The Structured Vacuum Theory
Part II: Violations of the vacuum lattice structural asymmetry and their relationship to traditional physics concepts

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In this letter we demonstrate that all basic physical concepts may be defined via the prism of symmetry breaking phenomena. Specifically, each type of symmetry breaking of the vacuum structure corresponds to some traditional concept of the modern physics. Thus, we can assign the most fundamental concepts to specific type of symmetry violation, as detailed in the following technical discussion.

Notations of velocities in double-helices, either straight or curved

Definitions of velocity components:

The vacuum is the medium supporting propagation of electromagnetic and gravitational waves. The Structured Vacuum Theory (SVT) asserts that the double-helical flows of superfluid substance are the basic building block of the vacuum lattice and is the only transmission line supporting propagation of electromagnetic and gravitational excitations along the lattice. This double-helical configuration of basic energy transmission medium composed of two oppositely directed helical flows was chosen for its ability to support two propagation modes: symmetric and anti-symmetric. These modes are orthogonal in straight double-helical sections of this transmission line and are coupled in curved double-helical sections.

The double-helical flow may be characterized by spatial distribution of its velocity vector. Following are notations of the velocity vector components comprising the double-helical flow:
$\vec{\mathbf{v}}_{+}(s.t)$ is the vector of the total superfluid velocity tangential to the first streamline of the superfluid flow.
$\vec{\mathbf{v}}_{-}(s.t)$ is the vector of the total superfluid velocity tangential to the second streamline of superfluid flow.
Here s and t are, respectively, the spatial coordinate defined along the helical flow and time variables. In the following discussion these variables in majority of cases are omitted by default.
<u>Note:</u> In the unperturbed vacuum the velocity distribution between two helical streams is anti-symmetric $\vec{\boldsymbol{v}}_{-}^{\mathbf{0}} = -\vec{\boldsymbol{v}}_{+}^{\mathbf{0}}$, where the upper index "$\mathbf{0}$" symbolizes that velocities $\vec{\boldsymbol{v}}_{+}^{\mathbf{0}}$ and $\vec{\boldsymbol{v}}_{-}^{\mathbf{0}}$ are attributes of the *unperturbed* vacuum. In general case of the perturbed vacuum, $\vec{\mathbf{v}}_{-} \neq -\vec{\mathbf{v}}_{+}$.

In general case, velocity vectors in double helices may be decomposed in cylindrical coordinates to longitudinal and transverse components directed along the longitudinal axis with the unity vector $\hat{\boldsymbol{z}}$ and transverse direction with the unity vector $\widehat{\boldsymbol{\theta}}$, respectively:

$$\vec{\boldsymbol{\upsilon}}_{+} = \upsilon_{\parallel}^{+}\hat{\boldsymbol{z}} + \upsilon_{\perp}^{+}\widehat{\boldsymbol{\theta}}$$
$$\vec{\boldsymbol{\upsilon}}_{-} = \upsilon_{\parallel}^{-}\hat{\boldsymbol{z}} + \upsilon_{\perp}^{-}\widehat{\boldsymbol{\theta}}$$

In the general case, a single double-helical flow may be decomposed to symmetrical and anti-symmetrical components:

$\vec{\boldsymbol{\upsilon}}_{+} = \vec{\boldsymbol{\upsilon}}_{\mathrm{s}} + \vec{\boldsymbol{\upsilon}}_{\mathrm{a}}$, and $\vec{\boldsymbol{\upsilon}}_{-} = \vec{\boldsymbol{\upsilon}}_{\mathrm{s}} - \vec{\boldsymbol{\upsilon}}_{\mathrm{a}}$

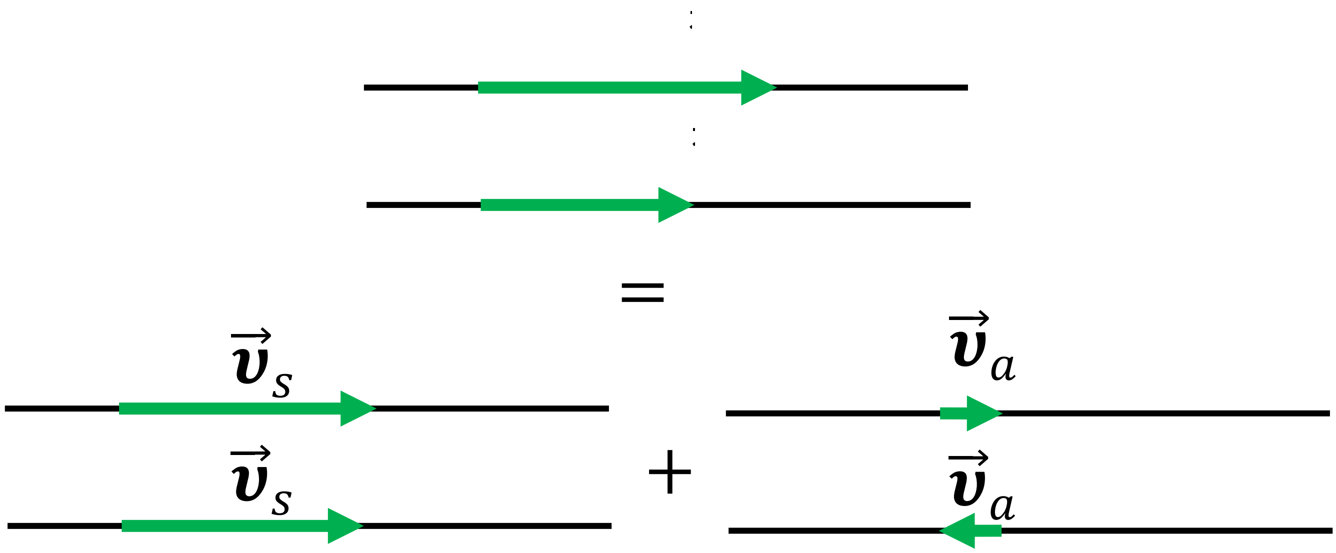

Fig. 1 Decomposition of velocity vectors in double-helix to symmetric and anti-symmetric components.

, where $\upsilon_s = \frac{1}{2}(\upsilon_+ + \upsilon_-)$ and $\upsilon_a = \frac{1}{2}(\upsilon_+ - \upsilon_-)$ are absolute values of symmetric and anti-symmetric velocity components.

Note: the indices + and – are always assigned to the first and the second helical streams, respectively.

Gravitation phenomena

The *gravitation* phenomena may be detected in our experiments due to abnormally large or abnormally low values of the anti-symmetrical component of the superfluid flow in the double-helices, as compared with the unperturbed vacuum. Structure of the unperturbed vacuum is comprised of absolutely identical cells. Hence the unperturbed vacuum does not manifest us the gravity phenomenon. The anti-symmetrical velocity component of a single double-helix may be trivially described by the cell array with two vector elements $[\vec{\boldsymbol{\upsilon}}_{\mathrm{a}}^{+}(s.t), \vec{\boldsymbol{\upsilon}}_{\mathrm{a}}^{-}(s.t)]$, where $\vec{\boldsymbol{\upsilon}}_{\mathrm{a}}^{+} = -\vec{\boldsymbol{\upsilon}}_{\mathrm{a}}^{-}$ by definition. The anti-symmetric mode carrying gravitational energy may be presented in terms of the total velocity vectors $\vec{\boldsymbol{\upsilon}}_{+}$and $\vec{\boldsymbol{\upsilon}}_{-}$:

$$[\vec{\boldsymbol{\upsilon}}_{\mathrm{a}}^{+}, \vec{\boldsymbol{\upsilon}}_{\mathrm{a}}^{-}] = \left[\frac{1}{2}(\vec{\boldsymbol{\upsilon}}_{+} - \vec{\boldsymbol{\upsilon}}_{-}), -\frac{1}{2}(\vec{\boldsymbol{\upsilon}}_{+} - \vec{\boldsymbol{\upsilon}}_{-})\right] = \left[\upsilon_{\mathrm{a}}^{\mathrm{k}}\hat{\boldsymbol{z}} + \upsilon_{\mathrm{a}}^{\mathrm{p}}\hat{\boldsymbol{\theta}}, -\upsilon_{\mathrm{a}}^{\mathrm{k}}\hat{\boldsymbol{z}} - \upsilon_{\mathrm{a}}^{\mathrm{p}}\hat{\boldsymbol{\theta}}\right],$$

where

$\left[\upsilon_{\mathrm{a}}^{\mathrm{k}}\hat{\boldsymbol{z}}, -\upsilon_{\mathrm{a}}^{\mathrm{k}}\hat{\boldsymbol{z}}\right] = \left[\frac{1}{2}\left(\vec{\boldsymbol{\upsilon}}_{\parallel}^{+} - \vec{\boldsymbol{\upsilon}}_{\parallel}^{-}\right)\hat{\boldsymbol{z}}, -\frac{1}{2}\left(\vec{\boldsymbol{\upsilon}}_{\parallel}^{+} - \vec{\boldsymbol{\upsilon}}_{\parallel}^{-}\right)\hat{\boldsymbol{z}}\right]$ is the longitudinal component of velocity of the anti-symmetric mode carrying the gravitational *kinetic* energy, and $\left[\upsilon_{\mathrm{a}}^{\mathrm{p}}\hat{\boldsymbol{\theta}}, -\upsilon_{\mathrm{a}}^{\mathrm{p}}\hat{\boldsymbol{\theta}}\right] = \left[\frac{1}{2}(\vec{\boldsymbol{\upsilon}}_{\perp}^{+} - \vec{\boldsymbol{\upsilon}}_{\perp}^{-})\hat{\boldsymbol{\theta}}, -\frac{1}{2}(\vec{\boldsymbol{\upsilon}}_{\perp}^{+} - \vec{\boldsymbol{\upsilon}}_{\perp}^{-})\hat{\boldsymbol{\theta}}\right]$ is the transverse component of the anti-symmetric mode carrying the gravitational potential energy. The kinetic part of the gravitational energy is responsible for the inertia effect, including the energy confined in the inert mass, m_i, appearing in the Newton's Second Law of classical mechanic. The potential part of the gravitational energy is the origin of the Newton's gravity effects, and stands behind the gravity mass, m_g, appearing as the coefficient in the Newton's Law of Gravity.

Electromagnetic phenomenon

Similar relationships hold for the *electromagnetic energy* carried by symmetric propagation mode supported by double-helices:

$$[\vec{\boldsymbol{\upsilon}}_{\mathrm{s}}^{+}, \vec{\boldsymbol{\upsilon}}_{\mathrm{s}}^{-}] = \left[\frac{1}{2}(\vec{\boldsymbol{\upsilon}}_{+} + \vec{\boldsymbol{\upsilon}}_{-}),\ \frac{1}{2}(\vec{\boldsymbol{\upsilon}}_{+} + \vec{\boldsymbol{\upsilon}}_{-})\right] = \left[\upsilon_{\mathrm{s}}^{\mathrm{k}}\hat{\boldsymbol{z}} + \upsilon_{\mathrm{s}}^{\mathrm{p}}\hat{\boldsymbol{\theta}}, \upsilon_{\mathrm{s}}^{\mathrm{k}}\hat{\boldsymbol{z}} + \upsilon_{\mathrm{s}}^{\mathrm{p}}\hat{\boldsymbol{\theta}}\right],$$

where

$\left[\upsilon_{\mathrm{s}}^{\mathrm{k}}\hat{\boldsymbol{z}}, \upsilon_{\mathrm{s}}^{\mathrm{k}}\hat{\boldsymbol{z}}\right] = \left[\frac{1}{2}\left(\upsilon_{\parallel}^{+} + \upsilon_{\parallel}^{-}\right)\hat{\boldsymbol{z}},\ \frac{1}{2}\left(\upsilon_{\parallel}^{+} + \upsilon_{\parallel}^{-}\right)\hat{\boldsymbol{z}}\right]$ is the longitudinal component of velocity of the symmetric mode carrying the electromagnetic *kinetic* energy, and $\left[\upsilon_{\mathrm{s}}^{\mathrm{p}}\hat{\boldsymbol{\theta}}, \upsilon_{\mathrm{s}}^{\mathrm{p}}\hat{\boldsymbol{\theta}}\right] = \left[\frac{1}{2}(\upsilon_{\perp}^{+} + \upsilon_{\perp}^{-})\hat{\boldsymbol{\theta}},\ \frac{1}{2}(\upsilon_{\perp}^{+} + \upsilon_{\perp}^{-})\hat{\boldsymbol{\theta}}\right]$ is the transverse component of the symmetric mode carrying the electromagnetic potential energy. The longitudinal component $\left[\upsilon_{\mathrm{s}}^{\mathrm{k}}\hat{\boldsymbol{z}}, \upsilon_{\mathrm{s}}^{\mathrm{k}}\hat{\boldsymbol{z}}\right]$ is responsible for magnetic phenomena, including magnetic polarization and magnetic field, whereas the transverse component of the symmetric mode $\left[\upsilon_{\mathrm{s}}^{\mathrm{p}}\hat{\boldsymbol{\theta}}, \upsilon_{\mathrm{s}}^{\mathrm{p}}\hat{\boldsymbol{\theta}}\right]$ is responsible for electric phenomena and is the origin of electrical charge and electric field.

Discussion:

In the unperturbed vacuum the superfluid motion velocity is stable, and its longitudinal component equals to $c = 3 \cdot 10^8 m/sec$ known as the light velocity. On one hand, the energy of the universe is stored in the perpetual motion, but on the other hand, the energy should be confined in some specified volume. This contradiction is resolved by means of bi-directional motion. In the unperturbed vacuum the velocities in positive and negative directions are equal and oppositely directed. This technique enables energy storage with twice larger density. The motion of any elementary volume occupied by the superfluid substance is helical, since such flow pattern can be decomposed to the longitudinal and transverse components of its velocity. Actually, this decomposition is natural, since such behavior of the superfluid flow is in line with the general principle of the system energy equal division between all available degrees of freedom. According to the generally adopted consensus, the longitudinal component is recognized as responsible for the energy translation in space and is the carrier of *kinetic* energy. The transverse component of the flow velocity generates circular motions in a plane transverse to the direction of the translational motion, and it is responsible for the energy accumulation in a given spatial location. Hence it is the carrier of potential energy, which is traditionally assumed to be the function of only coordinates and is independent of velocity. The modern mechanics is formulated for single-scale systems and for the large-scale observations. For the large-scale observer the small-scale transverse motion is not detectable, but is reflected in hydrodynamic of continuous medium by *pressure* parameter. In contrast, the structured vacuum model provides the description of the universe hierarchal structure including all its multiple spatiotemporal scales.

Physical concepts and their symmetry breaking mechanisms

The vacuum lattice performs not only as the dominant energy reservoir of the entire universe, but also as a free energy generator. As such it is the origin of the observable surrounding us reality. The universe free energy E_{free} always appears as the energy of some kind of symmetry breaking perturbation of the vacuum lattice structure.

Most of the universe energy $E_{vacuum\ lattice}$ is not detectable due to ideal symmetry of the unperturbed vacuum structure and its enormously large quality factor $Q_{universe} = E_{vacuum\ lattice} / E_{free}$. Only deviations from the ideal symmetry give birth to free energy, the only part of the universe energy which may be detected in our experiments.

Modern physics science operates with a variety of fundamental concepts. The following definition assigns each concept to some specific type of symmetry breaking of the vacuum lattice structure, as it was exposed above. Assigning the familiar yet abstract concept to its simple geometrical equivalent demystifies and visualizes it.

Definitions of Energy modalities:

Unperturbed vacuum	**The intrinsic vacuum energy**	**Comments**	**Math expressions (*)**
Energy of the unperturbed vacuum lattice, δE_0	Energy carried by of the velocity components of pair of anti-symmetric streamlines comprising double-helical flow in the absolutely anti-symmetric cells of unperturbed vacuum lattice.	Non-detectable energy of the unperturbed vacuum is a potential candidate to be the initial source of the dark energy effects.	$\delta E_0 = \frac{1}{2}\rho_0[(v_+^0)^2 + (v_-^0)^2]\delta l = 2\rho_0 c^2 \delta l$ $v_+^0 = abs(\vec{\boldsymbol{v}}_+^{\boldsymbol{0}}) = c\sqrt{2}$ $v_-^0 = abs(\vec{\boldsymbol{v}}_-^{\boldsymbol{0}}) = c\sqrt{2}$ $\vec{\boldsymbol{v}}_-^{\boldsymbol{0}} = -\vec{\boldsymbol{v}}_+^{\boldsymbol{0}}$ The total amount of the superfluid matter $\delta\mathcal{M}$ in the element of the double-helical flow is $2\rho_0\delta l$.
Gravitation & Electromagnetic energies supported by perturbed vacuum structure	**The intrinsic vacuum energy**	**Comments**	**Math expressions (*)**
Total *detectable energy* of the vacuum excitations, δE_{exc}	Difference between total energies of superfluid flows in perturbed and unperturbed vacuum lattices.	The detectable energy may be either positive or negative. Any type of the excitation energy is associated with some kind of symmetry breaking in the vacuum lattice structure.	$\delta E_{exc} =$ $\frac{1}{2}\rho_0[v_+^2 + v_-^2 - (v_+^0)^2 - (v_-^0)^2]\delta l =$ $\frac{1}{2}\rho_0[v_+^2 + v_-^2 - 4c^2]\delta l$
Gravitational energy	Abnormally large or abnormally	The gravitational excitation	

of the vacuum excitation due to abnormally large or low amplitude of anti-symmetrical component of the superfluid velocity, δE_G	low energies carried by *anti-symmetric* velocity components of the perturbed double-helical flows, may be generated in structures of curved double-helices, where energies of symmetrical and anti-symmetrical excitations are coupled. In extreme locations within structures of massive particles the entire energy of symmetric excitation is converted to the energy of anti-symmetric excitation.	preserves anti-symmetry of the double-helical flow. The abnormally large anti-symmetric velocity component, see the note (***), $$\upsilon_a^+ = -\upsilon_a^- = \upsilon_a$$ is the origin of Newton's gravitational attraction force and Newton's inertness effect as the property of any massive body. The abnormally large gravitational effects are abundant in the universe, since the vacuum permanently generates excessive randomized energy which is then condensed to isolated particles with positive gravity and inert masses. Generation of local abnormally low (negative) gravitational energy density is principally feasible but atypical since particle with negative mass is unstable. Particles with abnormally large and abnormally low densities of gravitational energy correspond	$$\delta E_G = \frac{1}{2}\rho_0[2\upsilon_a^2 - 2c^2]\delta l = \rho_0[\upsilon_a^2 - c^2]\delta l$$ The gravitational energy may be decomposed to its kinetic and potential counterparts, which corresponds to the υ_a decomposition to longitudinal υ_a^k and transverse υ_a^p components. In the private case of low-frequency monochromatic excitation with radial frequency Ω, see note (***), the kinetic energy (carried by longitudinal velocity component) and potential energy (carried by transverse component) of the asymmetric velocity constituents are, respectively: $\upsilon_a^k = \upsilon_a^{\parallel,\Omega}(x,t) \approx c\cdot[1 + sin(\Omega t - k_\Omega x)]$ and $\upsilon_a^p = \upsilon_a^{\perp,\Omega}(x,t) \approx c\cdot[1 + cos(\Omega t - k_\Omega x)]$. Correspondingly, expressions for the kinetic and potential energies may be written as $$\delta E_a^k = \rho_0[(\upsilon_a^k)^2 - c^2]\delta l$$ and

		to phononic excitations of the vacuum lattice in a form of bright and dark ring solitons, respectively.	$\delta E_a^p = \rho_0 \left[\left(\upsilon_a^p\right)^2 - c^2\right] \delta l$
Electromagnetic energy of the vacuum excitation due to abnormally large or low amplitude of anti-symmetrical component of the superfluid velocity, δE_{EM}	Abnormally large or abnormally low energies, relatively to the non-disturbed vacuum, carried by *symmetric* constituent of velocity vectors comprising perturbed double-helical flows.		$\delta E_{EM} = \frac{1}{2}\rho_0[2\upsilon_s^2 - 2c^2]\delta l = \rho_0[\upsilon_s^2 - c^2]\delta l$ carried by the $[\vec{\upsilon}_s^+, \vec{\upsilon}_s^-]$ velocity components. The total electromagnetic energy may be decomposed to its kinetic and potential components: $\delta E_{EM} = \delta E_e + \delta E_m$ The $\delta E_m = \frac{1}{2}\rho_0 \left[\left(\upsilon_s \cdot \hat{\boldsymbol{z}}\right)^2 - c^2\right]\delta l$ and $\delta E_e = \frac{1}{2}\rho_0 \left[\left(\upsilon_s \times \hat{\boldsymbol{z}}\right)^2 - c^2\right]\delta l$ are energy components, corresponding to projections of the vector $[\vec{\boldsymbol{\upsilon}}_s^+, \vec{\boldsymbol{\upsilon}}_s^-]$ on the longitudinal axis of the double-helical flow and on the plane normal to the axis. These energies are due to magnetic and electrical polarizations of the vacuum lattice.

Mass and charge definitions as derivatives of above energy definitions	Description	Comments	Math expressions (*)
Gravity mass, m_G	m_G is the integral parameter of any massive physical body, starting with massive elementary particles.	The product of the inert mass and c^2 is the equivalent of the potential gravitational energy stored in the structure of the massive body.	$m_G = \frac{1}{c^2}\int_{\mathcal{L}} \delta E_a^p(s)$, where the variable s is defined along the curvilinear 1D path $\mathcal{L}$ comprising the entire structure of the massive physical body.
Inert mass, m_I		The product of the inert mass and c^2 is the equivalent of the kinetic gravitational energy stored in the structure of the massive body.	$m_G = \frac{1}{c^2}\int_{\mathcal{L}} \delta E_a^k(s)$.
Energy of the electric, and magnetic polarizations stored in the physical object.	Q is the integral parameter of any physical body storing in its structure the electric polarization.		$E_e = \int_{\mathcal{L}} \delta E_{\mathrm{e}}(s)$ $E_m = \int_{\mathcal{L}} \delta E_{\mathrm{m}}(s)$
Electric charge, Q stored in the electrically charged body	Q is the integral parameter of any physical body storing in its structure the electric polarization.	The relationship between the potential energy E of the electric charge Q and electrical potential V in the charge location is $V = \frac{E}{Q}$. This relationship may be considered of the concept of	Within the near zone of the electrically charged particle we avoid using the concept of charge. Instead, we introduce the concept of the energy of electrical polarization distributed along the particle's structure.

		electrical potential V, where Q is the coefficient characterizing the electrically charged body. The potential of the point-like charge Q is $V = Q/(4\pi\varepsilon_0 r)$. This expression is singular at the $r = 0$ point, i.e. in the charge location. This is the consequence of neglect of the finite dimensions of any electrically charged body, even if we have in mind elementary particle, like electron. In the SVT this discrepancy is removed since the charged particle has finite dimensions. The above expression for the electrical potential $V(r)$ is invalid when the observer approaches the particle at distances comparable with the particle's largest physical dimension.	

Symmetry breaking and corresponding physical phenomena:

Physical Phenomena	Relevant type of anti-symmetry breaking	Comments	Math expressions (*)
Total detectable energy of the vacuum excitations, δE_{exc}	Difference between total energies of superfluid flows in perturbed and unperturbed vacuum lattices. The energy difference is due to the symmetry breaking of the vacuum structure.	The detectable energy may be either positive or negative. Any type of the excitation energy is associated with some kind of symmetry breaking in the vacuum lattice structure.	$\delta E_{exc} = \frac{1}{2}\rho_0[\upsilon_+^2 + \upsilon_-^2 - (\upsilon_+^0)^2 - (\upsilon_-^0)^2]\delta l = \frac{1}{2}\rho_0[\upsilon_+^2 + \upsilon_-^2 - 4c^2]\delta l$
Potential energy	Symmetry breaking of energies carried by amplitudes of transverse velocity components of two streamlines comprising double-helical flows in perturbed vacuum lattice.	Difference between energies carried by transverse velocity components in perturbed and unperturbed vacuum lattices.	$\delta E_p = \frac{1}{2}\rho_0\left[\left(\vec{\upsilon}_\perp^+\right)^2 + (\vec{\upsilon}_\perp^-)^2 - 2c^2\right]\delta l$
Kinetic energy	Symmetry breaking of energies carried by amplitudes of longitudinal velocity components of two streamlines comprising double-helical flows in perturbed vacuum lattice.	Difference between energies carried by longitudinal velocity components in perturbed and unperturbed vacuum lattices.	$\delta E_k = \frac{1}{2}\rho_0\left[\left(\vec{\upsilon}_\parallel^+\right)^2 + (\vec{\upsilon}_\parallel^-)^2 - 2c^2\right]\delta l$
Momentum $\vec{\mathbf{P}}$ of mechanical motion of macroscopic body	Anti-symmetry breaking of two members of the double-helical flows by adding symmetrical constituent.	Vector $\vec{\mathbf{P}}$ is directed along the vector sum of two velocities $\vec{\boldsymbol{\upsilon}}_s^+$ and $\vec{\boldsymbol{\upsilon}}_s^-$ of superfluid streamlines. The $\vec{\mathbf{P}}$	$\delta\vec{\mathbf{P}} = \rho_0(\vec{\boldsymbol{\upsilon}}_+ + \vec{\boldsymbol{\upsilon}}_-)\delta l$

(**)		absolute value is the product of the amount of the superfluid matter $\delta\mathcal{M} = 2\rho_0\delta l$ of elements with length δl in both streamlines, and the mean value of the sum $(\vec{\mathbf{v}}_+ + \vec{\mathbf{v}}_-)$. In straight double-helical sections of the unperturbed vacuum lattice the momentum vector is identically zero, since $\vec{\mathbf{v}}_s^+ + \vec{\mathbf{v}}_s^-$=0.	
Linear momentum $\vec{\mathbf{p}}$ of mechanical motion of macroscopic body	Anti-symmetry breaking between the transverse components of the double-helical flows by adding identical symmetric longitudinal additive to both flows.	Linear momentum of mechanical motion is due to projection of the total momentum vector of the symmetric substituent of the superfluid flow velocities upon the axis of the double-helical axis.	$\delta\vec{\mathbf{p}} = \rho_0(\vec{\mathbf{v}}_+ + \vec{\mathbf{v}}_-)\cdot\hat{\boldsymbol{z}}\,\delta l$ The unity vector $\hat{\boldsymbol{z}}$ is directed along the axis double-helix. The anti-symmetry breaking is achieved adding the same additive $\frac{1}{2}(\vec{\mathbf{v}}_+ + \vec{\mathbf{v}}_-)\cdot\hat{\boldsymbol{z}}$ both anti-symmetric flows.
Rotational momentum $\vec{\mathbf{L}}$ of mechanical motion of macroscopic body	Anti-symmetry breaking between the transverse components of the double-helical flows by adding identical symmetric transverse additive to both flows.	The rotational momentum of mechanical motion is due to projection of the total momentum vector of the symmetric substituent of the superfluid flow velocities upon the plane normal to the double-helical axis $\hat{\boldsymbol{z}}$.	$\delta\vec{\mathbf{L}} = \rho_0(\vec{\mathbf{v}}_+ + \vec{\mathbf{v}}_-)\times\hat{\boldsymbol{z}}\,\delta l$ The anti-symmetry breaking is done by adding the same additive $\frac{1}{2}(\vec{\mathbf{v}}_+ + \vec{\mathbf{v}}_-)\times\hat{\boldsymbol{z}}$ to both anti-symmetric flows.

It should be remembered that all velocities in above table are functions of coordinate and time, e.g. $\vec{\mathbf{v}}_{+} \equiv \vec{\mathbf{v}}_{+}(x,t)$.

(*) The universe energy is carried by continuous streamline flows of an inviscid incompressible superfluid. The superfluid is characterized by per-unit-length density ρ_0 and the pair of velocity vectors $[\vec{\mathbf{v}}_{+}, \vec{\mathbf{v}}_{-}]$. The superfluid flows are, in essence, universal carriers of what is nowadays known as "energy". All expressions for energy and momentum are given for elementary length of the superfluid streamline flow, a constituent of the one-dimensional elementary section of the flow with the length $\delta l \ll L_{PL}$. Here $\mathrm{L_{PL}} = 1.6 \text{ x } 10^{-35}$ metres is the Planck length.

(**) Classical Newton mechanics assumes that the macroscopic object (or particle) behaves as a solid body. The SVT model reveals that the particles are composed of a large number of Planck-scale cells of the vacuum lattice involved in mutual coherent oscillation at its De Broglie frequency. These high-frequency oscillations and inner small-scale motions within the particle may be neglected when its macroscopic mechanical motion is under consideration. Since the relative motion within the solid body is neglected, we may assume that all cells comprising the body are involved only in common mechanical motion with the velocity $\frac{1}{2}(\vec{\mathbf{v}}_{s}^{+} + \vec{\mathbf{v}}_{s}^{-})$ relatively the vacuum lattice. This means that the macroscopic motion affects only the symmetrical component of the superfluid velocities in the Planck-scale double-helices. Most of already developed technologies are based on the symmetrical-mode excitations of the vacuum lattice. In contrast, we do not have in possession the technology associated with the asymmetric-mode vacuum excitation and completely lack control over the transformation of the symmetrical component of either gravitational or electromagnetic energy into the gravitational energy carried by the anti-symmetrical component of the superfluid velocity.

(***) Extreme values of the υ_a velocity are dictated by the maximum energy density which may be developed in the vacuum lattice. The amplitude modulation of the superfluid velocity takes place in a course of two optional scenarios:

(a) resonant energy exchange between transverse component of anti-symmetric mode (the energy of gravity mass) and longitudinal component of the symmetric mode (the energy of magnetic polarization);
(b) energy exchange between longitudinal component of anti-symmetric mode (the energy of inert mass) and transverse component of the symmetric mode (energy of electric polarization).

The Planck-frequency wave carriers propagate along straight trajectories coinciding with axes of symmetry of the vacuum lattice. At this special frequency the wave energy excites only a single raw of cells, whereas the rest cells are not engaged in the energy propagation process. Nevertheless, there is a mechanism of energy coupling to neighbor cells and even sudden change of the propagation direction by 60°, switching from one axis of symmetry to the other. Excitation distribution developed by the traveling wave propagating along the cascade of the Planck-scale cells may be presented as a superposition of Planck-frequency carriers $expj(\omega_P t -$

$k_P x)$, where $\omega_P = 2\pi F_P$ and $k_P = \frac{2\pi}{\lambda_P}$. The carrier waves may propagate back and forth along three axes of symmetry of each 2D honeycomb sub-lattice comprising the 3D vacuum lattice. The longitudinal and transverse velocities in these carrier waves are each equals to c, the light velocity. The *amplitude* modulation, enabling abnormally large superfluid velocities greater than c, becomes possible only due to two listed above mechanisms of energy conversion. The amplitude-modulated excitation waves propagating along the ring resonator of the particle structure may be described as $\upsilon_{\parallel,0}(x,t) = \upsilon_{\perp.0} = c \cdot expj(\omega_P t - k_P x)$, while the amplitude modulation adds slow sine variations with the De Broglie angular frequency Ω: $\upsilon_{\parallel,\Omega}(x,t) = c \cdot expj(\omega_P t - k_P x)[1 + sin(\Omega t - \mathrm{k}_\Omega \mathrm{x})$. In our experiments we cannot detect the fast Planck-frequency oscillations, and perceive only its average value equal to 1. Hence, within the ring structure of massive particles the detectable velocity component is the low-frequency term $\upsilon_{\parallel,\Omega}(x,t) \approx c \cdot [1 + sin(\Omega t - \mathrm{k}_\Omega \mathrm{x})]$. This is the De Broglie wave circulating along the circular ring resonator exchanging its energy between asymmetrical and symmetrical propagation modes. As can be seen, the velocity amplitude varies within the range $[0, 2c]$. The limiting factor is the lower boundary of this range, which is zero. Any further increase of the modulation depth leads to negative values of the longitudinal velocity component, which is equivalent reversal of its direction of propagation. Crossing the zero velocity limitation also means conversion of right-hand helical rotations to the left-hand rotation. Physical meaning of this conversion is generation of anti-matter, which is unstable structure in our right-hand part of the universe.

In its apogee, in the points at which $\upsilon_{\parallel,\Omega} = 2c$, or $\upsilon_{\perp,\Omega} = 2c$ density of the kinetic or potential gravitational energies is four times larger than in the unperturbed vacuum.

Formulation of physics laws

In their traditional formulations, physics laws describe dynamical energy transformations within physical systems. The laws operate with macroscopic concepts of the body (or particle) kinetic and potential energies, mass, charge, magnetic moment, etc. The laws do not pretend to describe the inner dynamics of the massive body or particle, which are assumed not to be affected by energy transformations. They also do not go into detailed description of different mechanisms of the energy transformation. For instance, the massive body m moving in gravitational potential field is assumed to be absolutely structurally unchanged while moving from one point with potential V_{G1} to the other one with different gravitational potentialV_{G2} . In order to take into account the obvious change of the system's energetic state, the physics assigns to the massive body the change of its potential energy $\Delta U = m(V_{G2} - V_{G1})$. The SVT asserts that the changes of potential or kinetic energies are at the expense of changes in the body's inner structure. In addition, the SVT describes mechanisms of the inner energy variations and transformations from one type of energy to the other. All variations are formulated in terms of changes of velocity components in the superfluid substance double-helical flows. All changes and mechanisms are described with the Planck-scale resolution. Hence, energy transformations of even the elementary particles are addressed as macroscopic events.

The SVT moves the discussion of the physical situation from the macroscopic level to the Planck scale. Hence, in order to proceed with the model development, we have to find equivalents of traditional concepts to the Planck scale reality. This is partially done in the following table. In the following description we employ notations of all velocity components as they were listed above. Where necessary, the description takes into account that elementary cell of the vacuum lattice is a closed hexagonal contour and that the excitation simultaneously affects two double-helices, as shown, for example, in the following drawing:

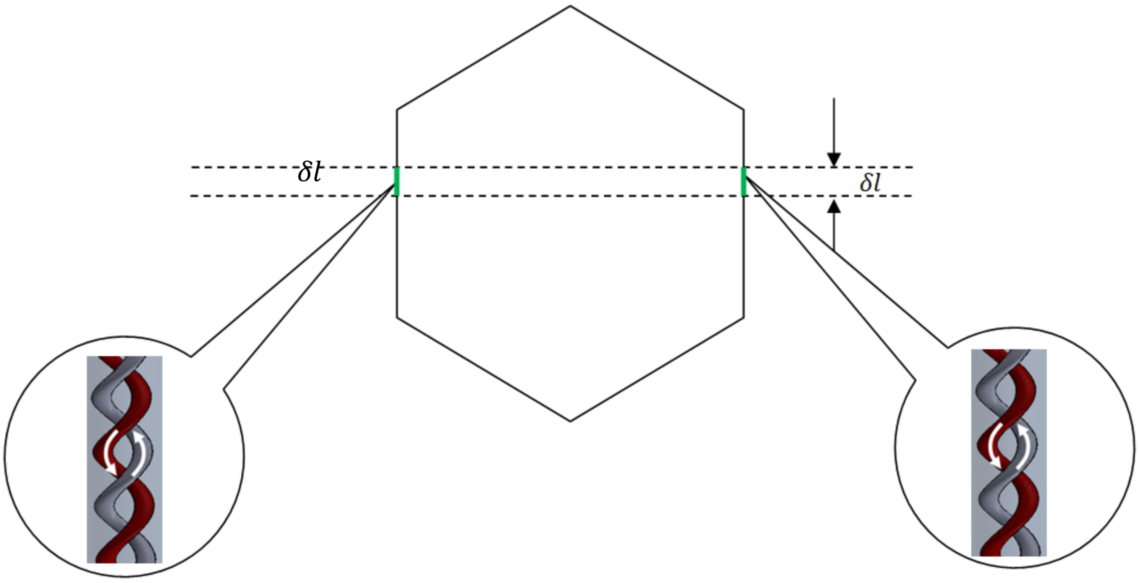

Fig.2 Illustration of macroscopic excitation on elements of the Planck-scale vacuum cell

All expressions appearing in the table were written for elementary sections δl shown in Fig.2.

Macroscopic concept	Planck-scale concept
Macroscopic motion with linear velocity $\vec{\boldsymbol{v}}$.	The vector $\vec{\boldsymbol{v}}$ is added to both velocities $\vec{\boldsymbol{v}}_a$ and $-\vec{\boldsymbol{v}}_a$ comprising the double-helical flows: $\vec{\boldsymbol{v}}_+ = \vec{\boldsymbol{v}}_a + \vec{\boldsymbol{v}}$, and $\vec{\boldsymbol{v}}_- = -\vec{\boldsymbol{v}}_a + \vec{\boldsymbol{v}}$. The total energy of the double-helix affected by this excitation is: $E_{exc} = \frac{1}{2}\rho_0 \delta l[(c+v)^2 + (-c+v)^2 - 2c^2] = \frac{1}{2}\mathcal{M}v^2$, where $\mathcal{M}$ is the

	amount of matter carried by the δl section of the double-helix. **Note:** it may be anticipated that the symmetrical addition of the velocity $\vec{\boldsymbol{v}}$ will generate some magnetic field effect. The magnetic effect is cancelled since the total momentum of the moving matter in both streams of the unperturbed vacuum cell is zero: $\frac{1}{2}\mathcal{M}\left(\vec{\mathbf{v}}_{\parallel 0}^{+} - \vec{\mathbf{v}}_{\parallel 0}^{-}\right)\cdot \hat{\boldsymbol{z}} = 0$ due to the cell symmetry $\left(\vec{\mathbf{v}}_{\parallel 0}^{+} = \vec{\mathbf{v}}_{\parallel 0}^{-}\right)$. As we shall see later, this is not the case in electrically polarized vacuum cells, where the magnetic effect is generated as the result of mechanical linear motion.
Rotation of massive neutral body with angular velocity $\vec{\boldsymbol{\omega}}$.	Refer to Fig.3. The massive body rotates around the center point O. Rotation leads to imbalance of longitudinal velocities in inner and outer sides of cells. This is equivalent to symmetric velocity component of the symmetric mode in the cells. It is assumed that the rotation radius R is much less than the size of Planck cell, which is in order of the Planck length. Then, $v_1 = \mathrm{c} + \omega \cdot R$, $v_2 = -\mathrm{c} + \omega \cdot R$, $v_3 = \mathrm{c} + \omega \cdot R$, $v_4 = -\mathrm{c} + \omega \cdot R$ may be decomposed to symmetric and anti-symmetric modes: $v_s = \frac{1}{2}(v_1 + v_2) = \frac{1}{2}(v_3 + v_4) = c + \omega \cdot R$ and $v_a = \frac{1}{2}(v_1 - v_2) = c$ Energy carried by the symmetric mode which may be detectable in our experiments is $E_{exc} = \frac{1}{2}\rho_0 \delta l[2(c + \omega \cdot R)^2 - 2c^2] = \frac{1}{2}\rho_0 \delta l \cdot 2[2c\omega \cdot R + \omega^2 \cdot R^2]$. For cases when the tangential velocity is much smaller than the light velocity, i.e. when $\omega \cdot R \ll c$, the $E_{exc} = \frac{1}{2}\mathcal{M}\omega^2 \cdot R^2$. For the macroscopic bodies composed of a large number of Planck cells, the energy of the mass rotation effect may be calculated as a volume integral of above expression calculated over its entire volume. The result will be proportional to the body's moment of inertia $I = \int_V m(r) r^2 dV$, where $m(r)$ is the mass density distribution within the volume V of the body. In the SVT the vacuum magnetization is associated with the energy carried by longitudinal component of symmetric excitation mode of double-helical flows comprising the matter. The longitudinal velocity component in mass-less medium does not yield mass translation, and is known as magnetic field. In the case of massive medium, such velocity component will necessarily mean mass translation along the vacuum lattice, unless the motion is closed in loops. So, in the Planck scale the macroscopic rotation with the radius $R \gg \lambda_{PL}$ is nearly linear, whereas in the macroscopic scale it is rotational.

	Magnetization of massive body as the result of its mechanical rotation is known as the Barrett effect.

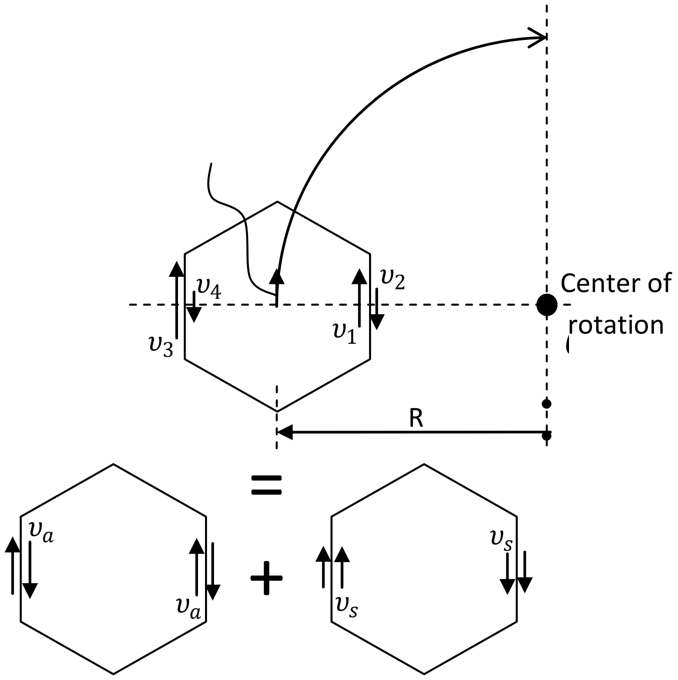

Fig.3 Notation of velocities in the rotating massive body

Linear or rotation motion of massive electrified body.	Actually, such linear or rotation motion is equivalent to flow of electrical current. Presence of electric charge is equivalent to excessive (relatively to the unperturbed vacuum) density of transverse component in the symmetric mode of the dual-helical flows. In static cases of motionless charge, the vacuum lattice reacts by electric polarization of opposite sign. This means that if the static charge is positive, the vacuum reacts by generation of static areas with symmetric mode of velocity, whereas the transverse velocity is below the velocity of light. We are used to name this phenomenon as the Coulomb electric field. If the charge moves, the vacuum reaction is dynamic, and there appears the longitudinal component of the polarization effect, which is equivalent to the longitudinal component of symmetric mode. According to our definition, this is the magnetic moment

	phenomenon, and is the Planck-level mechanism standing behind the Faraday's law of induction.
The Maxwell equations $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$ and $\nabla \times \mathbf{B} = \mu_0 \left(\mathbf{J} + \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t}\right)$	The equations reflect the vacuum lattice ability to perform its own steepest descent to the minimum level of its own free energy. The alternative formulation of this fundamental property is the steepest descent to the total energy optimally equal division between degrees of freedom. In this case, the energy may be divided between the potential energy carried by transverse component of the symmetric mode and the kinetic energy of the longitudinal component of the same symmetric mode. The potential-to-kinetic energy conversion is performed by the mechanism of knot in the right-angle interception site between 2D honeycomb sub-lattices comprising the 3D vacuum lattice. The rotor operator reflects the locality of the energy conversion process. The locality makes necessary closed-loop motion, which prevents irrevocable matter translation along the vacuum lattice, changing its average energy density. The behavior described by the Maxwell equation permits local non-homogeneity. The equations may serve an excellent example of the wavelike description of the energy transformations in the vacuum lattice propagating with the light velocity.

The known to us physics laws may be derived from geometrical and energy balances considerations. All physics laws may be formulated in matrix form as spatiotemporal transformations of the velocity vector $\left[\vec{\boldsymbol{v}}_g^p,\ \vec{\boldsymbol{v}}_g^k,\ \vec{\boldsymbol{v}}_e^p,\ \vec{\boldsymbol{v}}_e^k\right]$. As such, any elementary volume of space, in which the energy transformations occur, may be described by fourth-rank tensor.

Wavelike character of physical laws

All dynamical processes described by macroscopic physical laws have their Planck-scale equivalents. The Planck-scale equivalents are formulated in terms of the velocity vector $\left[\vec{\boldsymbol{v}}_g^p,\ \vec{\boldsymbol{v}}_g^k,\ \vec{\boldsymbol{v}}_e^p,\ \vec{\boldsymbol{v}}_e^k\right]$. This equivalent presentation are descriptions of the wavelike mechanisms of energy exchange between the listed above four velocity components. Therefore, all the Planck-scale laws formulations should have the following common structure:

$$\frac{\partial^2 \epsilon_m^n}{\partial t^2} = \upsilon^2 \frac{\partial^2 \epsilon_m^n}{\partial q^2}$$

, where ϵ_m^n are different types of the Planck-scale vacuum structure deflections (strains) from its unperturbed state. The index m is either a (antisymmetric) or s (symmetric), and symbolize either gravitational or electromagnetic type of the vacuum excitation. The index n is either k (i.e. kinetic, corresponding to the longitudinal deflection component), or p (i.e. potential, corresponding to the transverse deflection component).

The term $\frac{\partial^2 \epsilon_m^n}{\partial t^2}$ has the physical sense of acceleration A, and the equation may be rewritten as $\mathcal{M}\frac{\partial^2 \epsilon_m^n}{\partial t^2} = \mathcal{M}v^2\frac{\partial^2 \epsilon_m^n}{\partial q^2}$, or $\mathcal{M}A = \mathcal{E}\frac{\partial^2 \epsilon_m^n}{\partial q^2}$, the 2-nd Law of Newton, where $\mathcal{M}$ is the equivalent of the matter density, i.e. the amount of matter carried by the infinitesimally small section δl of the double-helix. The term $\mathcal{E} = \mathcal{M}v^2$has the sense of the total energy density carried by the superfluid double-helical flows, and the term $\mathcal{E}\frac{\partial^2 \epsilon_m^n}{\partial q^2}$ is the stress force imposed on the double-helical flows. The stress is proportional to the second partial derivative of the strain ϵ_m^n, as always in crystalline structures. This fact reflects the fact that any structural element of the vacuum lattice is surrounded on all its sides by similar elements, and elongation of relative locations to the element located on one side is at the expense of compression of the spacing to the element on the opposite side.

The structured vacuum model is described in terms of velocities. Hence, it is convenient for us to replace the deflections by velocities using identities $\frac{\partial \epsilon_m^n}{\partial t} = \upsilon_m^n$.

Our goal is to convert the traditional wave equation relatively the unknown ϵ_m^n to the other form relatively the unknown v_m^n. The wave equation in these notations may be then rewritten as:

$$\frac{\partial v_m^n}{\partial q} = \frac{1}{c^2}T_{mn}\frac{\partial (v_m^n)^T}{\partial t}$$

The matrix T_{ij} is composed of 16 elements, each of which reflects some specific types of energy transformation occurring in the vacuum lattice. For instance, the element t_{12} describes contribution of the energy carried by the $\vec{\boldsymbol{v}}_g^p(q)$ to the energy carried by $\vec{\boldsymbol{v}}_g^k(\dot{q})$. In other words, the t_{12} establishes the microscopic relationship between potential and kinetic components of the gravitational energy. This relationship may be derived by analysis of velocity conversion mechanisms existing within the vacuum lattice structure and may be addressed as the microscopic Planck-scale structural equation.

Eventually, all velocity transformations within the vacuum lattice may be presented as:

$$\frac{\partial}{\partial q}\left\| \vec{\boldsymbol{v}}_g^p(q) \quad \vec{\boldsymbol{v}}_g^k(\dot{q}) \quad \vec{\boldsymbol{v}}_e^p(q) \quad \vec{\boldsymbol{v}}_e^k(\dot{q}) \right\| = \frac{1}{c^2} \begin{vmatrix} t_{11} & t_{12} & t_{13} & t_{14} \\ t_{21} & t_{22} & t_{23} & t_{24} \\ t_{31} & t_{32} & t_{33} & t_{34} \\ t_{41} & t_{42} & t_{43} & t_{44} \end{vmatrix} \times \frac{d}{\partial t} \left\| \begin{matrix} \vec{\boldsymbol{v}}_g^p(q) \\ \vec{\boldsymbol{v}}_g^k(\dot{q}) \\ \vec{\boldsymbol{v}}_e^p(q) \\ \vec{\boldsymbol{v}}_e^k(\dot{q}) \end{matrix} \right\|$$

, where $(q, \dot{q})$ are the generalized coordinates in the macroscopic phase space. All transverse and longitudinal velocity components are dependent either of the macroscopic location coordinate q, or of the macroscopic velocity $\dot{q}$. In this presentation, the matrix $|t_{ij}|$ is the transfer operator which defines how the elementary Planck cell modifies the flow velocity vectors. The matrix coefficients t_{33}, t_{34}, t_{43} and t_{44} are responsible for mutual transformations of electrical and magnetic energies, and this quadrant is the matrix form of the Faraday-Maxwell law of electromagnetic induction. Similar transformation for kinetic and potential components of the gravity energy, is reflected by t_{11}, t_{12}, t_{21} and t_{22} quadrant. These two transformations are linear, and occur in unperturbed vacuum and gravity lattices, respectively.

Other two quadrants are of special interest, since they reflect the possibility of gravity and electromagnetic energies mutual bidirectional transformations. In the unperturbed vacuum, all members of both quadrants are zero, and are non-zero only if the cell symmetry is broken by presence of collocated electrical charge, or gravity mass. Such situations are encountered within the quark structure. Such areas may be found near atomic nuclei, whereas the massive nucleons (quarks) are the result of curled closed-loop trajectories of the gravity lattice excitations at frequencies close to the edge of the lattice conduction band.

The disturbed vacuum cell is able to perform bidirectional nonlinear transformations of potential and kinetic components of electromagnetic energy, represented by velocity vectors $\vec{\boldsymbol{v}}_e^p(q)$ and $\vec{\boldsymbol{v}}_e^k(q)$, to the gravity energy components presented by vectors $\vec{\boldsymbol{v}}_g^p$ and $\vec{\boldsymbol{v}}_g^k$. All matrix coefficients t_{ij} are differential operators, and may be alternatively presented in terms of two scalar and two vector potentials.