It turns out that any physical body is the indissoluble and component part of the quantised space-time. Bodies and particles isolated (closed) from the environment do not exist in nature. Then any motion of the body (particle) should be regarded as the wave transfer of its mass in the quantised space-time. This explains the fundamentality of the principle of the corpuscular-wave duality, when the body (particle) simultaneously manifests its wave and corpuscular properties.

In the theory of Superunification it is shown that the inertia is a property of elastic body-medium system. To those who are interested I propose to repeat out simplest experiment which clearly demonstrates the property of the body-medium elastic system. This experiment proves the presence of the elastic structure in the quantised space-time with which it is possible actively to interact. The first attempts to reveal the structure in the outer space were undertaken more than 100 years ago in the interference experiments by Michaelson and Morley. However, the initial prerequisites for the experiments were selected erroneously. It was planned to fix the motion of the Earth relative to the ponderable mechanical aether which, as shown in the theory of Superunification, does not exist in nature. It is natural that no such aether was discovered.

So what did the experiments of Michaelson and Morley show? As regards the theory of Superunification, these experiments that the quantised space-time, in view of its colossal elasticity, is subordinated to the principle of spherical invariance. This principle establishes the retention of the spherical identity of the elementary particle regardless of the speed of its motion including the region of relativistic speeds. For an Earth-type planet which consists of elementary particles, the principle of spherical invariance preserves the configuration of its gravitational field irrespective of the speed of motion of the planet. Only the intensity (strength) of the gravitational field changes. In the theory of Superunification the speed of light is determined by the value of the gravitational potential whose value on the surface of the planet does not depend on the direction of the speed vector of motion (along or across). This gives the constancy of the speed of light in the local region of space both across the motion and in the direction of motion of the planet. This was also observed in the experiments by Michaelson and Morley. In this case it is important not to confuse the law of relativity and the system of relative measurements.

The law of relativity originates from the fundamentality of the principle of the spherical invariance, in accordance with which the identity of the form of the gravitational field of any cosmological object during its motion in the outer space remains unchanged. It appears that each object in the universe is a seemingly independent center with the speed of light being constant in its local areas. This explains the fundamentality of the law of relativity. The theory of Superunification gives the theoretical substantiation of the validity of the law of relativity as the fundamental property of the quantised space-time.

The system of relative measurements gives the picture of peace for the external observer for whom it seems that with an increase in the speed of motion all objects are compressed in the direction of motion. This is indeed recorded by instruments in the hands of the observer. In reality, the bodies (particle) moving inside the quantised space-time are subjected to the effect the principle of spherical invariance which preserves the identity of the shape of the body (particle) in the entire speed range (excluding relativistic collapse with reaching the speed of light). This is possible only when the quantised space-time possesses colossal elasticity.

Figure 10.22 shows the schematic of a simple instrument (front view and side view of the rotor of the instrument) which clearly demonstrates the presence of the elastic properties and structure in the quantised space-time. Instrument includes: rotor 1, electric motor 2 with shafts 3 and 4, flywheels 5 and 6, framework 7, transverse axis 8, longitudinal axis 9, electric motor (with the reducer) 10, crank gear 11, springs 12, base 13.

Rotor 1 consists of electric motor 2 with two shafts 3 and 4 protruding from the sides which carry flywheels 5 and 6. Rotor 1 is installed inside framework 7 on the transverse rotational axis 8 with the possibility of free running with frequency ù inside the framework in any direction. Rotational axis 8 carries the collector ring (not shown on the drawing) for powering electric motor 2. Framework itself 7 has the longitudinal rotational axis 9, perpendicular to transverse axis 8. Framework 7 is fitted with an oscillatory drive powered by the electric motor (with the reducer) 10 through crank gear 11, which ensures fluctuations of framework 7 (with the rotor 1) through angle á on longitudinal axis 9. Springs 12 are used for the softening of the fluctuations of framework 7. The instrument is established on base 13.

In the instrument designed by the author the diameter of steel flywheels

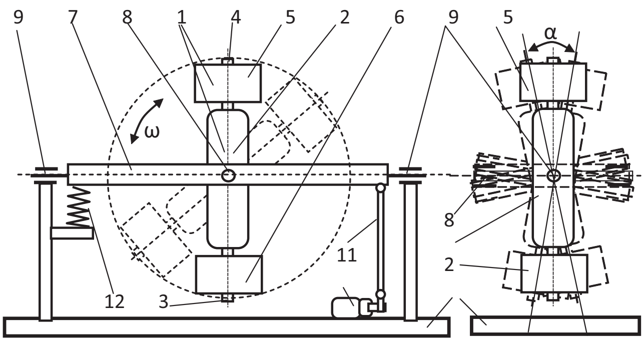


Fig. 10.22. A simple device for investigating the properties of quantised space-time. The device includes: rotor 1, electric motor 2 with shafts 3 and 4, flywheels 5 and 6, frame 7, transverse axis 8, longitudinal axis 9, electric drive (with reducing gear) 10, crank gear 11, springs 12, base 13.

5 and 6 was 100 mm. the mass of one flywheel approximately 3 kg. Flywheels 5 and 6 were enclosed in the housing (not shown on the drawing). Electric motor 2 ensures the frequency of the rotation of the flywheels of 3000…5000 rpm. It is more efficient to use a long collector DC motor with the powder of the order of 100 W with the output of long shafts 3 and 4 to different sides or to replace the short shaft in the engine by a long one. The rotor is 300…500 mm long. The oscillatory drive of framework 7 with rotor 1 is represented by the electric motor 10 (with the reducer) from a car windshield wiper with a frequency of vibrations of the crank gear 11 of 1…2 Hz. Angle α of the oscillattions of framework 7 is set at 10…15°.

The instrument shown in Fig. 10.22 operates as follows. The electric motors 2 and 10 are activated at the same time. The flywheels 5 and 6 accelerate to the frequency of rotation of 3000…5000 rpm. The frequency of the oscillations of framework 7 with rotor 1 it is set at 1…2 Hz. For the instrument to be activated it is necessary to push slightly rotor 1 by hand on the rotational axis 8 to any direction of rotation. Therefore, for safety reasons the rotors are protected by the housing. The process of retraction of rotor 1 to the regime of the autosynchronization of rotation then begins. In the steady-state regime, rotor 1 stably revolves with a frequency 1...2 Hz (60…120 rpm) in the autosynchronization regime. The autosynchronization regime of the rotation of rotor 1 is accompanied by characteristic sound (rumble) and the elastic straining of the entire structure of the instrument.

As is evident, rotor 1 does not have any drive with the axis 8 on which it spontaneously revolves. In the context of classical mechanics a stator is required for rotating the rotor, i.e., an additional device (stator) must be installed for repulsion of the rotor when the torque of the rotor is generated. However, the stator as the element of construction is absent and the rotor revolves without the stator. All after, the stator in this instrument is the quantised space-time from which the rotor 1 is repulsed thus ensuring its rotation.

This instrument is the converter of the reciprocating oscillationg of framework 7 to the rotary motion of rotor 1. In mechanics, the conversion of reciprocating motion to rotary motion is provided by the crank gear similar to mechanism 11. But this mechanism is also absent framework 7 and rotor 1. The role of the crank gear is played by the elastic quantised space-time which is the carrier of energy and also a converter of energy to different forms of motion, in this case, oscillating motion to the rotary motion of the rotor.

It may be suggested to discuss that the gyroscopic effects and Coriolis forces work in this instrument. However, these forces are altogether only the consequence of the inertial forces. The nature of the inertial forces, like gravity, is directly connected with the elastic properties of quantised space-time. This is examined in detail in the theory of Superunification. By the way, the direction of the vector of the force acting on the revolving flywheel 5 (or 6) in the instrument coincides with the direction of the force in the Magnus effect which acts on the revolving body in a gas or a liquid. This crude analogy makes it possible to accurately determine the direction of the force and the direction of the torque of rotor 1.

It is natural that to prove the elastic properties of quantised space-time it is necessary to use the inexpensive and simple instrument show in Fig. 10.22. However, this instrument can also be used for fundamental research if it is fitted with contemporary measuring devices. Then the significance of such studies for the fundamental science will be similar to studies on the Large Hadron Collider (LHC) at CERN.

First of all, the instrument shown in Fig. 10.22 should be used to verify:

1. The energy balance in the conversion of different types of motions. It is justified to assume that the energy balance will be not observed since part of the energy will be scattered by gravitational radiation. This is so because the conversion of motion is connected with the stresses of quantised space-time through the inertial forces. These stresses are variable and have no explicit electromagnetic nature. These can be longitudinal stresses of quantised space-time characteristic of gravitational perturbation.

2. The instrument can be used as a gravitational antenna controlling the changes in the quantum density of the medium (change in the concentration of quantons) of the quantised space-time. It has been assumed that the quantum density of the medium in the cosmic space-time has a certain

heterogeneity and shows some specific cyclic recurrence during the motion of the Earth. It is necessary to maximally stabilize the conditions for the work of the instrument and to control only the change in the frequency of the rotation of rotor 1 or its period. Using digital computer technology, this can be carried out with very high accuracy. Then changes (fluctuations) of rotation of the rotor 1 will testify the heterogeneity of the quantised space-time. Possibly, this heterogeneity has consequences in the health of people and is connected for with specific cataclysms (earthquake, tsunami and others) on the Earth, if anomalous zone falls in the path of motion of the Earth. Such cataclysms can be predicted by the instrument. It is also necessary to compare the readings of the instrument with the cyclic recurrence of solar activity, which, possibly, is also connected with the heterogeneity of the quantised space-time.

3. The use of other materials instead of the steel flywheels is an interesting possibility. These materials can included ferrodielectrics with the superposition of external electrical and magnetic fields, flywheels from rare-earth magnets or electrets. This is important for the study of the influence of electromagnetism on the nature of inertia and gravity.

This large volume of fundamental research can be carried out within the framework international collaboration of scientists with government financing. For the university laboratories we propose to order from us the simple instrument shown in Fig. 10.22. It is surprising that the effect of the autosynchronization of rotation, forecast by the theory of Superunification, was not previously known, in spite of simplicity of the instrument for realising this effect. This instrument and the results of experimental studies obtained on it are more informative in comparison with the classical experiments of Michaelson and Morley.

10.9.3. What will the launching of the Large Hadron Collider at CERN yield?

It is necessary to provide explanation of the previous statement that the significance of studies on this instrument (Fig. 10.22) for fundamental science will be not lower that that of LHC experiments. An article of the author dealing with this question was published on the Internet on July 10, 2008.

Apocalypse is abolished

In the very near future when this book is published, the world scientific community will be able to become acquainted with the most powerful analytical apparatus for study of matter, including the of physics of elementary particles and the atomic nucleus. The structure of the main elementary particles is practically established: electron, positron, electronic neutrino, proton, neutron, photon, and the nature of nuclear forces has been discovered. But, most importantly, the phenomenon of the formation of the mass of the elementary particles as a result of the spherical deformation (bending according to Einstein) of quantised space-time has been discovered. The nature of gravity, whose control becomes reality, has been established.

Against the background of the latest fundamental discoveries there have been some really stupid public statements regarding the launch of the LHC at CERN. There will be no end of the world, no apocalypse, no black holes, and no magnetic monopoles, Higgs particle or time tunnels will not be discovered. This is predicted by the theory of Superunification on the basis of strict mathematical calculations of energy processes inside the quantised space-time. The tests of the collider only confirm the assumptions of the theory of Superunification.

On the road to superforce and to Superunification

Let us recall that the hadrons include the nucleons (protons and neutrons) which form the basis of nuclear material, determining the region of strong interactions for the nuclear forces. It was considered that the strong interactions represent the maximum concentration of forces which can exist in nature inside the atomic nucleus between the nucleons in the form of special nuclear material. In this case the nature of nuclear forces remained unexplained as the reason for the formation of the mass of elementary particles. But the mass defect in particular is the basis of energy release in nuclear and thermonuclear reactions which appear to be not connected directly with the nuclear forces. The expensive experiments conducted over several decades on ever more powerful accelerators shed no light on these fundamental problems and their discrepancies. The structure of elementary particles also remained obscure.

It is necessary to note that the physical science is developed cyclically from experiment totheory, and vice versa. When experiments do not give the desired result in spite of enormous effort it is necessary to hope that theory will help. The theory of the Superunification of fundamental interactions became this theory: electromagnetism, gravity, nuclear and electroweak forces.

There is a legend that allegedly the theory of the unification of interactions in the form of the theory of the unified field was created by the genius of Einstein during the Second World War but, fearing the fate of humanity which was not prepared for the perception of colossal knowledge, the great physicist destroyed the manuscript. In reality, the unification of space and time in the united continuum and the creation of the concept of the unified field on the road to integrating electromagnetism and gravity is the main achievement of Einstein. He fanatically believed in the realia of the unified field which unites everything and for almost 30 years worked intensively on this problem without any result. However, the analytical apparatus of the general theory of relativity for was clearly not sufficient for this. In his last posthumous article Einstein indicated that it is necessary to search for new approaches to the problem. But what approach to the solution should be used?

It follows from the logic of things: in order to combine the nuclear forces (strong interactons) with the remaining three forces (electromagnetism, gravity, electroweak interaction), is necessary to have the fifth force or more precisely the superforce in the form of superstrong electromagnetic interaction (SEI), the carrier of which, as is shown in the theory of Superunification, is the quantised space-time and the very space-time quantum (quanton) unknown earlier to science. Only the superforce is capable of subordinating the remaining forces - this is the golden rule of physics. The searches for the fifth force were conducted without result throughout the entire 20th century. Some physicists believed that they search for something very weak constantly slipping away from the researcher. However, the outstanding English theoretical physicist Paul Davies, considering only the physical logic, formulated the concept of superforce which found its confirmation in the theory of Superunification (Davies P., Superforce, New York, 1985) [17].

Quarks, quantons, magnetic monopoles, nucleons

At the beginning of the 21st century everything in theoretical physics was so tangled that it was quite difficult to unwind the complex tangle of different hypotheses and complex mathematical searches. However, physics is experimental science and the fundamental theory must not only explain the known physical phenomena but also predict new ones. Unfortunately, the nature of electromagnetism, gravity and nuclear forces could not be explained by the standard model. However, quarks, magnetic charges (Dirac's monopoles), fundamental length, black holes, time phenomena of time, were predicted and the fundamental laws of relativity and wave-particle duality and the unity of space-time were formulated even earlier. Thus, it would seem that separate knowledge and also the concepts of the unified field and the superforce formed the basis of the theory of Superunification.

It should be noted that the theory of Superunification does not abolish any of the fundamental physical laws and, on the contrary, explains their nature. At the same time, the theory of Superunification is based on 'shoulders of the giants of physical thinking' and, first of all, on the Einstein's concept of the unified field (primary matter) based on only four quarks (two electrical and two magnetic quarks with opposite polarities) in the composition of the space-time quantum (quanton).

The quarks were introduced in theoretical physics in 1974 already after Einstein's death (1955) and they formed the basis of quantum chromodynamics (QCD) created to explain the nature of nuclear material. As a whole, the right direction was based on the false concept of fractional electric charges relative to the whole (elementary) electron charge. However, it has not as yet been possible to experimentally detect directly fractional charges but allegedly their indirect manifestation can be explained on the basis of other positions. For this reason, QCD has encountered many problems which were successfully solved in the theory of Superunification in return to the whole electrical quarks of the opposite polarity in the structure of the alternating nucleon shell.

Calculations show that the alternating proton shell includes 69 electrical quarks, of them 34 quarks of negative polarity and 35 quarks of positive polarity. The presence of one uncompensated quark of positive polarity determines the value of the positive charge of the proton. The neutron shell contains 70 quarks of equally negative and positive polarity, ensuring as a whole the electrical neutrality of the particle when moving away from it. The binding energy of the quarks in the shell of nucleons in the rest state is estimated by the value of the order of 1 GeV (gigaelectron-volt). The shell model of the nucleons completely corresponds to experimental observations which also explain the electrical nature of nuclear forces as the short-range forces of the electrostatic attraction of alternating shells [6].

However, the discovery of the quark alternating shell of nucleons without considering the structure of the quantised space-time was insufficient for the complete description of the structure and mass of the nucleons. However, if the shell of the nucleons includes only electrical quarks of different polarity, then the space-time quantum (quanton) includes, in addition to the two electrical quarks of different polarity, also two magnetic quarks (Dirac's monopoles) of different polarity, uniting electricity and magnetism into the united substance – electromagnetism.

That the quanton is the carrier of electromagnetism or more precisely the carrier of superstrong electromagnetic interaction (SEI) is logically completed by the formation of the structure of the quantised space-time whose quantisation is reduced to the filling of its volume with quantons. This is initial weightless primary matter – its field form. We live in the electromagnetic universe.

Is the experiment on the hadron collider capable of destroying the quantised space-time causing apocalypse? Calculations show that no. Let us present some data. According to the theory of Superunification the diameter of the quanton is of the order of 10^{-25} m. This the fundamental length which determines the discreteness of space-time. With such small distances the binding energy of quarks inside the quanton is approximatey 10^{7} GeV, and in the volume of the nucleon 10^{39} GeV. The maximum energy of the proton in the collider is 14 TeV (terraelectronvolt) or $1{,}4 \cdot 10^{4}$ GeV. The orders of magnitude of 10^{39} GeV and $1.4 \cdot 10^{4}$ GeV can not be compared. **The energy acquired by the proton in the collider is negligibly small to be able to destroy quantised space-time**. This is equivalent to the effect of a speck falling on the back of an elephant who will feel nothing. Apocalypse has been abolished.

On the other side, magnetic quarks (Dirac's monopoles) are connected inside the quanton and in accordance with the theory Superunification cannot be found in the free state. The surplus of free electrical charges - quarks is determined by the electrical asymmetry of quantised space-time. The magnetic monopoles can be freed only by destroying the quanton with the destruction of the quantised space-time. But, as shown, this cannot be carried out in the collider. **Magnetic monopoles cannot be produced by experiments.**

The phenomenon of the proton mass and its possible decay

Only the presence of the quantised space-time makes it possible to explain the phenomenon of the formation of mass in elementary particles and the nature of gravity. This can be shown based on the example of the formation of the nucleon mass when the alternating shell spherically compresses the quantised space-time inside the shell, extending it on the outerside. The gravitational field of the particle is thus formed. The elastic energy of the spherical deformation (bending according to Einstein) of the quantised space-time serves as the equivalent of mass expressed in other measurement units. It turns out that mass is manifested altogether only as a secondary formation inside the quantised space-time, being its indissoluble part. In this case, the mass transfer of the particle is the wave transfer of the spherical deformation of the quantised space-time which explains the fundamentality of the principle of the wave-particle duality when the particle simultaneously manifests its wave and corpuscular properties. This is the nature of wave mechanics.

Thus, the nature of formation of mass by the particles is connected with the spherical deformation of the quantised space-time and the hypothetical Higgs particles, allegedly responsible for the formation of mass, are of no significance here. **Higgs's particles cannot be discovered in the experiment in the collider since they simply do not exist in nature.**

Can protons be destructed in the collider or, more precisely, their alternating shells in counter collisions at energies of 14 TeV? This question remains open. QCD predicts the destruction of the proton and the formation of quark-gluon plasma at energies of 200 GeV. But this has not taken place. Energies 70 times greater have been generated. What does the theory of Superunification predicts in this case?

The effect of a relativistic increase of the mass which is explained by the capture of the quantons inside the alternating nucleon shell from the exterior of space, has been confirmed by experiments. In this case the alternating nucleon shell preserves its spherical identity and diameter because of colossal tension. This is equivalent to an increase in the energy of spherical deformation, and respectively, the mass of the particle. It is experimentally established that no destruction of the proton is observed in the region of the relativistic speeds close ones to the speed of light. This is possible only when an increase in the speed automatically increases the binding energy of quarks inside the nucleon shell. This effect can be explained by a change in the electromagnetic (electrical and magnetic permeability) properties of the quantised space-time during its deformation which leads an increase of the binding energy quarks in the shell.

What does take place during head-on collision of protons? Where will the freed energy go? Will the effect of the automatic preventing of the decay of the proton shell still operate or it will the shell decompose into free quarks? Will the quarks lead to the generation of a cluster of other particles inside the quantised space-time? This must be answered by experiments. But, as already mentioned, the disintegration of even the proton accelerated in the collider proton is by its energy is negligibly small in comparison with the concentration of energy of the quantised space-time and cannot lead to any apocalypse. Such processes constantly occur in cosmos which is a natural accelerator. This can now be investigated in the terrestrial conditions.

The proton black microhole

Theoretically, on reaching the speed of light the proton must pass into the relativistic black microhole. This is predicted by the theory of Superunification which yields a formula for calculating the maximum energy of relativistic particles in accordance with which the proton energy must be of the order of 10^{36} TeV. The collider is capable of accelerating the proton to the energy of only 14 TeV. **No proton black microhole can form.**

Big Bang

The deeper the researcher penetrates into the depth of material, the higher the energy concentration which must be taken into. It would seem that science penetrated into the region of nuclear forces at distances of the order of 10^{-15} m and encountered the colossal concentration of energy. Now science has penetrated iono the region of quantons at distances of 10^{-25} m and detected the monstrous concentration of energy which is evaluated by the gigantic value of the order of 10^{73} J/m^3. If we activate only one cubic meter of the quantised space-time, then the freed energy is sufficient for generating one additional material universe as a result of a Bing Bang large from the singular state. Now the Big Bang hypothesis is substantiated from the viewpoint of energy substantiation but is it this only a hypothesis.

To our satisfaction, the LHC is not a wick the capable of setting fire to our universe and of producing a Bing Bang. **Its energy is insufficient for us even to glance to glance at the initial moment of formation of the universe.** Simply, in nature there are no energies capable of activating the quantised space-time, after freeing completely the stored energy. The quantised space-time is the most stable substance in nature. **No Bing Bang will take place.**

Time phenomenon

The quantion is simultaneously not only the carrier of electromagnetism and gravity but also a cavity electromagnetic resonator defining the lapse of time at each point of the quantised space-time. The effect of gravity resuls in expansion of space, and the lapse of time and also all processes slows down, whereas in the case of compression they are accelerated. Therefore, the theory of Superunification considers the quantised space-time as a certain scalar chronal field. The gradient of this field as a vector quantity indicates only the direction of the most rapid change in the lapse of time but has no relationship with the arrow of time and time cannot be turned back. Inside the quantised space-time it is necessary to deal with a very large number of quantons and other particles. Therefore, in practice all processes can be considered as irreversible as ‘we cannot enter the same river twice’. We can discuss phenomena cyclically repeated in time.

What will happen to the lapse of time when the proton is accelerated? The quantised space-time will be pressed inside its alternating shell and the lapse of time will be accelerated, and on the outside the situation will be reveresed - the lapse of time will slow down. In this context, the collider presents a machine for change the lapse of time in a very localised region of space, limited by the dimensions and gravitational field of the proton. But this the time machine for time travel. Similarly, we cannot consider the formation of time tunnels for transfer in time. The time machine is only fantasy.

General conclusions

The beginning of the building of the LHC practically coincided with the beginning of my work on the theory of Superunification which was completed at the time of launch of the LHC. Apparently, this is not simple coincidence. The theory of Superunification radically changes our view of the world. First of all, this concerns the quantised space-time, which is the carrier of superstrong electromagnetic interaction (SEI). Specifically, the SEI is the superforce which unites electromagnetism, gravity, nuclear and electroweak forces.

But the main thing is that at the time of launch of the collider, the theory of Superunification yielded clear scientific forecasts which remove many myths which formed around these studies:

– Apocalypse will not take place. The energy, achieved by the proton in the collider is negligibly small in order to destroy the quantised space-time.

– The energy of the collider it is extremely insufficient for glanceing at the initial moment of formation of the universe.

– Higgs's particles cannot be discovered in the experiment in the collider since they simply do not exist in nature.

– Magnetic monopoles cannot be produced in the experiment.

– The proton black microhole cannot be produced.

– No Bing Bang will take place.

– Time tunnels for time travel cannot be formed.

Furthermore, studies on the LHC will not discover the structure of any elementary particle or the nature of nuclear material and gravity. All this is done in the theory of Superunification.

It would seem that in spite of the colossal expenditure for construction, the effectiveness of the collider is extremely small in comparison with the effectiveness of the theory of Superunification. But this not entirely so. Studies on the collider must confirm the basic assumptions of the theory of Superunification. Only the unification of theory and experiment brings our knowledge closer to the real picture of universe. We shall impatiently wait for the launch of the collider. The question: 'Can the alternating shell of the proton survive or will it break down into a large number of particles in collision with the counter proton?', can only be answered by experiments. This result is very important to theorists for the further development of the theory of Superunification and the theory of nucleons.

10.9.4. Priority of Usherenko (1974) in the region of cold synthesis

Cold synthesis (cold fusion) has been a tempting hypothesis for a long time but is difficult to verify by experiments. It is necessary to note that no acceptable theory of cold synthesis (CS) nor of controlled thermonuclear fusion (CTF) exists. The possibility of creating such a theory now exists using the theory of Superunification.

The traditional problem of CF and CTF is reduced to the solution of the problem of overcoming the electrostatic repulsion of the positively charged nuclei of light elements during their confluence into heavier nuclei with the release of excess energy as a result of the mass defect of the new nuclei. The level of the existing knowledge within the framework of the standard model makes it possible to propose only one solution of the problem of CTF - this is a temperature thermal hypothesis. The solution of the problem is reduced to the external thermal effect on the light nuclei when heating plasma in a magnetic trap. This solution was obtained from the positive results of the H-bomb tests. However, it is not possible to transfer all conditions of the synthesis reactions in the explosion of an H-bomb to the laboratory conditions in Tokamak-type installations. The reaction of controlled thermonuclear fusion has not been started in the laboratory despite the fact that temperatures exceeding the temperatures of thermonuclear explosion have been reached.The temperature hypothesis does not work when starting the CTF reaction.

The question: 'Why the temperature hypothesis of CTF does not work?' is answered by the theory of Superunification. It was necessary to develop a method for calculating the forces acting on the atomic nucleus during emission (or re-emission) of the photon. Calculations show that the forces of the thermal oscillations of atoms with the emission (re-emission) of the photon are in principle insufficient for overcoming the electrostatic repulsion of the nuclei. It will never be possible to start the CTF reaction in Tokamaks only by external heating of plasma. New ideas are necessary.

Supporters of controlled thermonuclear fusion, in spite of their own failures, critised extensively the possibility of realization of the cold synthesis reaction, although there is no fundamental difference between CF and CTF on the microlevel. Therefore, when Prof. Martin Fleischmann and Prof. Stanley Pons reported in 1989 in the USA on the discovery by them of the reactions of cold nuclear fusion in the laboratory, the report was received with distrust by the scientific community. Moreover, it was impossible to repeat their experiences in other laboratories. But the idea was tempting and new followers appeared. In 1995 at the International conference on nuclear reactors in the USA the Russian physicist Robert Nigmatulin presented a plenary report ‘On the prospects for the bubble thermonuclear reaction’, together with the American professor Richard Lahey [18]. This fact can be considered critical both in the theory of CTF and CF. The temperature inside a cavitation bubble during its collapse rises to millions of degrees with a simultaneous increase in the pressure, and the front of propagation of pressure is capable of generating forces, sufficient for overcoming the electrostatic repulsion of nuclei. The collapse of the cavitation bubble is the analog of the controlled microhydrogen bomb when the effect of high temperature is accompanied by high pressures and accelerations, as in a large H-bomb.

Already in 2002, R. Nigmatulin together with R. Lahey, R. Taleyarkhan and other scientists, published an article in the journal Science about the preliminary results of experimental studies on the starting of the thermonuclear fusion reaction inside ‘heavy’ acetone under laboratory conditions in the cavitation regime [19]. In spite of some distrust, the results of experiments were repeated in independent laboratories.

However, as early as in 1974 the Belorussian scientist Sergey Usherenko discovered the effect of the ultradeep penetration (UDP) of particle-strikers of micron sizes in solid targets with the release of colossal energy in the channel of the target. The particles 10…100 microns in size, accelerated to a speed on the order of 1 km/s, pierced right through a steel target with a thickness of 200 mm, leaving a molten channel. Even according to approximate calculations the energy required for melting the channel is 100...10000 times greater than the kinetic energy of the particle-striker. This cannot be achieved by chemical reactions. Where does the additional energy in the Usherenko effect come from? It is obvious, that this additional energy can be generated only by the high-energy processes characteristic of nuclear physics and elementary particles [7].

Analyzing the Usherenko effect on the basis of the theory of Superunification, and repeating its experiments, it was established that the collapse of the melted channel in the ultradeep penetration regime in the Usherenko effect resembles the collapse of the cavitation bubble in the liquid. However, the steel target and the particles-strikers contained no light element atoms. Nuclear fusion of heavier elements or their splitting in the superdeep penetration regime with the generation of excess energy was not regarded as basic, in spite of the exposure of x-ray film next to the target. Since suitable equipment was not available, no neutrons were registered.

In spite of a shortage of primary information, and taking into account only the new knowledge in the theory of Superunification, a hypothesis was proposed according to which the basic source of energy release the

Usherenko effect is not nuclear fusion or splitting but the synthesis of elementary particles and antiparticles from the quantised space-time. For power engineering these are the most favourable power cycles since the use of antiparticles in interaction with the particles as the fuel is ensured by the reactions with no radioactive waste. Figure 10.1 shows the dependence of an increase in the efficiency of the power cycle on the energy yield of fuel. Maximum efficiency is obtained from the use of the reaction of antiparticles and particles.

The energy problem in the application of particles and antiparticles is not so much connected with the processes of their synthesis from the quantised space-time as with the guarantee of the output of excess energy. Excess energy cannot be produced under the external influence of gamma-quanta in the synthesis of electron-positron pairs. The expenditure on the creation of a power cycle does not exceed the energy generated as a result of annihilation. For this reason, in spite of the prospect for using antimatter as fuel, the realization of such cycles with the positive energy yield, when examined purely hypothetically, has no foundation for realisation in practice.

The discovery of superstrong electromagnetic interaction (SEI) created suitable conditions for using the internal energy of the SEI for the synthesis from the quantised space-time of the electron-positron plasma as a promising energy source. The clusters of electron-positron plasma can form only in interaction with matter when the spherical shell of the cluster is balanced by the pressure of matter inside the shell. Electron-positron plasma cannot form in vacuum. The alternating shells of nucleons, which include the electrical whole quarks of different polarity, form in vacuum.

Some preliminary results of the experimental investigations of the clusters of electron-positron plasma are of definite interest even now despite the fact that these studies have not yet been finished. It was necessary to verify that clusters of electron–positron plasma form the superdeep penetration regime as a result of the deformation of the quantised space-time at the moment of the impact of the flow of particles-strikers on the solid target. Colossal accelerations and forces which excite the waves of elastic deformation inside the target in the direction of the impact of the flow of particles-strikers appear at the moment of impact, causing numerous lattice vibrations of the material of the steel target.

In our experiments we detected different types of fluctuations in the target in the superdeep penetration regime with the aid of electromagnetic sensors of solenoid and toroidal types, at ultrasound or higher frequencies. A target was placed inside the solenoid or toroid with a winding. Resonance phenomena are possible if we consider the channel of the target and the target itself as elements of a cavity resonator for elastic deformation waves.

In accordance with the theory of Superunification, the set of many physical deformation and wave factors at the moment of impact of particles-strikers with the target leads to the release of energy of superstrong electromagnetic interaction and subsequent shaping of the clusters of electron-positron plasma which burns the channel in the target, releasing the energy of superstrong electromagnetic interaction.

The experimental detection of the spherical tracks of the clusters of electron-positron plasma was of special interest. Originally strange numerous spherical points with a diameter of the order of 1 mm were discovered on the x-ray film, placed next to the target. However, numerous spherical tracks with a diameter of the order of 1 mm were subsequently discovered also on the sections of a steel target after the effect on the target of the accelerated particles-strikers with the diameter of 100 mm and more. A change of the structure of the target material in the region of the spherical track is distinctly evident under the microscope. The shell of the sphere appears brighter and its internal content is dark. There is every reason to believe that the discovered spherical tracks are the tracks of the clusters of the electron-positron plasma, forecast originally by the theory of Superunification. No other explanation is available at the moment.

It should be noted that the Usherenko effect discovered as early as in 1974, has been insufficiently the object of fundamental physics. The researchers lack the continuous particle accelerators of the micron size to speeds on the order of 1 km/s. It was necessary for us to construct such an accelerator. Certainly, there is still a very large amount of work to carry out from the first encouraging results for the release of energy in the Usherenko effect to real reactors (Fig. 10.2). This also concerns the cavitation effect when a long road must be travelled from the first positive results to their practical realisation. It is important that the new effects of the release of energy have been discovered experimentally, whereas in the Tokamak-type installations the CTF reaction has not as yet been started. Our task is to draw the attention of the world scientific community to the new power cycles and to investment in projects in the area of new energy technologies.

The results of experimental studies and tests of new energy apparatuses will be described in greater detail in the second volume of this book. It is important that a source of global energy in the form of the earlier unknown superstrong electromagnetic interaction (SEI), the carrier of which is the quantised space-time, has been discovered. Mastering of the new power cycles is the priority task of our civilization in solving the problems of the power supply of humanity.

10.9.4. Leonov's forecast for 100 years

Now follows the statements by Vladimir Leonov in the interview with the Russian newspaper 'Power engineering and the industry of Russia', 2009, No. 7, April:

– What is your forecast for the development of quantum power engineering for the next, let us say, 100 years?

– I am not a prophet of the Nostradamus type, and if I make the forecast of the development of science and technologies, then I am guided in this case by the fundamentally new knowledge which the theory of Superunification provides. It is natural that the transition to quantum power engineering will not occur immediately and decades will be required before we introduce the new technologies and the branches of management throughout the entire world. Let us define two large directions: quantum reactors -[heat generators] and quantum engines. Nuclear reactors also belong in the group of quantum reactors -[heat generators].

Quantum engines are the fundamentally new devices, intended for carrying out mechanical work due to the creation of thrust without the ejection of reactive mass. I would like to mention that the level of the technologies at the beginning and the end of the 20th century cannot be compared. To attempt to look 100 years into future is possible relying only on the prospects for the development of quantum power engineering: power engineering will be completely decentralized over hundreds years. Many autonomous quantum energy sources with satisfy all needs for the supply of heat and electrical energy. Evidently, the sphere of sale of heat and electric power will disappear and will be replaced by business dealing with the production of energy sources, their operation and repair and also with the delivery of fuel, for example the sand prepared for cold synthesis reactors utilising the Usherenko effect and also catalysis preparations for cavitation reactors.

Quantum engines will prevail in the field of transportation. Possibly, the classic automobile on the wheels will disappear (analogous example with the locomotive) and a gravitational 'cushion' will replace them. There will no longer be any need for arterial roads which will benefit Russia with its huge territory. 'The flying saucer' will become the main universal transport means. The Moon will be colonised and inteplanetary flights will become regular.

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Conclusion on volume 1

“Quantum Energetics. Theory of Superunification”

The development of civilization determines fundamental scientific discoveries. The discovery of the quantum of space-time (quanton) and of the superstrong electromagnetic interaction has been used as the basis for the development of the theory of Superunification of fundamental interactions: electromagnetism, gravity, nuclear and electroweak forces. The theory of Super-integration is a scientific fact.

The theory of Superunification shows that the superstrong electromagnetic interaction (SEI) is the sole energy source in the universe. It has been established that the quantised space-time, which possesses the colossal energy content, serves as the carrier of superstrong electromagnetic interaction. We live in the electromagnetic universe. All known forms of energy, including chemical, nuclear, gravitational, electromagnetic, etc, are only methods of extraction or conversion of united energy of SEI.

The electromagnetic nature of gravity and antigravity and the electrical nature of nuclear forces have been confirmed. The structure of the basic elementary particles has been revealed: electron, positron, proton, neutron, electronic neutrino and photon. The elementary particles proved to be not only elementary and they have a complex structure being the indissoluble and component part of the quantised space-time.

New fundamental discoveries have high applied value. The theory of Superunification opens the page of physics of open quantum-mechanical systems forming the basis of quantum energetics. The ability of quantum energetics to extract the energy of superstrong electromagnetic interaction through the new power cycles determines the development of power engineering, transport and communications in the 21st century. The construction of quantum engines, heat-generators and reactors is discussed in the book. The successful tests of a quantum engine generating thrust without the ejection of reactive mass have been carried out (Leonov effect). A thrust of 500 N with the mass of the apparatus with the chassis being 50 kg was produced. New results have been obtained in the studies of the Usherenko effect, with the generation of excess energy as a result of cold synthesis. Preliminary experiments have been conducted with the generation of a longitudinal gravity wave in the quantised space-time. New energy and space technologies are examined in detail in the second volume of Quantum energetics: New energy and space technologies.

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Blog "Quantum Energetics" by Vladimir Leonov
http://theoryofsuperunification-leonov.blogspot.ru/

Russia successfully tested antigravity engine by Leonov
16.01.2015, Alexander Petrov, KM.RU, Moscow, Russia
Interview with Vladimir Leonov
http://theoryofsuperunification-leonov.blogspot.ru/2015/01/russia-successfully-tested-antigravity.html
Russian:
http://www.km.ru/science-tech/2015/01/16/nauka-i-tekhnologii/753573-rossiya-uspeshno-ispytala-antigravitatsionnyi-dvi

Russia has no other way of development, as a way of scientific and technical progress, said Vladimir Leonov

In an interview with a Russian scientist, winner of the award of the Russian Government Vladimir Leonov, we reported on the establishment to them of fundamental the theory of Superunification (http://www.km.ru/science-tech/2012/08/14/nauchnye-issledovaniya-i-otkrytiya-v-mire/russkii-uchenyi-vladimir-leonov-op) that gives of the fundamental science Russian world leadership (http://www.atomic-energy.ru/papers/42752).
Theory of Superunification:
http://leonov-leonovstheories.blogspot.ru/
https://www.blogger.com/profile/03427189015718990157

Then the scientist shared with us the results of tests of quantum engine in 2009 with a horizontal thrust with a force 50 kg (500 N) in the pulse. It took more than five years, and we asked of Leonov current state of affairs:

- Vladimir, on the blog you have placed video testing of an apparatus with a quantum engine inside in 2009 (Results of the tests of a quantum engine for generating thrust without the ejection of reactive mass http://theoryofsuperunification-leonov.blogspot.ru/2011/05/results-of-tests-of-quantum-engine-for.html). Drive wheel absent nevertheless apparatus moves horizontally due to internal forces. Opponents argue that the whole point in friction in bearings of a wheels. It will not work in zero gravity.

- To remove the existing skepticism, I have made over the years the quantum engine with vertical take-off to remove the "factor of bearings." In June 2014 were successfully held its bench tests. At weight of apparatus in the 54 kg the impulse of the vertical thrust was 500 ... 700 kg (5000…7000 N) for electric power consumption 1 kW. The apparatus flies up vertically along the guide rails with acceleration in the 10 ... 12 G (10…12 m / s^2). These tests prove conclusively that gravity is neutralized experimentally confirming the theory of Superunification.

- You can give the comparative characteristics of modern quantum engine and a rocket engine?

- Based on the bench test such characteristics are obtained. For comparison, a modern jet engine (hereinafter - J.E.) on 1 kW of power creates a thrust in 1 N (Newton). Prototype quantum engine (Q.E.) of the sample in 2014 to 1 kW of power creates a thrust in 5000 N in pulse.

Of course in a continuous mode the traction characteristics Q.E. per unit of power are reduced. However, in a pulsed mode Q.E. now 5,000 times more efficient J.E This is because the Q.E. unlike J.E combustion products fuel does not heat the atmosphere and space. Q.E. uses electrical energy.

- But this is a revolution in engine. And how will this affect the development of the space industry?

- Today, jet engines (J.E.) spacecraft reached its technical limits. For 50 years the pulse of their work time increased from 220 seconds (V-2) only a 2 times to 450 seconds (Proton). Impulse operation of quantum engine is not hundreds of seconds, but for many years. Rocket with J.E. weighing 100 tons, at best, is 5 tons (5%) of payload.

The device with the quantum engine of 100 tons will have a quantum engine and reactor weighing 10 tons, a payload of 90 tons; it is 900% versus 5% in J.E.

- And what will be the speed characteristics of interplanetary spacecraft new generation?

- *The maximum velocity of the spacecraft with the quantum engine can reach 1000 km / s compared to 18 km / s at the rocket. But most importantly, the spacecraft with a Q.E. have a great pulse thrust and it can move with constant acceleration. For example, a flight to Mars in a spaceship of new generation with a quantum engine in the constant acceleration of ± 1G (9.8 m / s^2) up it will take time of 42 hours and with full compensation weightlessness. Flying to the Moon will require time 3.6 hours. A new era has come in space technology.*

- What an energy source you plan to apply for power supply quantum engine?

- *The most promising energy source is a reactor cold fusion (CF), for example, according to the scheme of the Italian engineer Andrea Rossi, working on nickel. Nuclear cycle has energy-conversion efficiency of the fuel a million times higher than that of chemical fuel. So, 1 kg of nickel in the nuclear cycle releases energy as 1 million kg of gasoline.*

But Russia has its own experience in the field of cold fusion. I wrote about this in the article "The Commission on pseudoscience and cold fusion raw bury Russia's economy" http://newsland.com/news/detail/id/884606/. Today, we are reaping the fruits of this in the form of falling prices for hydrocarbon energy.
Read: "Russia is going to choke cold fusion" http://vpk.name/forum/s187.html.
http://leonov-quantumenergeticscoldfusion.blogspot.ru/2011/12/theory-of-superunification-examines.html

- Cold Fusion – this is a separate big topic, and returning to the quantum engine, I would like to know about its application in aviation.

- Creation of a universal motor, which could also work in space, in the atmosphere, on land and under water is a top priority of fundamental science.

Meets this requirement only one engine it is the quantum engine. For example, a passenger aircraft with turbojet engine at flight altitude of 10 ... 12 km have a flow rate of fuel to overcome the air resistance. He does not fly above. Installation of the quantum engine on aircraft will allow it flying at heights of 50 ... 100 km. There is the air resistance is reduced by orders of magnitude, and thus is reduced the consumption of traditional fuel. The aircraft flies essentially on inertia.

The aircraft can fly for many years without refueling in the transition to the regime the cold fusion. For example, a flight time can be reduced from 10 hours to 1 hour on the flight path Moscow-New-York by increasing the speed.

- Well, it's fantastic. And what will happen with the car?

- Yes, this is not a fantastic. There is a fundamental theory Superunification, which defines the physical foundations of new reactors CF and quantum engine, working on new physical principles.

The present level of development of science technology a hundred years ago would be perceived as a fantasy, when aircraft and car have been in its infancy. And what will happen in a hundred years?

Already setting the quantum engine on the car radically changes him scheme. We have the vehicle body on wheels with a quantum engine and power unit. Transmission is not needed. The quantum engine creates thrust force for a car. Therefore, the wheels have no of sliding. A total of 1 kg of nickel will allow cars equipped with a nuclear reactor to drive 10 million kilometers without refueling. This is the 25 distance to the Moon.

The car will be almost "eternal" – 50 ... 100 years service life. There will be flying cars with antigravity cushion capable of by air across water obstacles.

- You have outlined our idealistic picture of the near future. But who will allow make it? Transnational corporations whose business is based on gasoline and oil will not allow this. And 50% of the budget of Russia before Western sanctions is made at the expense of oil and gas exports.

- This is not so in principle. All that now moves and flies – it's the last century. Believe me, it will take time, and transnational corporations will run a race to develop the production of new vehicles, aircraft and reactors. These are the rules of a successful business, and they are very tough. Who is late for the distribution, he will go bankrupt.

And Russia has no other way of development, as a way of scientific progress. Russian resource-based economy the sale of hydrocarbons was vulnerable to sanctions policy of the West, and it was not a secret. Now for the sanctions we have to thank the West that he awakened Russia. We must have just 2-3 years to modernize and rapidly grow the economy. Deng Xiaoping was 74 years old when he began the modernization of China and its economy was in worse shape. Putin has 62 years old.

- As far as we know, you spent 20 years at work on the theory of Superunification, quantum engine and reactor CF. But it turned out so that the Italian Andrea Rossi launched the first cold fusion reactor. The US and China are also working on the creation of quantum engine. Maybe we going to be late and who in Russia hinder the development of new energy and space technology?

It is ironic, but the main opponent of cold fusion and research in the field of anti-gravity was and remains the management of the Russian Academy of Sciences (RAS), or rather the commission of RAS on pseudo-science, which announced cold fusion and antigravity, like terry pseudoscience.

It is easy to prove that the commission of RAS on pseudoscience was a special project from the outside, when the background of the fight against witches and pseudo-healers in RAS were crushed all groups of scientists and enthusiasts in the field of CF.

Fortunately for us experts in the field CNF did not give up and continued to work in the "underground", at the initiative one of the pioneers of CNF Yuri Bazhutov which organizes annual conferences on cold nuclear transmutation and CF. Now they are prepared by holding the 22nd conference. http://www.unconv-science.org/pdf/6/bazhutov-ru.pdf. As the reactor Rossi, special secrets he does not, and the reactor would have repeated Russian scientist Alexander Parkhomov.
But members of the commission of RAS on pseudoscience have reached to the military to the Russian Federal Space Agency (Roscosmos). Were stopped work on creating an artificial gravity in the Institute of Space Systems (NIIKS), and one of the pioneers of a new direction on engine space Maj.-Gen. Valery Menshikov resigned.

The media has hyped the company to discredit these works. Read: "The resumption of testing gravitsape - a volley of cannon at the Academy of Sciences". http://sibkray.ru/news/3/28217/. As a result, time was lost, and Roscosmos could not participate in the modernization of the quantum engine.

I should add that in the Q.E. there is no violation of Newton's third law. Q.E. creates traction when interacting with a quantized space-time. China and the United States are also working on the creation of quantum engine. But they got a thrust force less 0,01N compared with a thrust of 5000 N at the Russian Q.E. (Read: "New American engine has denied the laws of physics" http://www.rg.ru/2014/08/06/dvigatel-site.html).

- Vladimir, thank you very much for the interesting interview. And what do you say about the Higgs boson?

- As I stated, the Higgs boson and its searches at the LHC - the largest anti-scientific falsification. We were promised that after the discovery of the Higgs boson they will create a new physics

and they will be able to solve the problem of quantum gravity. But they have not decided. Higgs boson does not exist in nature. http://leonov-higgsnot.blogspot.ru/.
Read: "Einstein vs. Higgs: or what is a mass?"
https://docs.google.com/file/d/0B1gwB1O4JZNwbjFPM0hmdU5KcW8/edit?pli=1

The theory of Superunification solves all problems of quantum gravity and artificial gravity control. The theory of Superunification is a new physics http://leonov-leonovstheories.blogspot.ru/. The basis of the theory of Superunification is quantum of space-time (quanton). Quanton was discovered by me in January 1996.

Quanton there is zero missing an element in the Mendeleev table – Newtonium . Quanton it is an atom of vacuum without which cannot form the chemical elements http://www.zrd.spb.ru/letter/2012/letter_0017.htm.

- Thank you for your interview. We hope that Western sanctions really push the development of national science in priority areas.

Books by Leonov:

1. Leonov V.S. Quantum Energetics. Volume 1. Theory of Superunification. Cambridge International Science Publishing, 2010, 745 pages.

2. V.S. Leonov. Quantum Energetics: Theory of Superunification. Viva Books, India, 2011, 732 pages.

Read more:

Spaceship with quantum engine can fly to Mars in 42 hours http://leonovprojects.blogspot.ru/2013/05/spaceship-with-quantum-engine-can-fly.html.

Quantum engine for generating thrust without the ejection of reactive mass
http://leonovprojects.blogspot.ru/2013/05/quantum-engine-for-generating-thrust.html

Spacecraft of the new generation with the quantum engine

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Leonov V.S., Russian Federation patent No. 220 1625, A method of generation of energy and a reactor for this purpose, Bull. 9, 2003.
https://drive.google.com/drive/my-drive
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https://np.reddit.com/r/EmDrive/comments/3j7bq7/russia_successfully_tested_antigravity_engine_by/

Leonov's report "The discovery of the zero element of the periodic table" 01.06.17

http://theoryofsuperunification-leonov.blogspot.ru/2017/05/leonovs-report-discovery-of-zero.html

On the nature of the four-dimensional gravitational potential C^2

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http://theoryofsuperunification-leonov.blogspot.ru/2017/05/the-upper-limit-of-mass-and-energy-of.html

Nature of nuclear and internuclear forces in the theory of Superunification as the basis of physics nanotechnology

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Yes repulsive force in General Relativity
http://theoryofsuperunification-leonov.blogspot.ru/2017/01/yes-repulsive-force-in-general.html

Vladimir Leonov: China has successfully tested a microwave quantum engine EmDrive in orbit
http://theoryofsuperunification-leonov.blogspot.ru/2016/12/vladimir-leonov-china-has-successfully.html

Leonov: Elon Musk make mistakes, we must reduce the cost of human spaceflight by a factor of 100.
http://leonovprojects.blogspot.ru/2016/06/leonov-elon-musk-make-mistakes-we-must.html

Vladimir Leonov
We must reduce the cost of human spaceflight by a factor of 100. But this is impossible to do by using a jet engine. The era of jet propulsion has come to an end. To reduce the cost of space launches in the 100 times we need new ideas. The theory of Superunification gives us these new ideas (Quantum Cosmonautics) and the fundamental knowledge (Quantum Energetics).
The laws of classical Newtonian mechanics do not work in Quantum Cosmonautics. For example, a UFO with a quantum engine is hanging motionless. The apparatus does not have a jet engine. How do we calculate the energy and power of quantum engine in this case? Newtonian mechanics does not have formulas for such calculations. These calculations are in the theory of Superunification.
Commercial space tourism and interplanetary travel will be able to develop rapidly if we are able completely abandon the jet propulsion.
Read more:

1. Leonov V. S. Quantum Energetics. Volume 1. Theory of Superunification. Cambridge International Science Publishing, 2010, 745 pages. http://www.cisp-publishing.com/acatalog/info_54.html
2. V.S. Leonov. Quantum Energetics: Theory of Superunification. Viva Books, India, 2011, 732 pages. http://www.vivagroupindia.com/frmBookDetail.aspx?BookId=7922
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5. Quantum engine for generating thrust without the ejection of reactive mass http://leonovprojects.blogspot.ru/2013/05/quantum-engine-for-generating-thrust.html
6. Spacecraft of the new generation with the quantum engine http://leonovprojects.blogspot.ru/2013/05/the-spacecraft-of-new-generation-with.html
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9. Video: The tests 2009 of a quantum pulsed engine for generating thrust without the ejection of reactive mass. http://theoryofsuperunification-leonov.blogspot.ru/2011/07/video-tests-2009-of-quantum-pulsed.html
10. Vladimir Leonov: Commercial aerospace orbital aircraft with the quantum engine.

https://www.youtube.com/watch?v=o-2iW9ifvVA
http://leonovprojects.blogspot.ru/2016/05/vladimir-leonov-commercial-aerospace.html
11. Vladimir Leonov: mini space ship with a quantum engine will reach Alpha Centauri in 8 years.
http://leonovprojects.blogspot.ru/2016/04/vladimir-leonov-mini-space-ship-with.html
12. Fifth force (Superforce) of nature was opened by Vladimir Leonov in 1996
http://theoryofsuperunification-leonov.blogspot.ru/2016/06/fifth-force-superforce-of-nature-was.html

Fifth force (Superforce) of nature was opened by Vladimir Leonov in 1996

Leonov V. S. Quantum Energetics. Volume 1. Theory of Superunification. Cambridge International Science Publishing, 2010, 745 pages. http://www.cisp-publishing.com/acatalog/info_54.html

Chapter 1. Fundamental discoveries of the space-time quantum (quanton) and superstrong electromagnetic interaction (SEI):

"Ginzburg clearly understood that the problem of Superunification lies in the fifth force but made the serious error in its formulation: 'Physicists know that the micro- and macroworld are controlled by four forces. The attempts to find the fifth force have been unsuccessful for more than 50 years. The physicists realise that they are looking for something incredibly weak that has been eluding detection so far (Vestnik RAS vol. 9, No. 3, 1999, p. 200). In fact, in order to combine the four fundamental interactions (forces): gravitation, electromagnetism, nuclear and electroweak forces, the fifth force is essential. However, dear Vitalii Lazarevich, to combine these forces, they must be governed by the fifth force: any schoolboy knows that: in 'in order to subordinate a force, an even greater force is required'. This is the golden rule of physics. In order to subordinate nuclear (strong) interactions, it is necessary to have a force which is greater than the nuclear force. So what is the force you are referring to, saying that ‘it is something incredibly weak?’. There is for example the electroweak force, i.e., we are discussing the fifth force as the superweak force. However, this force is not capable of combining all other forces. For this reason, you have not been able to create the theory of Superunification because no accurate concept of unification has been developed.

Superunification requires the Superforce. The well-known English theoretical physicist and science populariser Paul Davis devoted his popular book ‘Superforce’ in this problem, claiming: ‘Entire nature, in the final analysis, is governed by the effect of some Superforce, manifested in different ‘hypostases’. This force is sufficiently powerful to create our universe and provide it with light, energy, matter and the structure. However, the Superforce is something greater than simply something creating the beginning. In the Superforce, matter, space-time and interaction are combined into the indivisible harmonic whole generating such unity of the universe which previously no one assumed’. [Davies P., Superforce. The search for a grand unified theory of nature, New York, 1985]. It can be seen that not all the physicists in the world shared Ginzburg’s views. I find it surprising why Davies, who correctly formulated the concept of the Superforce more than 10 years prior to the discovery of the quanton – the particle of the carrier of Superforce – did not do this instead of me. This could have been done by Einstein who accurately formulated the concept of the unified field whose carrier is also the quanton. The unified Einstein field cannot be separated from the Superforce.”

Hungarian physicist Attila Krasznahorkai confirmed the discovery of a fifth force
http://leonov-comments1000.blogspot.ru
Has a Hungarian physics lab found a fifth force of nature?
http://www.nature.com/news/has-a-hungarian-physics-lab-found-a-fifth-force-of-nature-1.19957
Physicists have discovered a fifth force 20 years after its discovery
http://vladimir-leonov.livejournal.com/9899.html

Vladimir Leonov: Commercial aerospace orbital aircraft with the quantum engine
http://theoryofsuperunification-leonov.blogspot.ru/2016/05/vladimir-leonov-commercial-aerospace.html

Vladimir Leonov: mini space ship with a quantum engine will reach Alpha Centauri in 8 years
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The universe: Boiling 'bouillon' of quantons
http://theoryofsuperunification-leonov.blogspot.ru/2011/07/universe-boiling-bouillon-of-quantons_16.html

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Projects

http://leonovprojects.blogspot.ru/

SPACESHIP WITH QUANTUM ENGINE CAN FLY TO MARS IN 42 HOURS

http://leonovprojects.blogspot.ru/2013/05/spaceship-with-quantum-engine-can-fly.html

QUANTUM ENGINE FOR GENERATING THRUST WITHOUT THE EJECTION OF REACTIVE MASS

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THE SPACECRAFT OF THE NEW GENERATION WITH THE QUANTUM ENGINE

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2. 2. V.S. Leonov. Quantum Energetics: Theory of Superunification. Viva Books, India, 2011, 732 pages. http://www.vivagroupindia.com/frmBookDetail.aspx?BookId=7922