The quantised structure of the electron and the positron. The neutrino

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This article was published like chapter 4 in the Leonov's book: Quantum Energetics. Volume 1. Theory of Superunification. Cambridge International Science Publishing, 2010, pp. 262-351. What is an electron? Previously, we believed that an electron has an electric charge and mass that are inseparable from each other. In the theory of Superunification, an entire electric quark is used as the electron charge. An electric quark has no mass. The mass of an electron is formed as a result of spherical deformation of quantised space-time around a central electric charge-quark. Thus itself electric quark cannot be in a free state without mass inside the quantised space-time. Inside a quantised space-time an electric quark acquires mass. The same applies to the quantized positron structure. When the electron and positron approach each other, they annihilate. After annihilation, electric quarks form an electric dipole in the form of an electron neutrino that has no mass. The destruction of spherical deformation around the electron and positron leads to the release of the electromagnetic energy of their mass through the emission of gamma rays.

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]

$$W_o = \int_0^{C_o^2} m_e d\varphi = m_e C_o^2 \tag{4.1}$$

$$W_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_e} = m_e C_0^2 = 0.82\cdot 10^{-13}\,\mathrm{J} = 0.511\ \mathrm{MeV} \tag{4.2}$$

where

$$r_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{m_e C_0^2} = 2.82\cdot 10^{-15}\,\mathrm{m} \tag{4.3}$$

A sphere with radius r_e carries the electrical potential φ_{ere}

$$\varphi_{ere} = \frac{1}{4\pi\varepsilon_0}\frac{e}{r_e} = \frac{m_e C_0^2}{e} = 0.511\ \mathrm{MeV} \tag{4.4}$$

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]

$$\varphi_{1-2} = C_0^2\left(1 \pm \frac{R_e}{r}\right) = f(\pm 1/r) \tag{4.8}$$

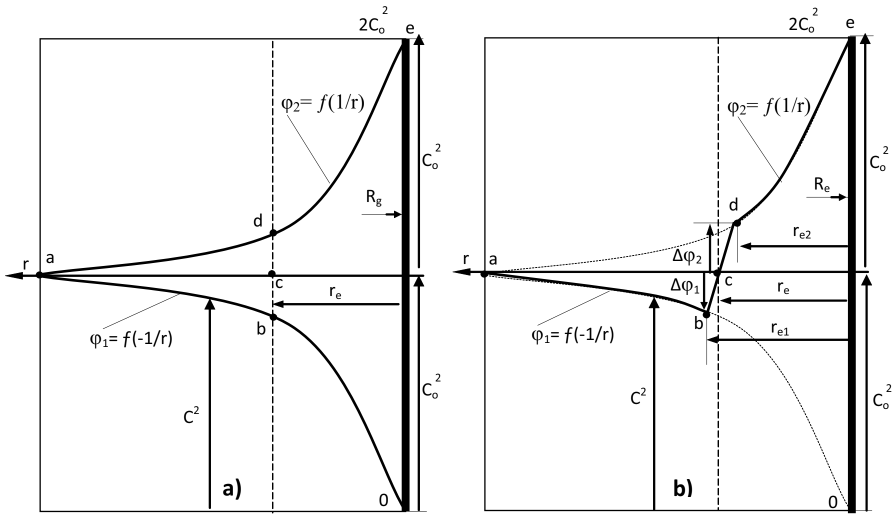

Fig. 4.1. Distribution of the gravitational potential of the electron in the form of the function $f(\pm 1/r)$ (8) (a) and combination of the functions on the gravitational diagram (b).

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...2C_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 $2C_0^2$ 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 $m_e C^2$, 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

$$\Delta\varphi = \Delta\varphi_1 + \Delta\varphi_2 \approx 2\varphi_n = \frac{2Gm_0}{r_e} = 4.3\cdot 10^{-26}\,\text{m}^2/\text{s}^2 \qquad (4.16)$$

$$\Delta r = r_{e1} - r_{e2} = 2R_g = \frac{2Gm_0}{C_0^2} = 1.35\cdot 10^{-57}\,\text{m} \qquad (4.17)$$

$$\mathbf{a} = -\frac{\Delta\varphi}{\Delta r}\mathbf{1}_r = -\frac{C_0^2}{r_e}\mathbf{1}_r = -3.19\cdot 10^{31}\,\text{m}/\text{s}^2\cdot\mathbf{1}_r \qquad (4.18)$$

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

$$W_{ev} = \iiint_V \frac{1}{2}\varepsilon_0 E^2 dV = \int_\infty^r \frac{1}{2}\varepsilon_0 E^2(4\pi r^2)dr \tag{4.22}$$

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)

$$W_{\max} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{R_e} = \frac{C_0^4}{G} r_e = 3.4\cdot 10^{29}\,\text{J} \tag{4.28}$$

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 $m_{\max}$:

$$m_{\max} = \frac{W_{\max}}{C_0^2} = \frac{C_0^2}{G} r_e = 3.8\cdot 10^{12}\ \text{kg} = 4.2\cdot 10^{42}\, m_e \tag{4.29}$$

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 $4.2\cdot 10^{42}$ times greater than the force F_g of their gravitational attraction:

$$F_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2} \tag{4.31}$$

$$F_g = \frac{Gm_e^2}{r^2} \tag{4.32}$$

$$\frac{F_e}{F_g} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{Gm_e^2} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{m_e C_0^2}\frac{1}{\frac{Gm_e}{C_0^2}} = \frac{r_e}{R_e} = \frac{W_e}{W_g} = 4.2\cdot 10^{42} \tag{4.33}$$

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

$$F_g = G\frac{m_e m_{\max}}{r^2} = m_e C_0^2 \frac{r_e}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2} \tag{4.34}$$

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

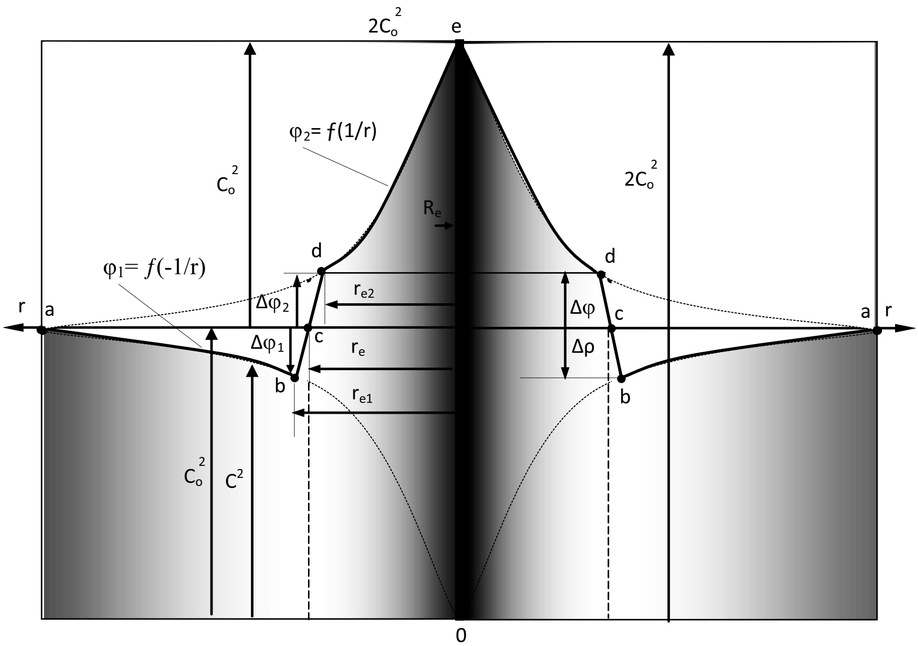

Fig. 4.2. Gravitational diagram of the electron in the form of the distribution of the gravitational potential in the compression zone (d–e) and in the stretching zone (a–b) of the spherically deformed quantised space-time.

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]:

$$\rho_1 = \rho_0 \frac{C^2}{C_0^2} \quad , \quad C^2 = C_0^2 \frac{\rho_1}{\rho_0} \tag{4.37}$$

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

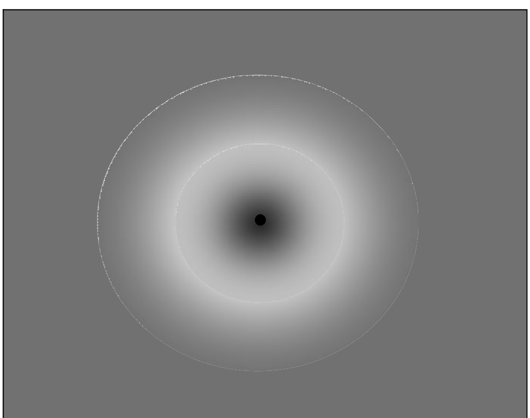

Fig. 4.3. Computer simulation of the structure of the electron in the quantised space-time as a result of its spherical deformation by the radial electrical field of the central charge.

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)

$$\mathbf{F}_g = m_0\mathbf{a} = m_0\mathbf{D}\frac{C_0^2}{\rho_0} = \frac{Gm_em_0}{r^2}\mathbf{1}_r \tag{4.42}$$

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 $m_0 = m_e$

$$W_g = \frac{dF_g}{dr} = \frac{Gm_em_e}{r} = m_eC_0^2\frac{R_g}{r} \tag{4.43}$$

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:

$$W_D = W_e = \int_0^{\varphi_e} e d\varphi = e\varphi_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r} \tag{4.44}$$

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

$$W_D = m_e C_0^2 \frac{r_e}{r} = W_0 \frac{r_e}{r} \tag{4.45}$$

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

$$\mathbf{F}_D = \frac{dW_D}{dr} = -m_e C_0^2 \frac{r_e}{r^2}\mathbf{1}_r \tag{4.46}$$

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

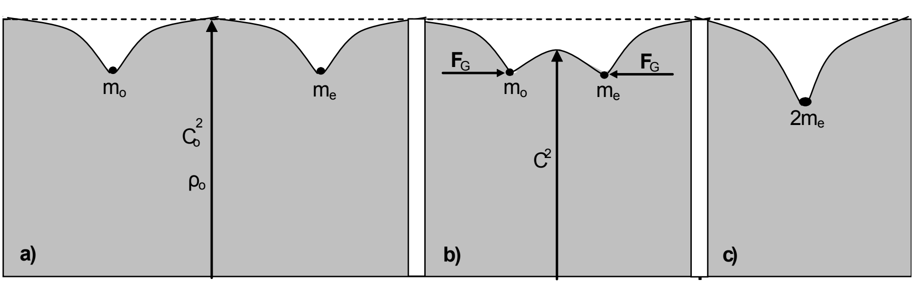

Fig. 4.4. Diagram of gravitational attraction of two masses m_0 under the effect of force $\mathbf{F}_G$.

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

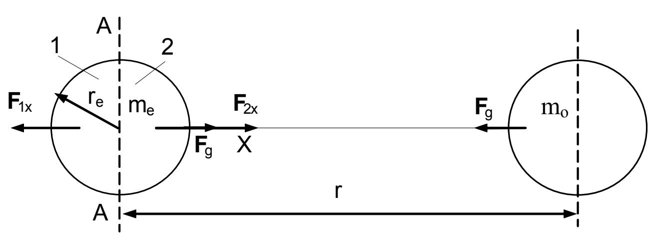

Fig. 4.5. Calculation of gravity force $\mathbf{F}_g$ of two identical masses m_e and m_0

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 ⅛ 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.

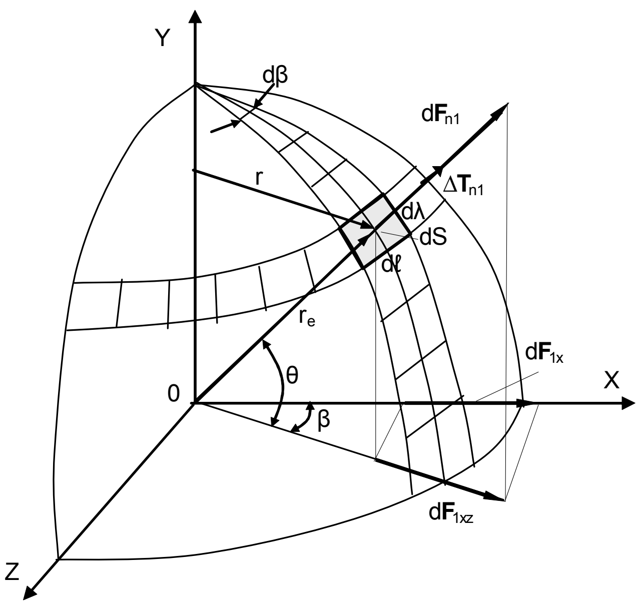

Fig. 4.6. Calculation of the surface tension forces acting on the electron.

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 $d\ell$ depends on the angle θ. The maximum value of the side $d\ell_{\max}$ is recorded at the angle $\theta = 0$. 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

$$F_g = F_{2x} - F_{1x} = 4\int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}} \Delta T_{n2} f(r_e, \theta, \beta) r_e^2 \cos^2\theta d\theta \cdot \cos\beta d\beta \cdot 1_x - \\ -4\int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}} \Delta T_{n1} f(r_e, \theta, \beta) r_e^2 \cos^2\theta d\theta \cdot \cos\beta d\beta \cdot 1_x \tag{4.71}$$

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

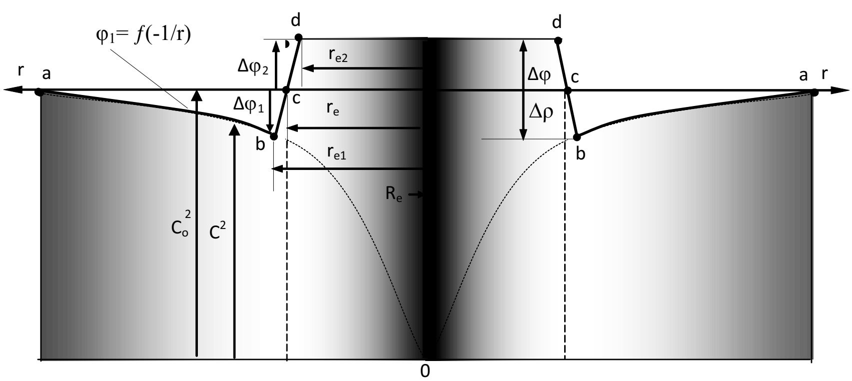

Fig. 4.7. Truncated gravitational diagram of the electron, responsible for the formation of its mass.

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 $2.8 \cdot 10^{-15}$ 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:

$$\mathbf{a} = -\frac{\Delta\varphi}{\Delta r}\mathbf{1}_r = -\frac{C_0^2}{r_e}\mathbf{1}_r = -3.19 \cdot 10^{31} \text{m}/s^2 \cdot \mathbf{1}_r \tag{4.75}$$

$$\mathbf{F}_g = m_p \mathbf{a} = 1.67 \cdot 10^{-27} \cdot (-3.19 \cdot 10^{31}) = -5.3 \cdot 10^4 \text{ N} \cdot \mathbf{1}_r \tag{4.76}$$

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)

$$\mathbf{F}_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_e^2}\mathbf{1}_r = 29 \text{ N} \cdot \mathbf{1}_r \tag{4.77}$$

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):

$$\varphi_2 = C_0^2\left(1 + \frac{R_e}{r}\right) \tag{4.79}$$

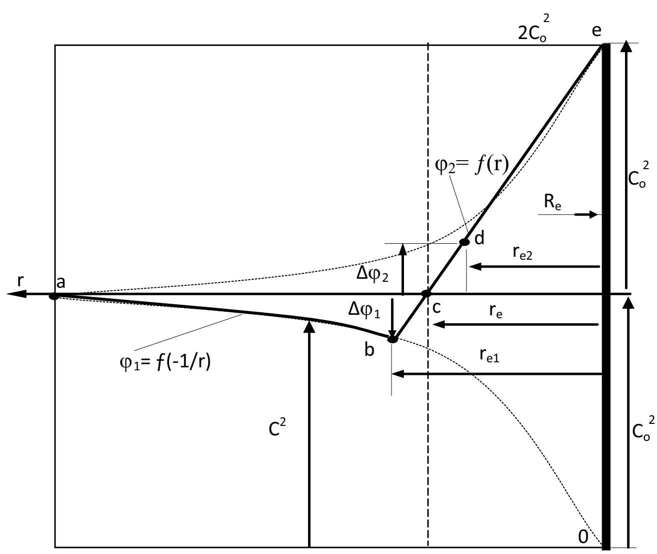

Fig. 4.8. Section of the gravitational diagram of the electron with the linear function (c-d-e) of the gravitational potential inside the classic radius r_e.

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 $r = R_e$, $\varphi_2 \approx 2\,C_0^2$.

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 **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 Δφ (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 ± the presence of the electrical charge) [9–14]

$$\begin{aligned} e_m^- + e_m^+ \to 2\gamma + e^- e^+ \to 2\gamma + \nu_e \\ \text{where} \quad e^- e^+ \to \nu_e \end{aligned} \tag{4.86}$$

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)

$$r_{a\max} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{2m_0C_0^2} = 1.41\cdot 10^{-15}\,\text{m} \tag{4.88}$$

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

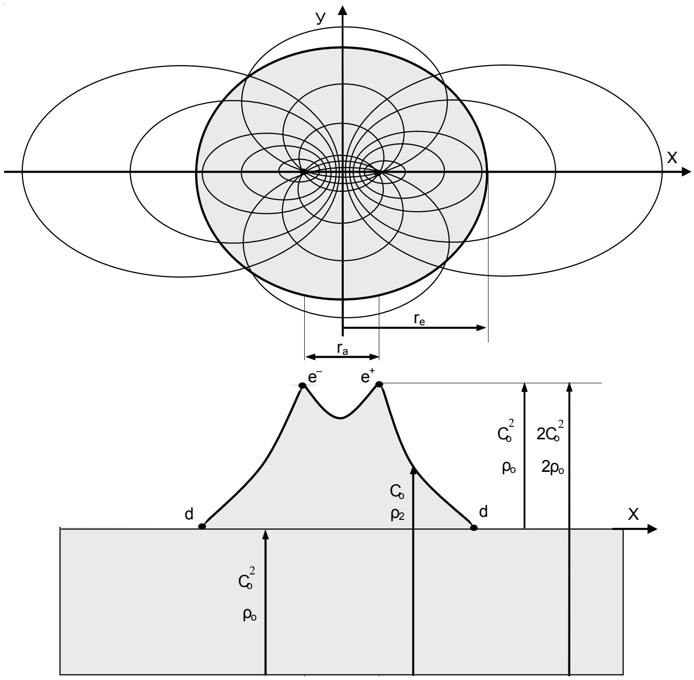

Fig. 4.9. Electrical field of the electronic neutrino as the field of the electrical dipole and its gravitational diagram with the double minus mass.

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

$$p_e = r_a e = 10^{-22} e \cdot \mathrm{m}, \quad \text{from which} \quad r_a = 10^{-22}\,\mathrm{m} \tag{4.90}$$

At the distance $r_a = 10^{-22}$ m between the dipole charges, the electrical energy W_{ev} of the electronic neutrino is:

$$W_{ev} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_a} = 2.3\cdot 10^{-6}\,\mathrm{J} = 1.4\cdot 10^{25}\ \mathrm{eV} \tag{4.91}$$

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 $R_e = 6.74\cdot 10^{-58}$ m (4.19) of the electron. However, the linear parameters of the quantised medium are determined by the quanton diameter $L_{q0} = 0.74\cdot 10^{-25}$ 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 $R_e = 6.74\cdot 10^{-58}$ 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 **E** in the direction of the force $\mathbf{F}_{qe}$, and forms some angle α_{pe}, including with radius **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]

$$\mathbf{F}_{qe} = (p_e \cdot \text{grad}\, E)\mathbf{1}_r \cdot \cos\alpha_{pe} \tag{4.93}$$

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 **E**; grad E is the gradient of the modulus of the strength of the electrical field of the charge.

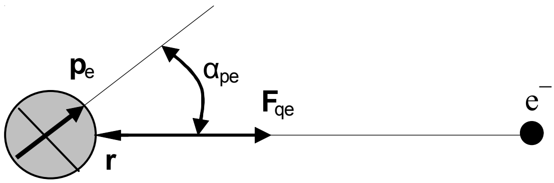

Fig. 4.10. Effect of electrical force $\mathbf{F}_{qe}$ on the quanton from the side of the point charge of the electron e^-.

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 $\mathbf{E}$

$$\mathbf{E} = \frac{1}{4\pi\varepsilon_0} \frac{e}{r^2} \mathbf{1}_r \tag{4.95}$$

Substituting modulus p_e (4.94) into (4.93), and determining the gradient of the modulus of the strength of the field $\mathbf{E}$ 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 $\mathbf{r}$ 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:

$$\mathbf{p}'_e = k_p \varepsilon_0 \int_V \mathbf{E}\ dV = k_p \varepsilon_0 \mathbf{E} \cdot \frac{1}{6} \pi L_{q0}^3 = \frac{k_p}{24} e \frac{L_q^3}{r^2} \mathbf{1}_r \tag{4.19}$$

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.

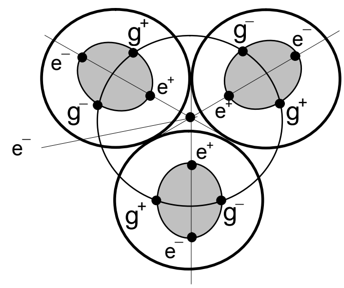

Fig. 4.11. The first layer of the quantons around the point charge of the electron.

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^1_{max} 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}

$$r_0 = \frac{0.5L_{q0}}{\cos 30^0} = 0.58L_{q0} \tag{4.101}$$

$$W^1_{max} = m_{max}\varphi_2 = \frac{C_0^2}{G} r_e \cdot C_0^2 \frac{R_e}{0.58L_{q0}} = \frac{C_0^4}{G}\frac{r_e}{0.58L_{q0}} R_e =$$
$$= m_0 C_0^2 \frac{r_e}{0.58L_{q0}} = 6.57\cdot 10^{10} m_0 C_0^2 = 3.36\cdot 10^{16}\,\text{eV} \tag{4.102}$$

The estimated value of the first stage of hidden energy W^1_{max} (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:

$$\mathbf{F}_{qe} = \frac{e^2}{4\pi\varepsilon_0}\frac{L_{q0}^3}{r^5}\mathbf{1}_r \tag{4.112}$$

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:

$$\frac{e^2}{4\pi\varepsilon_0}\frac{L_{q0}^3}{r^5}\mathbf{1} = \frac{e^2}{4\pi\varepsilon_0}\frac{L_{q0}}{r^3}\mathbf{1}_r \cos\alpha_{pe} \tag{4.113}$$

$$\cos\alpha_{pe} = \frac{L_{q0}^2}{r^2} \tag{4.114}$$

$$\alpha_{pe} = \arccos\frac{L_{q0}^2}{r^2} \tag{4.115}$$

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:

$$\mathbf{p}'_e = \frac{1}{2}eL_{q0}\frac{L_{q0}^2}{r^2}\mathbf{1}_r = p_e\frac{L_{q0}^2}{r^2}\mathbf{1}_r \tag{4.116}$$

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:

$$\mathbf{F}_{qe} = \frac{(\varepsilon_2 + 1)}{\varepsilon_0} \frac{e^2}{48\pi} \frac{L_{q0}^3}{r^5} \mathbf{1}_r \qquad (4.121)$$

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 $W_{\max}^1$ of the electron (4.102). The classic continues electrical field with strength $\mathbf{E}$ (4.95) determines hidden energy $W_{\max}^1$ (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]

$$\Delta\varphi_{1-ny} = \sum_{1x}^{n}\left(\int_{r_k}^{a_y - r_k} \mathbf{H}_\tau dy - \int_{r_k}^{r_{gy} - r_k} \mathbf{H}_{q\tau} dy \right) = 0 \tag{4.126}$$

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.

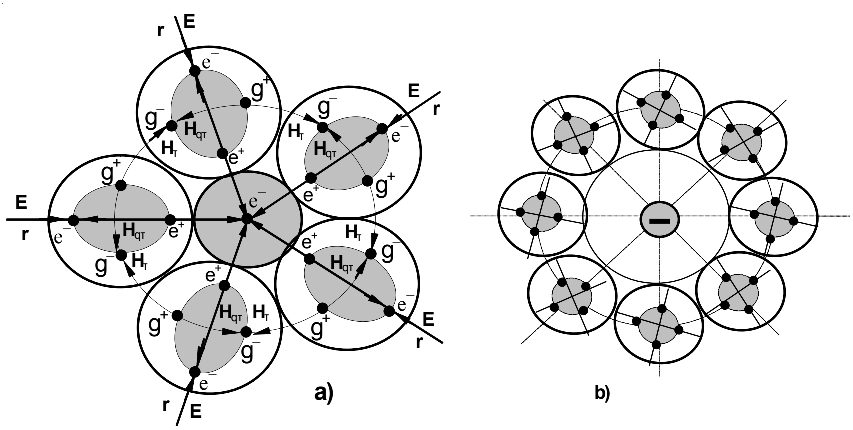

Fig. 4.12. Scheme of formation of the spherical magnetic field in the vicinity of the point charge of the electron (a) and when moving away from it (b).

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 **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 **r** like the vector **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 **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

$$i\mathbf{H} = i(\varepsilon_0 C_0)\mathbf{E} = \frac{1}{4\pi}\frac{ig}{r^2}\mathbf{1}_{r\tau} \qquad (4.129)$$

where ig is the imaginary magnetic charge located together with the central perturbing electrical charge e^- and describing the field i**H** (129); $g = C_0 e = 4.8\cdot 10^{-11}$ 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

$$Q = E + iH = \frac{1}{4\pi\varepsilon_0 r^2}e + \frac{1}{4\pi r^2}ig \qquad (4.130)$$

The complex strength Q (4.130) can be reduced to a single measurement units, for example, the electrical unit

$$Q = E + \frac{iH}{\varepsilon_0 C_0} = \frac{1}{4\pi\varepsilon_0 r^2}e + \frac{1}{\varepsilon_0 C_0}\frac{1}{4\pi r^2}ig = \frac{1}{4\pi\varepsilon_0 r^2}\left(e + \frac{1}{C_0}ig\right) \qquad (4.131)$$

Into (4.131) we introduce the complex charge of the electron q

$$q = e + \frac{1}{C_0}ig \qquad (4.132)$$

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].

$$\mu_B = \frac{1}{2}\hbar\frac{ig}{m_e C_0} \quad [\mathrm{A}\cdot\mathrm{m}^2 = \mathrm{Dc}\cdot\mathrm{m}] \tag{4 .137}$$

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

$$\mu_B = \frac{1}{2} ig \cdot \lambda_0 = 9.27 \cdot 10^{-24} \,\mathrm{Dc \cdot m} \tag{4.139}$$

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

$$\mu_{e\min} = ig \cdot r_e = 1.35 \cdot 10^{-25} \,\mathrm{Dc{\cdot}m} \tag{4.140}$$

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

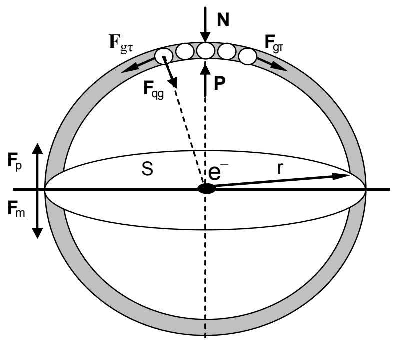

Fig. 4.13. Calculation of the magnetic force $\mathbf{F}_{qb}$ acting on the quanton in the spherical magnetic field of the electron.

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

$$\mathbf{F}_m = \mathbf{F}_{g\tau} n_q = \mathbf{F}_{g\tau} \frac{2\pi r}{L_{q0}} \qquad (4.148)$$

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 $\mathbf{P}$ of the quantised medium inside the spherical shell of quantons

$$\mathbf{P} = -F_{g\tau} \frac{2}{L_{q0} r} \mathbf{1}_r \qquad (4.149)$$

Substituting (4.149) into (4.145), we determine force $\mathbf{N}$ 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

$$\mathbf{N} = -\frac{\pi L_{q0}^2}{4} \mathbf{P} = \frac{1}{2} \frac{\pi L_{q0}}{r} F_{g\tau} \mathbf{1}_r \qquad (4.150)$$

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

$$\mathbf{F}_{qg} = \mathbf{N} = \frac{\mu_0 g^2}{8} \frac{L_{q0}}{r^3} \mathbf{1}_r \qquad (4.151)$$

$i^2 = -1$ 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 $r = r_e = 2.8\cdot 10^{-15}$ m, we obtain the required relationship:

$$\frac{F_{qg}}{F_{qe}} = \frac{\pi}{2}\left(\frac{r_e}{L_{q0}}\right)^2 = \frac{\pi}{2}\left(\frac{r_e}{L_{q0}}\right)^2 = 2.3\cdot 10^{21} \tag{4.154}$$

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

$$F_{qg} = F_{qe} \qquad \text{at} \quad r = L_{q0}\sqrt{\frac{2}{\pi}} = 0.8L_{q0} \tag{4.155}$$

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

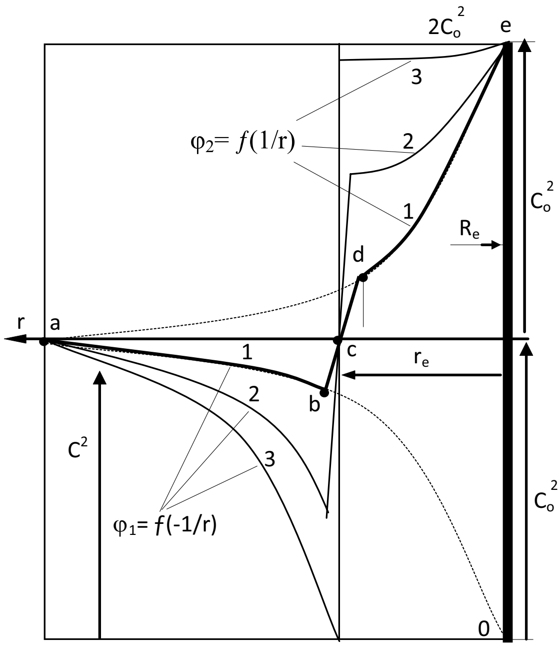

Fig. 4.14. Family of the curves 1, 2, 3 of gravitational potentials of the electron in relation to speed.

$$\mathbf{F}_{\perp} = \frac{d\mathbf{p}}{dt} = \frac{d(m_e\gamma_n^3\mathbf{v})}{dt} = m_e\gamma_n^3\frac{d\mathbf{v}}{dt} \tag{4.180}$$

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 **F** does not coincide with the direction of electron speed **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)

$$m = m_{\max} - m_s = m_e \gamma_n \tag{4.183}$$

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]

$$\mathbf{F} = C_0^2 \frac{dm}{dx} = C_0^2 \frac{dm}{vdt} \tag{4.184}$$

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

$$W = m_e C_0^2 \gamma_n = m_e C_0^2 + \frac{1}{2} m_e v^2 \tag{4.185}.$$

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

$$\mathbf{p} = \frac{dW}{dv} = m_e \mathbf{v} = m_e \frac{dx}{dt} \tag{4.186}$$

$$\mathbf{F} = \frac{dW}{dx} = \frac{d(0.5 m_e v^2)}{vdt} = m_e \frac{dv}{dt} = m_e \mathbf{a} \tag{4.187}$$

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

$$W_k = 0.5 m_e v^2 \tag{4.188}$$

It should be mentioned that the momentum **p** and force **F** are linked together

$$\mathbf{F} = \frac{d\mathbf{p}}{dt} = \frac{d(m_e\mathbf{v})}{dt} = m_e\mathbf{a} \qquad (4.189)$$

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]

$$\mathbf{D}_2^i = \mathrm{grad}(\rho_2^i) \qquad (4.190)$$

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]

$$\mathbf{F} = m\mathbf{a} = m\frac{C_0^2}{\rho_0}\mathbf{D}_2^i \qquad (4.191)$$

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 $W_k = 0.5m_e v^2$ (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

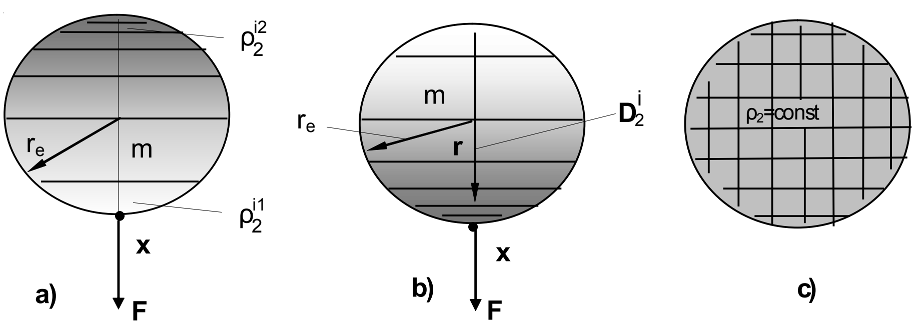

Fig. 4.15. Redistribution of the quantum density of the medium inside the electron as a result of the effect of accelerating force **F** (a), deformation of the quantised medium during its acceleration (b) and the uniform grid of quantum density of the medium in the absence of acceleration (c).

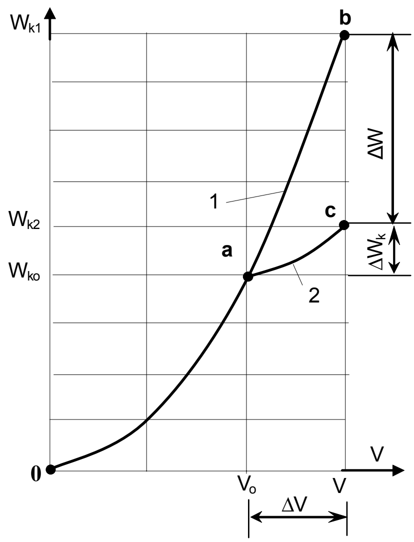

Fig. 4.16. Quadratic dependences of the absolute 1 and relative 2 electron energies on speed v in the absolute space-time.

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

$$W_{k1} = \frac{1}{2} m_e v^2 = \frac{1}{2} m_e (v_0 + \Delta v)^2 = \frac{1}{2} m_e (v_0^2 + \Delta v^2 + 2 v_0 \Delta v) \qquad (4.192)$$

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)

$$\text{at } r = R_e, \qquad \varphi_{2\max} = C_0^2\left(1+\frac{R_e}{r}\right) = 2C_0^2 \tag{4.207}$$

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· 10^{-25} m of quantons and the packing coefficient k_σ = 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 nuclons, 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 nuclons 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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