Unified Model of Bivacuum, Particles Duality, Electromagnetism, Gravitation & Time. The Superfluous Energy of Asymmetric Bivacuum

Alex Kaivarainen
University of Turku,
Vesilinnantie 5, FIN-20014, Turku, Finland
H2o@karelia.ru
http://www.karelia.ru/~alexk

CONTENTS

SUMMARY

Unified Model (UM) represents the next stage of our efforts for unification of vacuum, matter and fields from few ground postulates. New concept of Bivacuum is introduced, as a dynamic matrix of the Universe with superfluid and nonlocal properties, composed from non mixing *microscopic* sub-quantum particles of the opposite energies. The collective quantum excitations of sub-quantum particles and antiparticles form the correlated pairs [rotor (V^+) + antirotor (V^-)], representing *mesoscopic* **double cells-dipoles.** The *macroscopic* structure of Bivacuum is formed by the infinitive number of these cells-dipoles. The rotor (V^+) and antirotor (V^-) of cell-dipoles have the opposite quantized energy, virtual mass, spin, charge and magnetic moments. In **primordial** Bivacuum, i.e. in the absence of matter and fields, the absolute values of all these parameters in each dipole are equal. The radiuses of *primordial* rotor and antirotor are equal to Compton radius vortex: $[L^+ = L^- = L_0 = \hbar/m_0c]^i$, where m_0^i is the rest mass of the electrons of three leptons generation ($i = e, \mu, \tau$).

In **secondary** Bivacuum the poles of cell-dipoles do not compensate each other. Such a dipoles are named Bivacuum fermions ($\mathrm{BVF}^{\uparrow}$) and Bivacuum antifermions ($\mathrm{BVF}^{\downarrow}$) with spin $S = \pm\frac{1}{2}\hbar$, notated as ($\uparrow$ *and* $\downarrow$), depending on direction of their rotation: clockwise or anticlockwise.

The sub-elementary particles: *fermions and antifermions* ($\mathbf{F}_{\updownarrow}^{+}$ and $\mathbf{F}_{\updownarrow}^{-}$) of the opposite charge (+/-) and energy, composing the matter, emerge due to stable symmetry violation between the actual (V^+) and complementary (V^-) rotors of $\mathrm{BVF}^{\updownarrow}$ cells-dipoles: $[\mathrm{BVF}^{\updownarrow} \rightarrow \mathbf{F}_{\updownarrow}^{\pm}]$. The $\mathbf{F}_{\updownarrow}^{+}$ and $\mathbf{F}_{\updownarrow}^{-}$ are stable at the equality of their *internal and external* group and phase velocities, corresponding to Golden mean condition, coinciding in turn with condition of resonant virtual energy exchange with Bivacuum in a course of the asymmetric dipoles [Corpuscle (C) $\rightleftharpoons$ Wave (W)] pulsation. The **rest mass** of sub-elementary particles (fermions) and their **charge** are determined by the difference between the actual and complementary mass and between the actual and complementary charges of sub-elementary fermions/antifermions ($\mathbf{F}_{\updownarrow}^{+}/\mathbf{F}_{\updownarrow}^{-}$) at conditions of Golden mean. Corresponding differences are relativist effects, provided by inequality of spinning velocity of the *actual vortex* and *complementary rotor*, forming asymmetric dipoles of $\mathbf{F}_{\updownarrow}^{+}$ or $\mathbf{F}_{\updownarrow}^{-}$. The difference between the actual and complementary energies of $\mathbf{F}_{\updownarrow}^{+}$ or $\mathbf{F}_{\updownarrow}^{-}$, corresponding to Golden mean (ϕ) conditions, determines the carrying frequency of their $[C \rightleftharpoons W]$ pulsation: $[\omega_{C\rightleftharpoons W} = |m_C^+ - m_C^-|^{\phi} c^2/\hbar = m_0 c^2/\hbar = \omega_0]^i$.

Sub-elementary particles $(\mathbf{F}_{\updownarrow}^{\pm})^i$, like primordial Bivacuum fermions $(BVF^{\updownarrow})^i$, can be of three modes, corresponding to three lepton generation: $i = e, \mu, \tau$. The square root of product of radiuses of the actual vortex $(L^+ = \hbar/m_C^+ c)^i$ and complementary rotor $(L^- = \hbar/m_C^- c)^i$ of sub-elementary particles (the resulting radius) is equal to *Compton radius vorticity of the*

electron of corresponding generation: $L_0^i = (L^+L^-)^{1/2} = \hbar/m_0^i c$, as far $[m_C^+ m_C^- = m_0^2]^i$.

The coherent triplets of two sub-elementary fermions and one sub-elementary antifermion: $\langle[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+] + \mathbf{F}_\updownarrow^+\rangle$ or two sub-elementary antifermion and one sub-elementary fermion: $\langle[\mathbf{F}_\downarrow^+ \bowtie \mathbf{F}_\uparrow^-] + \mathbf{F}_\updownarrow^-\rangle$ represent the electrons and positrons, correspondingly. The absolute values of energy of sub-elementary particles/antiparticles in triplets are equal and determined by energy of *uncompensated* $[\mathbf{F}_\updownarrow^\pm\rangle$. Certain combinations of such triplets form quarks and photons. In latter case of elementary bosons, all the properties, except spins, of three sub-elementary particles are compensated by properties of three sub-elementary antiparticles. The in-phase $[C \rightleftharpoons W]$ pulsation of compensated pairs $[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+]$ provides the dynamic exchange interaction of elementary particles with Bivacuum.

The structure of triplets is stabilized by exchange of virtual clouds of sub-quantum particles between two sub-elementary fermions or antifermions of the opposite spins: $[\mathbf{F}_\downarrow^+]$ and $\mathbf{F}_\uparrow^+\rangle$ or $[\mathbf{F}_\uparrow^-]$ and $\mathbf{F}_\downarrow^-\rangle$ in a course of their *counterphase* pulsation. Stabilization of pair of sub-elementary fermion and antifermion of mirror symmetry $[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+]$ or $[\mathbf{F}_\downarrow^+ \bowtie \mathbf{F}_\uparrow^-]$, pulsing in-phase, occur due to minimization of local Bivacuum energy/symmetry shift, reflecting the spatially localized energy conservation.

The orientation of sub-elementary particles/antiparticles in triplets is normal to each other.

The physical nature of electromagnetic and gravitational potentials of elementary particles can be related to nonlocal equilibrium shift ($\mathrm{BVF}^\uparrow \rightleftharpoons \mathrm{BVF}^\downarrow$) of infinitive number of $\mathrm{BVF}^\updownarrow$ of Bivacuum, compensating the local symmetry shift, induced by zero-point *longitudinal (z) and transversal (x)* vibrations of uncompensated sub-elementary particles, as respect to (y) axe, coinciding with the axe of $[\mathbf{F}_\updownarrow^\pm\rangle$ rotation and vector of its external momentum. Two corresponding modulation frequencies (ω_z and ω_x) of the carrying frequency ($\omega_0 = m_0c^2/\hbar > \omega_z >> \omega_x$) of $[C \rightleftharpoons W]$ pulsation of particles, characterize the electromagnetic and gravitational potentials. The in-phase pulsation of pairs $[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+]$ are mediating the dynamic exchange interaction between triplets of sub-elementary particles and Bivacuum.

The mechanism of nonlocal $[\mathrm{BVF}^\uparrow \rightleftharpoons \mathrm{BVF}^\downarrow]$ dynamic equilibrium shifts, compensated the local shifts, is based on *different interaction* of magnetic fields $[\mathbf{H}_E, \mathbf{H}_G]$, - induced by these two modes of vibrations and modulated $[C \rightleftharpoons W]$ pulsations of elementary charges, with virtual magnetic moments: $\boldsymbol{\mu}_+$ and $\boldsymbol{\mu}_-$ of $\mathrm{BVF}^\uparrow \rightleftharpoons \mathrm{BVF}^\downarrow$.

The coherent formula, unifying the pace of kinetic energy change (dT_k/T_k) of any closed system with its electromagnetic (dE_{el}/E_{el}), gravitational (dE_G/E_G) energies and temporal field (dt/t) relative changes, has been obtained: $[d\ln t = -d\ln E_{el} = -d\ln E_G = -d\ln T_k]_{x,y,z}$. The spatial anisotropy of all of these parameters are determined by anisotropy of momentum and kinetic energy distribution: $\left[\vec{T}_k = \vec{p}^{\,2}/2m\right]_{x,y,z}$.

The new compensation principle of Bivacuum symmetry shifts, induced by matter and fields, has been formulated as follows: *the spatially localized Bivacuum symmetry shifts, induced by longitudinal and transversal translational kinetic energy contributions of charged particles, are compensated by nonlocal symmetry shifts of Bivacuum, realized by* $[BVF^\uparrow \rightleftharpoons BVF^\downarrow]$ *equilibrium shift.*

It is shown, that Principle of least action is a consequence of introduced in UM "Harmonization force (HaF)" of asymmetric Bivacuum. This new force, acting on particles by the mechanism of induced resonance, drives the matter on all hierarchical levels to Golden mean conditions. The HaF could be responsible for directed evolution of microscopic, mesoscopic and macroscopic systems (inorganic and biological ones) to states, optimal for interaction with Bivacuum.

The $[C \rightleftharpoons W]$ quantum beats of sub-elementary particles, forming triplets $\langle[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+] + \mathbf{F}_\updownarrow^\pm\rangle$ are followed by the energy exchange between the negative and positive realms of secondary Bivacuum and kinetic energy of particles. Corresponding [Bivacuum - matter] interaction can be the source of energy for self-acceleration of rotating magnets in Searl effect. This happens after overcoming of certain angular velocity of rotation, necessary for sufficient synchronization of

[C$\rightleftharpoons$ W] pulsation of particles of matter. The accompanied decreasing or increasing of weight of magnets, dependent on clockwise or anticlockwise rotation, is a result of the additional local Bivacuum symmetry shift, induced by rotating magnets and their magnetic field influence.

The superfluous energy of space, extracted by Motionless Electromagnetic Generators (MEG), constructed and patented in US by Patrick, Bearden, Hayes, Moore and Kenny (2002), also is a result of additional local Bivacuum energy symmetry shift, induced by permanent magnets. This additional energy of Bivacuum is converted to additional kinetic energy of the electrons in 'collectors', increasing the electrons actual charge and their coherency in short - living nonequilibrium states, realized in MEG.

Bivacuum has a properties of the active medium with ability to self-organization, as a result of interaction with matter. The asymmetric double cells-dipoles, pulsing between [C] and [W] phase, serve as the active elements of medium.

The full text of paper is located at: http://arXiv.org/abs/physics/0112027

Keywords: Bivacuum, duality, elementary particles, Golden mean, electromagnetism, gravitation, time, matter-vacuum interaction, harmonization force, Searl effect, Bearden Motionless electromagnetic generator (MEG).

1 Introduction

Einstein never accepted the Bohr's philosophy, that properties of particles cannot be analyzed without direct experimental control. Bohr's objection of EPR paradox was based on this point.

David Bohm was the first one, who made an attempt to explain wholeness of the Universe, without loosing the causality principle. Experimental discovery: "Aharonov-Bohm effect" (1950) pointing that electron is able to "feel" the presence of a magnetic field even in a regions where the probability of field existing is zero, was stimulating. For explanation of nonlocality Bohm introduced in 1952 the notion of **quantum potential**, which pervaded all of space. But unlike gravitational and electromagnetic fields, its influence did not decrease with distance. All the particles are interrelated by very sensitive to any perturbations quantum potential. This means that signal transmission between particles may occur instantaneously. The idea of **quantum potential or active information** is close to notion of **pilot wave**, proposed by de Broglie at the Solvay Congress in 1927. In fact, Bohm develops the de Broglie idea of pilot wave, applying it for many-body system.

In our model instead quantum potential we introduced the notion of nonlocal Bivacuum gap oscillation (BvO). These waves have a concrete interpretation in the framework of our model and are responsible for nonlocal interaction between Bivacuum and particles and quantum entalgement between particles by means of virtual pressure waves.

In 1957 Bohm published a book: Causality and Chance in Modern Physics. Later he comes to conclusion, that Universe has a properties of giant, flowing hologram. Taking into account its dynamic nature, he prefer to use term: **holomovement**. In his book: Wholeness and the Implicate Order (1980) he develops an idea that our *explicated unfolded reality is a product of enfolded (implicated) or hidden order of existence. He consider the manifestation of all forms in the universe as a result of enfolding and unfolding exchange between two orders, determined by super quantum potential.*

After Bohm, the manifestation of corpuscle - wave duality of particle is dependent on the way, which observer interacts with a system. He claims that both of this properties are always enfolded in particle.

It is a basic difference with our model, assuming that the wave and corpuscle phase are realized alternatively with high frequency during two different semiperiods of sub-elementary particles, forming particles.

In book, written by D. Bohm and B. Hiley (1993): "THE UNDIVIDED UNIVERSE. An ontological interpretation of quantum theory" the electron is considered, as a particle with well-defined position and momentum which are, however, under influence of special wave (quantum potential). Elementary particle, in accordance with these authors, is a **sequence of incoming and**

outgoing waves, which are very close to each other. However, particle itself does not have a wave nature. Interference pattern in double slit experiment after Bohm is a result of periodically "bunched" character of quantum potential.

The important point of Bohmian philosophy, coinciding with our, is that everything in the Universe is a part of dynamic continuum. Neurophysiologist Karl Pribram does made the next step in the same direction as Bohm: **"The brain is a hologram enfolded in a holographic Universe"**.

The good popular description of Bohm and Pribram ideas are presented in books: "The Bell's theorem and the curious quest for quantum reality" (1990) by David Peat and "The Holographic Universe" (1992) by Michael Talbot. Such original concepts are interesting and stimulating, indeed, but should be considered as a first attempts to transform intuitive perception of duality and quantum wholeness into clear geometrical and mathematical models.

In 1950 John Wheeler and Charles Misner published Geometrodynamics, a new description of space-time properties, based on topology. Topology is more general than Euclidean geometry and deeper than non-Euclidean, used by Einstein in his General theory of relativity. Topology does not deal with distances, angles and shapes. Drawn on a sheet of stretching rubber, a circle, triangle and square are indistinguishable. A ball, pyramid and a cube also can be transformed into the other. However, objects with holes in them can never be transformed by stretching and deforming into objects without holes.

For example black hole can be described in terms of topology. It means that massive rotating body behave as a space-time hole. Wheeler supposed that *elementary particles and antiparticles, their spins, positive and negative charges can be presented as interconnected black and white holes.* Positron and electron pair correspond to such model. The energy, directed to one of the hole, goes throw the connecting tube -"handle" and reappears at the other.

The connecting tube exist in another space-time than holes itself. Such a tube is undetectable in normal space and the process of energy transmission looks as instantaneous. In conventional space-time two ends of tube, termed 'worm holes' can be a vast distant apart. It gives an explanation of quantum nonlocality. Like Bohm's quantum potential, the Wheeler's quantum topology remains fascinating but unproved hypothesis.

Sidharth (1998, 1999) considered *elementary particle as a relativistic vortex of Compton radius, from which he recovered its mass and quantized spin.* He pictured a particle as a fluid vortex steadily circulating with light velocity along a 2D ring or spherical 3D shell with radius

$$L = \frac{\hbar}{2mc} \qquad 1$$

Inside such vortex the notions of negative energy, superluminal velocities and nonlocality are acceptable without contradiction with conventional theory.

Bohm's hydrodynamic formulation and substitution

$$\psi = \mathrm{Re}^{iS} \qquad 2$$

where R and S are real function of $\vec{r}$ and t, transforms the Schrodinger equation to

$$\frac{\partial \rho}{\partial t} + \vec{\nabla}(\rho \vec{v}) = 0 \qquad 3$$

$$or: \hbar \frac{\partial S}{\partial t} + \frac{\hbar^2}{2m}(\vec{\nabla} S)^2 + V = \frac{\hbar^2}{2m}(\nabla^2 R/R) \equiv Q \qquad 4$$

where: $\rho = R^2$; $\vec{v} = \frac{\hbar}{2m}\vec{\nabla} S$ *and* $Q = \frac{\hbar^2}{2m}(\nabla^2 R/R)$

Sidharth comes to conclusion that the energy of nonlocal quantum potential (Q) is determined by inertial mass (m) of particle:

$$Q \equiv -\frac{\hbar^2}{2m}(\nabla^2 R/R) = mc^2 \qquad 5$$

He treated also a charged Dirac fermions, as a Kerr-Newman black holes.

Barut and Bracken (1981) considered *zitterbewegung* - rapidly oscillating imaginary part of particle position, leading from Dirac theory (1958), as a harmonic oscillator in the Compton wavelength region of particle. Hestness (1990) proposed, that *zitterbewegung* arises from self interaction, resulting from electromagnetic wave-particle duality. Withing the region of Compton vortex the superluminal velocity and negative energy are possible. If measurements are averaged over time $t \sim mc^2/\hbar$ and over space $L \sim \hbar/mc$, the imaginary part of particle's position disappears and we are back in usual Physics (Sidharth, 1998).

Serious attack on problem of quantum nonlocality was performed by Roger Penrose (1989) with his twister theory of space-time. After Penrose, quantum phenomena can generate space-time. The twisters, proposed by him, are lines of infinite extent, resembling twisting light rays. Interception or conjunction of twistors lead to origination of particles. In such a way the local and nonlocal properties and particle-wave duality are interrelated in twistor geometry. The analysis of main quantum paradoxes was presented by Asher Peres (1992) and Charles Bennett et. al., (1993).

In our Unified model the *local* properties, within the Compton region of Bivacuum dipoles, are resulted from local Bivacuum symmetry shifts of sub-elementary particles, accompanied their inertial mass and charge origination. Their *nonlocal (field)* properties of particles are the consequence of Bivacuum gap symmetry oscillation (BvSO), exciting in a course of their $[C \rightleftharpoons W]$ pulsation, compensating the local symmetry oscillations.

It is important to note, that formalism and quite different approach for computational derivation of quantum relativist systems with forward-backward space-time shifts, developed by Daniel Dubois (1999), led to some results, similar to ours (Kaivarainen, 1993, 1995, 2001). For example, the group and phase masses, introduced by Dubois, related to internal group and phase velocities has analogy with actual and complementary masses, introduced in our Unified model (UM). In both approaches, the product of these masses is equal to the particle's rest mass squared. The notion of discrete time interval, used in Dubois approach, may correspond to PERIOD of $[C \rightleftharpoons W]$ pulsation of sub-elementary particles in UM. The positive internal time interval, in accordance to our model, corresponds to forward $C \to W$ transition and the negative one to the backward $W \to C$ transition.

In theory of Haisch, Rueda and Puthoff (1994), Rueda and Haish (1998) it was proposed, that the inertia is a reaction force, originating in a course of dynamic interaction between the electromagnetic zero-point field (ZPF) of vacuum and charge of elementary particles.

In our approach, the resistance of particle to acceleration (i.e. inertia force), proportional to its mass (second Newton's law) is a consequence of resistance of Bivacuum symmetry for changing, necessary for compensation of the particle's momentum and kinetic energy change.

*Consequently, the inertial property of mass is a consequence of Bivacuum reluctance to change its symmetry shift, necessary for compensation of the kinetic energy of particle change. In contrast to nonlocal Mach's principle, our theory of particle-Bivacuum interaction explains the existence of inertial mass of even single particle in empty Universe***.** The result of our Unified model, that the mass of fermion, is a primary phenomena and its charge is a secondary one, is more reliable, than vice-versa because the energy, related with mass ($E = mc^2$), is much bigger, than that related with charge.

Both approaches have similarity in final conclusion, that inertia may be explained as a local vacuum - related phenomena, without applying to nonlocal Mach's principle and Higgs field.

The work, presented here, is a next stage of development of the Unified model of Bivacuum, $[corpuscle\,(C) \rightleftharpoons wave\,(W)]$ **duality, electromagnetism and gravitation** (Kaivarainen, 1993; 1995; 2001a; 2002; 2002a).

The model of *Bivacuum* is a result of new interpretation of Dirac's theory, pointing to equal probability of positive and negative energy (Dirac, 1958). The symmetry of our Bivacuum as respect to probability of elementary particles and antiparticles creation, makes it principally different from asymmetric Dirac's vacuum (1958), with its realm of negative energy saturated with electrons. Positrons in his model represent the ’holes’, originated as a result of the electrons jumps in realm of positive energy. Currently it becomes clear, that the Dirac’s model of vacuum is not general enough to explain all know experimental data, for example, the bosons emergency.

The main goals of our work can be formulated as follows:

1. Development of Bivacuum model as the dynamic matrix of double cells-dipoles (Bivacuum fermions). Explanation of the elementary fermions: electrons, positrons, etc. and bosons, like photons creation from triplets of asymmetric Bivacuum dipoles - sub-elementary fermions. As far in each triplet, the sub-elementary fermion and sub-elementary antifermion, forming symmetric pairs, compensate the properties of each other, the resulting parameters of triplet (mass, charge, spin, etc.) are defined by third - uncompensated sub-elementary fermion. The *resulting external* properties of elementary particles are described by the existing formalism of quantum mechanics and Maxwell equations;
2. Development of the dynamic model of wave-corpuscle duality of sub-elementary particles/antiparticles, composing elementary particles and antiparticles. Explanation of the nonlocal quantum entanglement and double slit experiment, based on new models;
3. Development of the Einstein’s and Dirac’s formalism for free relativistic particles, based on new duality model, introducing the notions of the actual and complementary states of sub-elementary particles, as a mass, charge, magnetic dipoles;
4. Finding the relation between the internal and external parameters of sub-elementary particles and elucidation the quantum roots of Golden Mean;
5. Calculation of magnetic moment of the electron, based on our Unified Model (UM). Evaluation of the most probable velocities of zero-point oscillations, responsible for electromagnetic and gravitational potentials of the electron;
6. Unification of electromagnetism, gravitation and time in the framework of new model;
7. Explanation of symmetry of electromagnetism, providing the solution of Dirac’s monopole problem;
8. Demonstration of links between the Unified model of particles and the Maxwell’s equations;
9. Introducing a new Harmonization force of Bivacuum, driving the evolution of matter on all hierarchical levels to Golden mean conditions. New definition of the rest mass of elementary particles;
10. The realization of Principle of least action, as a result of Harmonization force action on particles dynamics and kinetic energy;
11. Construction of the new Hydrogen atom model, alternative to the Bohr’s one;
12. Explanation of the Searl and Bearden machines action, utilizing the uncompensated superfluous energy of the asymmetric Bivacuum.

1.1 New Model of Bivacuum

We define Bivacuum, as a dynamic matrix of the Universe with superfluid and nonlocal properties, composed from non mixing collective excitations of microscopic *sub-quantum particles* of the opposite energies. The *meso - structure of Bivacuum* is presented by infinitive number of three-dimensional (3D) double cells-dipoles, each cell containing a pair of correlated rotors and antirotors: (V^+) and (V^-) with the opposite quantized virtual mass ($m_C^+ = i^2 m_C^-$, where $i^2 = -1$). The rotors and antirotors, as a main elements of Bivacuum, are the result of collective excitations (circulation) of ultramicroscopic sub-quantum particles and sub-quantum antiparticles, correspondingly. The size of sub-quantum particles/antiparticles should be of 10^{-28} cm, or less, when all kind of interactions [electromagnetic (EM), weak and strong] come together. The (V^+) and (V^-) are separated by energetic gap, depending on the energy of collective excitations and related to their radius. It is assumed, that the medium of sub-quantum particles, filling Bivacuum, has a properties of superfluid liquid and the formalism of hydrodynamics for liquids without friction is applicable to Bivacuum.

We postulate in our model, that the fundamental quantized energies and frequencies $(\omega_0^{e,\mu,\tau} = |\pm m_0^{e,\mu,\tau}|c^2/\hbar)$ of each of rotor $[V^+]$ and antirotor $[V^-]$ correspond to the rest mass of three electron's generation: e, μ, τ.

Consequently, just a quantum discreet Bivacuum properties is a background of hierarchy of leptons (neutrino, electrons and quarks) generations.

The pairs of rotors (V^+) and antirotors (V^-) form different kinds of dipoles: the mass, electric and magnetic dipoles. They carry equal by absolute value, but opposite by signs virtual mass $|m_C^+| = |-m_C^-|$, electric charges $|e_+| = |-e_-|$ and magnetic moments $|\mu_+| = |-\mu_-|$. Consequently, the primordial Bivacuum (in the absence of matter and fields) on macroscopic scale is a neutral medium with resulting energy, mass, spin, charge, magnetic moment - equal to zero, due to zero symmetry shift. It is filled with infinitive number of double vorticity excitations (double cells - dipoles): Bivacuum fermions ($BVF^{\uparrow}_{S=1/2} = V^+ \upuparrows V^-$) and antifermions ($BVF^{\downarrow}_{S=-1/2} = V^+ \downdownarrows V^-$) with opposite half-integer spins, corresponding to the opposite circulation of pairs [rotor + antirotor]. In each pair of $BVF^{\uparrow}_{S=1/2}$ and $BVF^{\downarrow}_{S=-1/2}$ the rotor and antirotor are in-phase.

From condition of the resulting spin of Bivacuum equal to zero, it follows, that the total number of $BVF^{\uparrow}_{S=1/2}$ *and* $BVF^{\downarrow}_{S=-1/2}$ should be equal due to dynamic equilibrium. The intermediate transition state between Bivacuum fermions of opposite spins with antiphase (V^+) and (V^-) rotation represents Bivacuum boson ($BVB^{\pm}_{S=0} = V^{\pm} \updownarrow V^{\mp}$) of two possible polarization (+ and −) and zero spin:

$$BVF^{\uparrow}_{S=1/2} \rightleftharpoons BVB^{\pm}_{S=0} \rightleftharpoons BVF^{\downarrow}_{S=-1/2} \tag{1.1}$$

Bivacuum bosons have a properties of Falaco soliton in description of Kiehn (1998).

The double cells of $BVF^{\updownarrow}_{S=\pm 1/2}$ and $BVB^{\pm}_{S=0}$ with external momentum, equal to zero, can be considered as a virtual molecules of Bivacuum, forming Virtual Bose Condensate (VirBC) with nonlocal properties (Kaivarainen, 2001a; 2002a).

In primordial Bivacuum, i.e. in the absence of matter and fields, the absolute values of quantized energies of rotors ($|E^+_{\mathbf{V}}|^{e,\mu,\tau}$) and antirotors ($|-E^-_{\mathbf{V}}|^{e,\mu,\tau}$) are equal to each other and totally compensate each other:

$$|E^+_{\mathbf{V}}|^{e,\mu,\tau}_{n=0} = |-E^-_{\mathbf{V}}|^{e,\mu,\tau}_{n=0} = \frac{1}{2} m_0 c^2 = \frac{1}{2} |\pm\hbar\omega_0^{e,\mu,\tau}| \tag{1.2}$$

$$or: \; |\pm E^{\pm}_{\mathbf{V}}|^{e,\mu,\tau}_n = |\pm m_0^{e,\mu,\tau}| c^2 \left(\frac{1}{2} + n\right) = |\pm\hbar\omega_0^{e,\mu,\tau}| \left(\frac{1}{2} + n\right) = \frac{\hbar c}{[L^{\pm}_V]^{e,\mu,\tau}_n} \tag{1.2a}$$

where the quantized radiuses of Compton vortices of correlated rotors and antirotors, forming Bivacuum fermions (BVF$^{\uparrow}$ with spin $S = +1/2\hbar$ and BVF$^{\downarrow}$ with spin $S = -1/2\hbar$) and Bivacuum bosons (BVB$^{\pm}$ with spin $S = 0$) are also equal:

$$[L^+_V = L^-_V]^{e,\mu,\tau}_n = \hbar/[m_0 c(1/2 + n)]^{e,\mu,\tau} \tag{1.2b}$$

The energy of double cells - dipoles is a sum of [rotor + antirotor] energies. For symmetrical primordial Bivacuum it is equal to zero:

$$(E_{V^+ + V^-})^{e,\mu,\tau}_n = (E^+_{\mathbf{V}})^{e,\mu,\tau}_n + (-E^-_{\mathbf{V}})^{e,\mu,\tau}_n = 0 \tag{1.2c}$$

The total energy of primordial Bivacuum, as a sum of energy of all Bivacuum dipoles also is zero.

The energetic gap $(A^{e,\mu,\tau})_n$, separating rotor and antirotor, i.e. the difference of their energies, in each double cell is equal to difference of their energy:

$$(A^{e,\mu,\tau})_n = [E^+_{\mathbf{V}} - (-E^-_{\mathbf{V}})]^{e,\mu,\tau}_n = |\pm m_0^{e,\mu,\tau}| c^2 (2n+1) = \tag{1.3}$$

$$= |\pm\hbar\omega_0^{e,\mu,\tau}| (2n+1) = \frac{\hbar c}{[L_{V^+ + V^-}]^{e,\mu,\tau}_n} \tag{1.3a}$$

where the quantized Compton radius vortices of pairs of [rotor+antirotor], equal to that of BVF$^{\updownarrow}$ and BVB$^{\pm}$, is defined as:

$$[L_{V^+ + V^-}]_n^{e,\mu,\tau} = [L_{BVF^\updownarrow;BVB^\pm}]_n^{e,\mu,\tau} = \frac{\hbar}{m_0^{e,\mu,\tau}c(2n+1)} \qquad 1.3b$$

The double cells are in the process of permanent dynamic exchange interaction, following by absorption and emission of virtual clouds ($VC^\pm$) of sub-quantum particles and antiparticles in a course of transitions between the rotors and antirotors states of different quantum numbers: $n = 0, 1, 2, 3\ldots$

In accordance to model, the external momentum of double cells is zero ($p^{ext} = 0$), in contrast to internal momentum ($|p^+| = |-p^+| = m_C^\pm c$). It means that a system of double cells forms the virtual Bose condensate (VirBC) with nonlocal properties:

$$\lambda_{BC}^{ext} = [h/p^{ext}] = \infty \qquad 1.4$$

$$at \quad p^{ext} = 0$$

1.2. Virtual Bose Condensation (VirBC) of Bivacuum as a Base of Nonlocality

The Virial theorem in general form is correct not only for classical, but as well for quantum systems. It relates the averaged external kinetic $\bar{T}_k(\vec{v}) = \sum_i \overline{m_i v_i^2/2}$ and potential $\bar{V}(\mathrm{r})$ energies of particles, composing these systems:

$$2\bar{T}_k(\vec{v}) = \sum_i \overline{m_i v_i^2} = \sum_i \overline{\vec{r}_i \partial V/\partial \vec{r}_i} \qquad 1.5$$

If the potential energy $\overline{V}(\mathrm{r})$ is a homogeneous $n-order$ function like:

$$\overline{V}(r) \sim r^n \qquad 1.6$$

then average external kinetic and average potential energies are related as:

$$n = \frac{2\overline{T_k}}{\overline{V(r)}} \qquad 1.7$$

For example, for a harmonic oscillator, when $\bar{T}_k = \bar{V}$, we have $n = 2$.
For Coulomb interaction: $n = -1$ and $\bar{T} = -\bar{V}/2$.
It is interesting to note, that at the average kinetic energy and momentum ($\overline{p}$) tending to zero:

$$\overline{T_k} = \overline{p}^2/2m \to 0 \qquad 1.8$$

the interaction between particles of system becomes nonlocal, i.e. independent on distance between them:

$$\overline{V}(r) \sim r^{(0)} = 1 = const \qquad 1.9$$

We define nonlocality, as independence of any potential in the volume of Bose condensation (actual or virtual) on distance (r). In the case under consideration: $n = 2T_{kin}^{ext}/V = 0$, as far the external kinetic energy: $T_{kin}^{ext} = \left[(p^{ext})^2/2m_C^\pm\right] = 0$.

The resulting energy and momentum of primordial Bivacuum keeps constant in a course of strictly correlated spontaneous transitions in two parts of double cells, corresponding to positive (+) and negative (-) energy, because they compensate each other. The sequential excitation/relaxation of double cells of Bivacuum is followed by virtual pressure waves (VPW^+ and VPW^-) excitation, representing the oscillation of virtual pressure [VPr^+] and [VPr^-], correspondingly.

1.3. Quantization of Secondary Bivacuum

In asymmetric **secondary Bivacuum,** existing in presence of inertial matter or antimatter and fields, the dynamic equilibrium (1.1e) is shifted to the left or to the right. However, finally all Bivacuum symmetry shifts (local, induced by particles and nonlocal, corresponding to fields) compensate each other in order to keep in force the energy conservation law (see section 11.4).

For secondary Bivacuum the eqs.(1.2a), characterizing the energies of asymmetric rotors and antirotors of $BVF^{\updownarrow}$ and $BVB^{\pm}$, corresponding to three leptons generation $(i = e, \mu, \tau)$, looks like:

$$(E_V^+ + \Delta E_V^+)_n^i = +\hbar(\omega_0^i + \Delta\omega_0^i)(\frac{1}{2} + n) = +(m_0^i + \Delta m_0^i)c^2(\frac{1}{2} + n) = \frac{\hbar c}{(L_V^+)_n^i} \quad 1.10$$

$$(E_V^- - \Delta E_V^-)_n^i = -\hbar(\omega_0^i - \Delta\omega_0^i)(\frac{1}{2} + n) = -(m_0^i - \Delta m_0^i)c^2(\frac{1}{2} + n) = -\frac{\hbar c}{(L_V^-)_n^i} \quad 1.10a$$

The difference between the effective mass of V^+ and V^- of $BVF^{\uparrow}$ and $BVF^{\downarrow}$, in accordance to our model, means possibility of uncompensated inertial mass and uncompensated charge (positive and negative) existing.

The quantized Compton radiuses of rotor $(V^+)_n$ and antirotor $(V^-)_n$ are equal, correspondingly, to:

$$(L_V^+)_n^i = \frac{\hbar}{(m_0^i + \Delta m_0^i)c(\frac{1}{2} + n)} \quad 1.11$$

$$(L_V^-)_n^i = \frac{\hbar}{(m_0^i - \Delta m_0^i)c(\frac{1}{2} + n)} \quad 1.11a$$

For our case: $(L_V^+)_n^i < (L_V^-)_n^i$.

The value of energetic gap between similarly excited rotor and antirotor remains unchanged and equal to (1.3 and 1.3a).

However, the local energy of asymmetric $BVF^{\updownarrow}$ and $BVB^{\pm}$, composing secondary Bivacuum, as a sum of (10.10 and 10.10a), in contrast to primordial one (see 1.2c), is nonzero and dependent on the sign of vacuum shift $(+ \;\; or \;\; -)$, related in turn, to matter or antimatter excess in Bivacuum:

$$\left(E^i_{BVF^{\updownarrow},BVB^{\pm}}\right)_n = \pm 2\hbar\Delta\omega_0^i(\frac{1}{2} + n) = \pm 2\Delta m_0^i c^2(\frac{1}{2} + n) = \quad 1.12$$

$$= \pm\Delta m_0^i c^2(1 + 2n) \quad 1.12a$$

We can see, that the resulting energy of asymmetric $(BVF^{\updownarrow}\, and\, BVB^{\pm})^*$ of secondary Bivacuum is dependent on sign and value of Bivacuum symmetry shift: $\pm\hbar\Delta\omega_0^i = \pm\Delta m_0^i c^2$ and Bivacuum excitation state, determined by (n).

The gradient of difference of density between Bivacuum fermions of opposite spins, related with gradient of their equilibrium constant is equal to:

$$grad(1 - K_{BVF}) = grad(1 - [BVF^{\uparrow}]/[BVF^{\downarrow}]) \quad 1.13$$

and the gradient of difference in concentration of BVB^+ and BVB^- of opposite polarization:

$$grad(|1 - K_{BVB^{\pm}}|) = grad(|1 - [BVB^+]/[BVB^-]|) \quad 1.14$$

originated under the influence of rotating atoms, molecules or macroscopic bodies and curled electromagnetic field may be responsible for so called **TORSION field** in the framework of our model.

1.4. Virtual Particles and Antiparticles

Generally accepted difference of virtual particles from the actual ones, is that the former, in contrast to latter, does not follow the laws of relativist mechanics:

$$m = \frac{m_0}{\pm[1-(\frac{v}{c})^2]^{1/2}} \qquad 1.15$$

and, consequently, the Dirac's equation.

For actual free particle with rest mass (m_0) and relativist mass (m), the Dirac's formula, leading from (1.15) is:

$$E^2 - \vec{p}^{\,2}c^2 = m_0^2c^4 \qquad 1.16$$

where $E^2 = (mc^2)^2$ is the total energy squared and $p = mv$ is the momentum of particle.

For virtual particles and photons the Dirac's equality (1.16) is not valid. *It means that there are no velocity, momentum and energy limitations for virtual particles and antiparticles.*

For example, as a result of [electron - proton] interaction, mediated by virtual photons, the electron and proton total energies do not change. Only the directions of their momentums are changed.

In this case the energy of virtual photon in the Dirac's equation $E = 0$ and:

$$E^2 - \vec{p}^{\,2}c^2 = -\vec{p}^{\,2}c^2 < 0 \qquad 1.17$$

The measure of virtuality (Vir) is a measure of Dirac's relation validity:

$$(\mathrm{Vir}) \sim \quad |\ m_0^2c^4 - (E^2 - \vec{p}^{\,2}c^2)\ | \geq 0 \qquad 1.18$$

In contrast to actual particles, the virtual ones have a more limited radius of action. The more is the virtuality (Vir), the lesser is the radius. Each of emitted virtual quantum must be absorbed by the same wave B or another.

A lot of process in quantum electrodynamics can be illustrated by Feynman diagrams (Feynman, 1985). In these diagrams, *actual* particles are described as infinitive rays (lines) and virtual particles as stretches connecting these lines (Fig. 1).

Each peak (or angle) in Feynman diagrams means emission or absorption of quanta or particles. The energy of each process (electromagnetic, weak, strong) is described using correspondent fine structure constants.

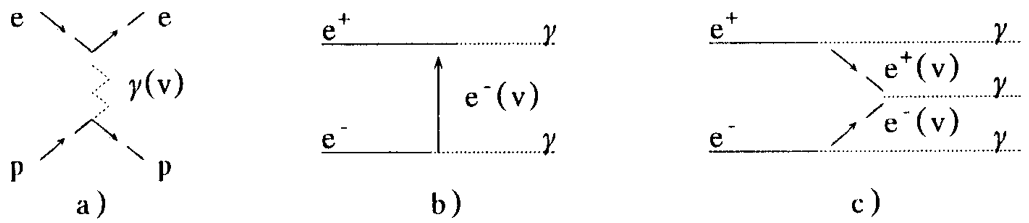


Fig. 1. Feynman diagrams describing electron-proton scattering (interaction), mediated by virtual photons: **a)** - annihilation of electron and positron by means of virtual electron $e^-(v)$ and virtual positron $e^+(v)$ with origination of *two* and *three* actual photons (γ) : diagrams **b)** and **c)** correspondingly.

It is shown in section above, that the symmetric excitations: $\mathrm{BVB}^{\pm}$, $\mathrm{BVF}^{\uparrow}$ and $\mathrm{BVF}^{\downarrow}$ may have a broad spectra of radiuses and energetic gaps, determined by the energy and effective mass of excitations. This means the existence of fractal hierarchic structure of Bivacuum**,** as a superposition of different circulations, pairs of torus or vortices.

The excitations, resulting from transitions between in-phase rotors $[(V_\uparrow^+)_j - (V_\uparrow^+)_k]^{\pm}$, are **virtual fermions** ($S = \pm\frac{1}{2}$) and those, resulting from transitions between antiphase rotors $[(V_\uparrow^+)_j - (V_\downarrow^+)_k]^{\pm}$, are **virtual bosons** ($S = 0$).

The transmission of signal in form of nonresonant Bivacuum gap oscillation (BvO), propagating in Bivacuum without origination/annihilation of pairs of virtual particles and antiparticles is instant. The infinitive velocity of signal transmission is a result of nonlocal *properties of any kind of Bose condensate: actual or virtual, as was demonstrated in section* 1.2.

Signals in form of BvO in the volume of virtual Bose condensate of BVF and $BVB^{\pm}$ are not related with energy-momentum transmission. However, they may modulate the virtual pressure waves ($VPW^{\pm}$) of Bivacuum. it may be responsible for nonlocal component of Bivacuum.

1.5 Virtual Pressure Waves ($VPW^{\pm}$) in Bivacuum

The creation of virtual particles and antiparticles in our model is a result of certain combinations of virtual clouds ($\mathbf{VC}^{+}_{j,k}$) and anticlouds ($\mathbf{VC}^{-}_{j,k}$). Virtual clouds and anticlouds represent a correlated transitions between different excitation states (j,k) of rotors ($V^{+}_{j,k}$) and antirotors ($V^{-}_{j,k}$), forming $[BVF^{\updownarrow}]^{i}$ *and* $[BVB^{\pm}]^{i}$, corresponding to three lepton generation $(i = e,\mu,\tau)$, from higher to lower levels $(j \to k)$:

$$\mathbf{VC}^{+}_{j,k} \equiv [\mathbf{V}^{+}_{j} - \mathbf{V}^{+}_{k}] \; - \; virtual\ cloud \tag{1.19}$$

$$\mathbf{VC}^{-}_{j,k} \equiv [\mathbf{V}^{-}_{j} - \mathbf{V}^{-}_{k}] \; - \; virtual\ anticloud \tag{1.19a}$$

($\mathbf{VC}^{+}_{j,k}$) and ($\mathbf{VC}^{-}_{j,k}$) exist in form of collective excitation sub-quantum particles and antiparticles, corresponding to the wave [W] phase of elementary particles (see Chapter 2).

The absorption (annihilation) of virtual cloud and anticloud represents the reverse transitions $[k \to j]$:

$$-\,\mathbf{VC}^{\pm}_{k,j} \equiv [\mathbf{V}^{\pm}_{k} - \mathbf{V}^{\pm}_{j}] \tag{1.20}$$

accompanied by absorption of $VC^{\pm}$ and excitation of corresponding Bivacuum fermion ($BVF^{\updownarrow}_{k} \to BVF^{\updownarrow}_{j}$) or Bivacuum boson ($BVB^{\pm}_{k} \to BVB^{\pm}_{j}$).

From (1.10 and 1.10a) the quantized energy of virtual clouds and anticlouds are:

$$(\mathbf{VC}^{+}_{j,k})^{i} = E^{i}_{j-k} = \hbar(\omega^{i}_{0} + \Delta\omega^{i}_{0})(j-k) = (m^{i}_{0} + \Delta m^{i}_{0})c^{2}(j-k) \tag{1.21}$$

$$(\mathbf{VC}^{-}_{j,k})^{i} = \widetilde{E}^{i}_{j-k} = -\hbar(\omega^{i}_{0} - \Delta\omega^{i}_{0})(j-k) = -(m^{i}_{0} - \Delta m^{i}_{0})c^{2}(j-k) \tag{1.21a}$$

At condition: $\Delta m^{i}_{0} \ll m^{i}_{0}$, and most probable transitions with $(j-k) = 1$ we have:

$$|\mathbf{VC}^{+}_{j,k}|^{i} \simeq |\mathbf{VC}^{-}_{j,k}|^{i} = m^{i}_{0}c^{2} \tag{1.22}$$

Comparing this formula with expression for quantum potential ($Q = mc^{2}$) in Sidharch's (1998) interpretation (5) for the case, when $m = m_{0}$, we can see that they coincide. It means that in the framework of our theory the nonlocal quantum potential of Bohm is equal to energy of most probable virtual clouds ($VC^{\pm}$). In huge domains of virtual Bose condensation of secondary Bivacuum the $VC^{\pm}$ may be modulated by nonlocal Bivacuum symmetry oscillation (BvSO). We may suppose, that quantum beats between the excited states [j and k] of $BVB^{\pm}_{j}$ and $BVB^{\pm}_{k}$ may lead to creation/annihilation of pairs of neutral virtual bosons and antibosons. The similar transitions between $BVF^{\updownarrow}_{j}$ and $BVF^{\updownarrow}_{k}$ correspond to creation/annihilation of pars of charged virtual fermions.

The process of [*creation* $\rightleftharpoons$ *annihilation*] of virtual clouds and their superposition in form of virtual particles, - should be accompanied by oscillation of *virtual pressure ($VP^{\pm}$) in form of positive and negative virtual pressure waves (VPW^{+} and VPW^{-}).*

In primordial Bivacuum the virtual pressure waves: VPW^{+} and VPW^{-} totally compensate each other. However, in asymmetric secondary Bivacuum, in presence of matter and fields such compensation is absent and the resulting pressure of virtual particles or antiparticles becomes nonzero. This displays, for example, in Casimir effect.

In contrast to actual particles, the virtual ones may exist only in the wave [W] phase, but not in corpuscular [C] phase (see Section 3). It is a reason, why [$VPW^{\pm}$] and their superposition do not obey the laws of relativist mechanics and causality principle.

The $[j \rightleftharpoons k]^{e,\mu,\tau}$ transitions of rotors and antirotors should be accompanied by electromagnetic

(EM) dipole radiation with frequency of such transitions. In accordance to our model of Bivacuum, the in-phase transitions $[j \rightleftharpoons k]^{e,\mu,\tau}$ of rotors and antirotors are accompanied by in-phase oscillations of internal charges ($e_\pm$) of dipoles. As a result of corresponding EM pumping, the population of higher (j) levels may get bigger, than the population of lower (k) levels ($j > k$). Besides this pumping effect, due to energy compensation in two compartments of double cells, this inversion of population may (like in lasers) occur even spontaneously.

This means that Bivacuum can be considered, as the active medium, where double cells are the active elements. Consequently, VPW^+ and VPW^- may have a properties of three-dimensional (3D) autowaves. It is known from existing theory of waves, that 3D autowaves can propagate in space, form rotating spiral structures (reverberations) or have the stationary structures.

2 Creation of Elementary Particles and Antiparticles, as a Result of Bivacuum Dipoles Symmetry Shift

2.1. Creation of Sub-Elementary Particles

The spontaneous or induced by external fields Bivacuum symmetry violation is accompanied by sub-elementary particles and antiparticles creation. Shifting the equality of positive and negative energy of Bivacuum to the left (eq.1.2) is accompanied by the leftward shift of equilibrium (1.1). This symmetry breach of Bivacuum fermions of positive and negative spins ($S = \pm 1/2$), turns them in conditions of resonant energy exchange with Bivacuum, to sub-elementary particles fermions $(\mathbf{F}^+_\updownarrow)^i$ of three generation ($i = e,\mu,\tau$):

$$\left(BVF^{\uparrow}_{S=+1/2} \rightarrow \left(BVF^{\uparrow}_{S=+1/2}\right)^+ \equiv \mathbf{F}^+_\uparrow = [\mathbf{V}^+ \upuparrows \mathbf{V}^-]^*\right)^i \qquad 2.1$$

$$\left(BVF^{\downarrow}_{S=-1/2} \rightarrow \left(BVF^{\downarrow}_{S=-1/2}\right)^+ \equiv (\mathbf{F}^+_\downarrow)^i = [\mathbf{V}^+ \downdownarrows \mathbf{V}^-]^*\right)^i$$

The opposite shift of Bivacuum fermions symmetry, as compared to (2.1), is accompanied by creation of sub-elementary antiparticles of opposite Bivacuum dipoles energy and charge:

$$\left(BVF^{\updownarrow}_{S=\pm 1/2} \rightarrow \left(BVF^{\updownarrow}_{S=\pm 1/2}\right)^- \equiv \mathbf{F}^-_\updownarrow = [\mathbf{V}^+ \updownarrow \mathbf{V}^-]^*\right)^i \qquad 2.1a$$

It will be shown in Chapter 4, that at Golden mean conditions the minimum energy of sub-elementary particle, as a sum of the asymmetric rotor and antirotor kinetic energies of spinning, is equal to the rest mass ($m_0^i c^2$) of particle:

$$\mathbf{E}^i_{\mathbf{F}^\pm_\updownarrow} = |E^+_\mathbf{V} + \Delta E^+_\mathbf{V}|^i + (-E^-_\mathbf{V} + \Delta E^-_\mathbf{V}) = |\Delta E^+_\mathbf{V}|^i + |\Delta E^-_\mathbf{V}|^i = \qquad 2.1b$$

$$= |m_C^+ c^2 - m_C^- c^2|^i \geqslant m_0^i c^2$$

where: m_C^+ and m_C^- are the actual and complementary mass of the asymmetric rotors and antirotors in asymmetric double cells-dipoles of Bivacuum $(\mathbf{F}^\pm_\updownarrow)^i$.

2.2 Fusion of Elementary Particles From Sub-Elementary Particles

The triplets of sub-elementary particles/antiparticles: $\langle [F^-_\updownarrow \bowtie F^+_\updownarrow] + F^\pm_\updownarrow \rangle^i$, corresponding to three lepton generation ($i = e,\mu,\tau$) build elementary particles, like electrons, positrons, photons and quarks. The systems of *asymmetric* double cells in form of sub-elementary and elementary particles, atoms and molecules is dissipative and is not more superfluid.

The electron and positron of each generation, in accordance to our model, are the triplets:

$$\langle [\mathbf{F}^-_\uparrow \bowtie \mathbf{F}^+_\downarrow] + \mathbf{F}^-_\updownarrow \rangle_{e,\mu,\tau} \qquad (electron) \qquad 2.2$$

$$\langle [\mathbf{F}^-_\uparrow \bowtie \mathbf{F}^+_\downarrow] + \mathbf{F}^+_\updownarrow \rangle_{e,\mu,\tau} \qquad (positron) \qquad 2.2a$$

formed by pair of [sub-elementary fermion + sub-elementary antifermion] of opposite spins and charges ($\mathbf{F}^-_\uparrow$ and $\mathbf{F}^+_\downarrow$) and one sub-elementary fermion ($\mathbf{F}^-_\updownarrow$) or antifermion ($\mathbf{F}^+_\updownarrow$), with two spins

($\pm\frac{1}{2}$, defined as $\uparrow$ and $\downarrow$), correspondingly. The notation $[\bowtie]$ means that $[C \rightleftharpoons W]$ pulsation of $\mathbf{F}_{\uparrow}^{-}$ and $\mathbf{F}_{\downarrow}^{+}$ are in-phase with each other and in counter phase with $\mathbf{F}_{\updownarrow}^{\pm}\rangle$.

The external properties of the electrons and positrons, like mass, spin, charge is determined by **uncompensated** sub-elementary particle $[\mathbf{F}_{\updownarrow}^{-} >$ or sub-elementary antiparticle $[\mathbf{F}_{\updownarrow}^{+} >$.

Photon may be represented as a superposition of electron and positron $<3[\mathbf{F}_{\updownarrow}^{+} \bowtie \mathbf{F}_{\updownarrow}^{-}| >$ in form of three coherent pairs:
$\left[3 \text{ sub-elementary fermion } (\mathbf{F}_{\updownarrow}^{-}) + 3 \text{ sub-elementary antifermion } (\mathbf{F}_{\updownarrow}^{+})\right]$ with boson properties and resulting spin $J = 1$. *The main difference between bosons and fermions is that the former particles are composed from equal number of standing sub-elementary fermions/antifermions: $F_{\uparrow}^{-}$ and $F_{\downarrow}^{+}$ and the latter ones - from their non equal number.*

In accordance to our model, the symmetry of photons and their inability to change Bivacuum symmetry - is a factor, which determines their propagation in Bivacuum with light velocity.

Two structure of photon ($S = \pm 1\hbar$), corresponding to its two polarization and spin can be presented as:

$$\langle [2\mathbf{F}_{\uparrow}^{-} \bowtie 2\mathbf{F}_{\downarrow}^{+}] + [\mathbf{F}_{\downarrow}^{+} + \mathbf{F}_{\downarrow}^{-}]\rangle \qquad S = -1 \qquad 2.3$$

$$\langle [2\mathbf{F}_{\uparrow}^{-} \bowtie 2\mathbf{F}_{\downarrow}^{+}] + [\mathbf{F}_{\uparrow}^{+} + \mathbf{F}_{\uparrow}^{-}]\rangle \qquad S = +1 \qquad 2.3a$$

The u-quark ($\mathbf{Z} = +\frac{2}{3}$) is considered in our theory, as a superposition of two positron - like structures of heavy μ and/or τ lepton generation:

$$\mathbf{u} \sim [\mathbf{e}^{+} + \mathbf{e}^{+}]^{\mu,\tau} = 2\langle [\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}] + \mathbf{F}_{\downarrow}^{+}\rangle^{\mu,\tau} \qquad 2.4$$

The d-quark ($\mathbf{Z} = -\frac{1}{3}$) can be composed from two electrons and one positron - like structures of the same generations:

$$\mathbf{d} \sim [\mathbf{2e}^{-} + \mathbf{1e}^{+}]^{\mu,\tau} = \{2\langle [\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}] + \mathbf{F}_{\downarrow}^{-}\rangle + \langle [\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}] + \mathbf{F}_{\downarrow}^{+}\rangle\}^{\mu,\tau} \qquad 2.5$$

Each of excessive standing sub-elementary particles: $\mathbf{F}^{+}$ and $\mathbf{F}^{-}$ in quark - has an electric charge (Z), equal to +1/3 and -1/3 correspondingly. The electron-positron structure of quarks is formed by sub-elementary particles/antiparticles of $[\mu \ and/or \ \tau]$ generation, much heavier, than $[e]$ – generation.

In our model, the proton with charge ($\mathbf{Z} = +1$):

$$\mathbf{p} = [\mathbf{2u} + \mathbf{d}]^{\mu,\tau} \qquad 2.6$$

contains more standing sub-elementary fermions $(\mathbf{12F}^{+})$, than that sub-elementary antifermions $(9\mathbf{F}^{-})$. Each proton contains three excessive standing sub-elementary fermions $\mathbf{F}^{+}$. The resulting spin and charge of proton is equal and opposite to that of the electron.

The neutron ($\mathbf{Z} = 0$):

$$\mathbf{n} = [\mathbf{d} + \mathbf{2u}]^{\mu,\tau} \qquad 2.7$$

is composed from the equal number of standing excited sub-elementary fermions and antifermions: $(12\mathbf{F}^{+})$ and $(12\mathbf{F}^{-})$.

One of predictions of our model is a possibility of emergency of unstable, short-living **isolated** sub-elementary fermions $(\mathbf{F}_{\updownarrow}^{-})$ and antifermions $(\mathbf{F}_{\updownarrow}^{+})$, as well as their more stable **pairs with opposite and similar spins:**

$$[\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}]^{e,\mu,\tau}; \quad [\mathbf{F}_{\downarrow}^{-} \bowtie \mathbf{F}_{\uparrow}^{+}]^{e,\mu,\tau} \qquad 2.8$$

$$[\mathbf{F}_{\downarrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}]^{e,\mu,\tau}; \quad [\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\uparrow}^{+}]^{e,\mu,\tau} \qquad 2.8a$$

Such kind of particles can be created, for example, by strong curled (axial) magnetic field, exciting Bivacuum fermions: $\left(BVF_{S=\pm 1/2}^{\updownarrow}\right)$, *turning them to sub-elementary fermions or* *antifermions* ($\mathbf{F}_{\updownarrow}^{\pm}$). The difference may be dependent on direction of the axion field rotation: *clockwise or anticlockwise*, as respect to surface of Earth (i.e. maximum of gravitational potential). The electrons, positrons and photons also can be created by the axion-field generator due to corresponding combination of the *excited by generator* sub-elementary particles $\left(BVF^{\updownarrow}_{S=\pm 1/2}\right)^* = \mathbf{F}_{\updownarrow}^{\pm}$, accompanied by the change of Bivacuum cells-dipole symmetry.

The experimental evidence of like phenomena has been obtained recently by Sue Benford (2002).

The isolated Bivacuum fermions and antifermions do not interact with photons, however, they are changing the curvature of Bivacuum, like the triplets of sub-elementary particles. This means that their nonhomogeneous density distribution could be responsible for 'dark' matter gravitational effects.

The intermediate transition stage between opposite spin states sub-elementary fermion or antifermion ($S = +\frac{1}{2} \rightarrow S = -\frac{1}{2}$) is a sub-elementary boson of two possible polarization ($\mathbf{B}^-$ *and* $\mathbf{B}^+$):

$$[\mathbf{F}_{\uparrow}^{-} \rightleftharpoons \mathbf{B}^{-} \rightleftharpoons \mathbf{F}_{\downarrow}^{-}]^{e,\mu,\tau} \qquad 2.9$$

$$[\mathbf{F}_{\uparrow}^{+} \rightleftharpoons \mathbf{B}^{+} \rightleftharpoons \mathbf{F}_{\downarrow}^{+}]^{e,\mu,\tau} \qquad 2.9a$$

Possible mechanism of elementary particles fusion from two kinds of sub-elementary **vortex-dipoles** ($F_{\updownarrow}^{+}$ and $F_{\updownarrow}^{-}$) and their pairs $[F_{\updownarrow}^{+} \bowtie F_{\updownarrow}^{-}]$ in superfluid Bivacuum with gradient of symmetry shift may have same analogy with suggested by Schester and Dubin (1999), Jin and Dubin (2000) the *"vortex crystal"* formation.

The structure of triplets is stabilized by exchange of virtual clouds of sub-quantum particles between two sub-elementary fermions or antifermions of the opposite spins: $[\mathbf{F}_{\downarrow}^{+}]$ and $\mathbf{F}_{\uparrow}^{+}\rangle$ or $[\mathbf{F}_{\uparrow}^{-}]$ and $\mathbf{F}_{\downarrow}^{-}\rangle$ in a course of their *counterphase* $[C \rightleftharpoons W]$ pulsation (see section 3). Stabilization of pair of sub-elementary fermion and antifermion of mirror symmetry $[\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}]$ or $[\mathbf{F}_{\downarrow}^{+} \bowtie \mathbf{F}_{\uparrow}^{-}]$, pulsing in-phase, occur due to minimization of local Bivacuum energy/symmetry shift, reflecting the spatially localized energy conservation (section 11.4).

We assume, that the orientation of cell-dipoles in triplets is normal to each other: the uncompensated $[\mathbf{F}_{\updownarrow}^{\pm}\rangle$ is oriented along the $[y]$ axe, coinciding with direction of particles external momentum, the sub-elementary particle $\mathbf{F}_{\updownarrow}^{+}$ is oriented along axe [z] and sub-elementary antiparticle $\mathbf{F}_{\updownarrow}^{-}$ is oriented along axe [x].

The symmetry of our Bivacuum as respect to probability of elementary particles and antiparticles creation, makes it principally different from asymmetric Dirac's vacuum (1958), with its realm of negative energy saturated with electrons. Positrons in his model represent the 'holes', originated as a result of the electrons jumps to realm of positive energy. Currently it is clear, that the Dirac's model of vacuum is not general enough to explain all know experimental data, for example, the bosons emergency.

The law of energy conservation keeps the total energy of [secondary Bivacuum + energy of sub-elementary particles] unchanged and equal to zero, like in primordial Bivacuum:

$$\sum^{n=N} \Delta\mathbf{E}_{\mathrm{V}}^{n}(F_{\updownarrow}^{\pm})^{i} + \sum^{j=\infty} \Delta\mathbf{E}_{\mathrm{V}}^{j}(BVF^{\uparrow} \rightleftharpoons BVF^{\downarrow})^{i} = 0 \qquad 2.10$$

The localized Bivacuum dipoles symmetry shift in $[\mathbf{F}_{\updownarrow}^{\pm}]^{i}$ is a consequence of different angular velocities of rotor and antirotor, leading due to relativist effect to generation of uncompensated inertial mass of sub-elementary particles/antiparticles and of the additional to kinetic energy of particles, related to their longitudinal and transversal zero-point vibrations.

The Bivacuum energy symmetry conservation (section 11.4) means the compensation of corresponding local energy shifts of rotor and antirotor of ($n = N$) sub-elementary particles/antiparticles:

$$\Delta \mathbf{E}_{\mathbf{V}}^{n}(F_{\updownarrow}^{\pm})^{i} = |m_{V}^{+}c^{2} - m_{V}^{-}c^{2}|_{(F_{\updownarrow}^{\pm})}^{i} \tag{2.10a}$$

by corresponding nonlocal symmetry shifts of the infinitive number ($j = \infty$) of $BVF^{\uparrow}$ and $BVF^{\downarrow}$ of secondary Bivacuum, is a result of dynamic [$\mathrm{BVF}^{\uparrow} \rightleftharpoons \mathrm{BVF}^{\downarrow}$] equilibrium shift:

$$\Delta \mathbf{E}_{\mathbf{V}}^{j}(BVF^{\uparrow} \rightleftharpoons BVF^{\downarrow})^{i} = |m_{V}^{+}c^{2} - m_{V}^{-}c^{2}|_{(BVF^{\uparrow} \rightleftharpoons BVF^{\downarrow})}^{i} \tag{2.10b}$$

This means, that the total energy of Bivacuum in the process of matter creation, remains unchanged and equal to zero due to symmetry compensation processes. The gravitational and electromagnetic potentials of the charged particles, in fact, represent such nonlocal reaction of the space properties on their longitudinal and transversal zero-point vibrations, in accordance of energy and charge conservation laws.

2.3 Conservation Rules for sub-Elementary Particles, as a Mass, Magnetic and Electric Dipoles

Two internal conservation rules, responsible for stability of **sub-elementary** particles and antiparticles (fermions and bosons), forming elementary particles of all three generations ($i = e, \mu, \tau$), are postulated in our Unified Model (UM):

I. *Conservation of the actual (measurable) and complementary (inaccessible for direct measurement) internal kinetic energies of vortex and rotor*, correspondingly in form of equality of modules of actual $|2T_{kin}^{+}|$ and complementary $|-2T_{kin}^{-}|$ kinetic energy to the total rest mass energy (m_0c^2) of sub-elementary particle, as a mass-dipole:

$$|2T_{kin}^{+}| = |m_{C}^{+}|(v_{gr}^{in})^{2} = |-2T_{kin}^{-}| = |-m_{C}^{-}|\left(v_{ph}^{in}\right)^{2} = m_0c^2 = const \tag{2.11}$$

where the product if *internal* group (v_{gr}^{in}) and phase (v_{ph}^{in}) velocities is equal to product of *external* group ($v_{gr} \equiv v_{gr}^{ext}$) and phase ($v_{ph} \equiv v_{ph}^{ext}$) velocities of sub-elementary particle in composition of elementary particle:

$$v_{gr}^{in}v_{ph}^{in} = v_{gr}v_{ph} = c^2 \tag{2.11a}$$

From (2.11), taking into account (2.11a), we get for the ratio of complementary (m_{C}^{-}) and actual (m_{C}^{+}) mass of sub-elementary particle:

$$\frac{|m_{C}^{-}|}{|m_{C}^{+}|} = \left[\frac{v_{gr}^{in}}{v_{ph}^{in}}\right]^{2} = \left[\frac{(v_{gr}^{in})^{2}}{c^{2}}\right]^{2} \tag{2.12}$$

The resulting internal momentum of sub-elementary fermion squared ($P_0^2 = m_0^2c^2$) is permanent and equal to Compton's one:

$$P_0^2 = P^{+}P^{-} = (m_{C}^{+}v_{gr}^{in})(m_{C}^{-}v_{ph}^{in}) = (m_{C}^{+}v_{gr})(m_{C}^{-}v_{ph}) = \tag{2.12a}$$
$$= m_0^2c^2 = \frac{\hbar^2}{L_0^2} = const; \qquad P_0 = m_0c$$

where the permanent **resulting** radius of sub-elementary particle, as a [vortex+rotor] dipole is equal to Compton vorticity radius, determined by particle's rest mass (m_0):

$$L_0 = \frac{\hbar^2}{m_0c} = (L^{+}L^{-})^{1/2} \tag{2.12b}$$

where for each sub-elementary particle, the radius of actual vortex is $L^{+} = \hbar/(m_{C}^{+}v_{gr}^{in}) = \hbar/P^{+}$ and the radius of complementary rotor: $L^{-} = \hbar/(m_{C}^{-}v_{ph}^{in}) = \hbar/P^{-}$.

As far from (2.11) we have:

$$(2T_k^+)^{in} = (P^+)^2/m_C^+ = (2T_k^-)^{in} = (P^-)^2/m_C^- = m_0c^2$$

we get for the ratio of cross section of the actual vortex $[S^+ = \pi(L^+)^2]$ and complementary rotor $[S^- = \pi(L^-)^2]$:

$$\frac{S^+}{S^-} = \frac{(L^+)^2}{(L^-)^2} = \frac{(P^-)^2}{(P^+)^2} = \frac{m_C^-}{m_C^+} = 1 - (v/c)^2 \qquad 2.12c$$

where, in accordance to our model: $m_C^- = m_0[1-(v/c)^2]^{1/2}$ *and* $m_C^+ = m_0/[1-(v/c)^2]^{1/2}$

II. *Conservation of the absolute values of the internal actual (*$\boldsymbol{\mu}_+$*) and complementary (*$\boldsymbol{\mu}_-$*) magnetic moments of vortex and rotor*, correspondingly, in form of the equality of their modules to the Bohr magneton ($\mu_B^\pm$):

$$|\pm\mu_+| \equiv \frac{1}{2}|e_+|\frac{|\pm\hbar|}{|m_C^+|v_{gr}^{in}} = |\pm\mu_-| \equiv \frac{1}{2}|-e_-|\frac{|\pm\hbar|}{|-m_C^-|v_{ph}^{in}} = \mu_B \equiv \frac{1}{2}|e|\frac{\hbar}{m_0c} = const \qquad 2.13$$

where: e_+ and e_- are the **internal** electric charges of actual vortex and complementary rotor, correspondingly; $|e|$ is a module of the resulting charge of the electron or positron.

For the case of primordial Bivacuum (in the absence of matter and fields), when $v = v^{ext} = 0$ and $v_{gr}^{in} = v_{ph}^{in} = c$, we have from (2.12) and (2.13):

$$|m_C^+| = |-m_C^-| = m_0 \qquad 2.14$$

$$|e_+| = |e_-| = e \qquad 2.14a$$

The resulting magnetic moments of sub-elementary fermion/antifermion ($\boldsymbol{\mu}_F^\pm$), equal to the Bohr's magneton ($\boldsymbol{\mu}_B$), we get as the average of its actual $|\boldsymbol{\mu}_+|$ and complementary $|\boldsymbol{\mu}_-|$ components:

$$\boldsymbol{\mu}_F^\pm = (|\boldsymbol{\mu}_+||\boldsymbol{\mu}_-|)^{1/2} = \left[\left(\frac{|e|}{m_0c}\right)^2\frac{\hbar^2}{4}\right]^{1/2} = \frac{|e|}{m_0c}\frac{\hbar}{2} = \boldsymbol{\mu}_B = const \qquad 2.15$$

where: $|e|^2 = |e_+e_-|$

For the other hand, the well known formula for the *normal* spin magnetic moment of the electron is:

$$\boldsymbol{\mu}_S = \frac{e}{m_0c}\mathbf{S} \qquad 2.16$$

where: $[e/m_0c]$ is gyromagnetic ratio of the electron.

It follows from our model, that: $\boldsymbol{\mu}_F^\pm = \boldsymbol{\mu}_B = \boldsymbol{\mu}_S^\pm$. Consequently, from eqs. (2.15 and 2.16) we get the value of the electron's spin and definition of the Plank constant, leading from our model of sub-elementary particles:

$$\mathbf{S} = \pm\frac{1}{2}\hbar \qquad 2.17$$

$$where:\ \pm\hbar = \pm\sqrt{|m_C^+||i^2m_C^-|(v_{gr}^{in}v_{ph}^{in})(L^+L^-)} = \pm\sqrt{m_0^2c^2L_0^2} \qquad 2.18$$

From (2.13) we get, that the *internal resulting electric dipole* ($\mathbf{d}_{el}^{in}$) of sub-elementary particles/antiparticles are related to that of magnetic dipole and the Bohr magneton, as:

$$\left|\mathbf{d}_{el}^{in}\right| = [(|e_+||\mathbf{L}^+|)(|-e_-||\mathbf{L}^-|)]^{1/2} = eL_0 = 2|\boldsymbol{\mu}_F^\pm| = 2\boldsymbol{\mu}_B \qquad 2.19$$

On the distance $r >> L_0 = \frac{\hbar}{m_0c}$, the electric and magnetic dipole radiations, emitted in a course of in-phase $[C \rightleftharpoons W]$ pulsation of sub-elementary particles or antiparticles should be equal, in accordance with existing theory of dipole radiation.

2.4 The Actual & Complementary Mass and Charge Compensation Principles. Extension of the Einstein's and Dirac's formalism for free relativistic particles

From (2.11 and 2.12a) follows the *actual* (m_C^+) *& complementary* ($-m_C^- = i^2 m_C^-$) *mass compensation principle:*

$$|m_C^+||i^2 m_C^-| = m_0^2 \quad 2.20$$

$$or: \quad |m_C^+ m_C^-| = m_0^2 \quad 2.20a$$

where actual (inertial) and complementary (inertialess) mass have the opposite relativist dependence on the external group velocity:

$$|m_C^+| = m_0/[1-(v/c)^2]^{1/2} \quad 2.21$$

$$|m_C^-| = m_0[1-(v/c)^2]^{1/2} \quad 2.21a$$

From the ratio of (2.21a) to (2.21), we have:

$$\frac{|m_C^-|}{|m_C^+|} = 1-(v/c)^2 \quad 2.22$$

The eqs. 2.21 and 2.21a can be transformed to following shape:

$$(E_C^+)^2 = (m_C^+)^2 c^4 = m_0^2 c^4 + (m_C^+ v)^2 c^2 \quad 2.23$$

$$(E_C^-)^2 = (m_C^-)^2 c^4 = m_0^2 c^4 - (m_0 v)^2 c^2 \quad 2.23a$$

where: E_C^+ and E_C^- are the actual and complementary energy of wave B, correspondingly.

The first eq. (2.23) coincides with those, obtained by Dirac. The second (2.23a) for complementary energy is a new one and reflects the generalization of special theory of relativity and Dirac's theory for relativist particles.

From (2.13; 2.11a and 2.20) follows the internal *actual & complementary charge compensation principle,* symmetric to *mass compensation principle*:

$$|e_+||i^2 e_-| = [i^2 e]^2 \quad 2.24$$

$$or: \quad |e_+ e_-| = (e)^2 \quad 2.24a$$

The positive *actual* and negative *complementary* **internal** negative charges: $[e_+]$ and $[i^2 e_-]$, correspond to *vortex* and *rotor* of sub-elementary **fermions.**

The logic of our Unified model demands the exchange of conventional notations of negative and positive charge for electron and positron or fermions and antifermions, as defined by the sign of their actual mass. From the left part of (2.13) we can see, that the internal actual charge (e_+) and actual magnetic moment (μ_+) of sub-elementary particle of the electron with **positive actual mass** ($+m_C^+$) is convenient to define as **"positive"**. For the other hand the uncompensated sub-elementary **antifermion** of the positron with actual mass ($-m_C^-$) is natural to consider as a carrier of *"negative" internal charge* (e_-) and the internal negative magnetic moment (μ_-). Consequently, the resulting, experimentally measurable, charges of the electron and positron from (2.24a) we define, as:

$$e^+ = +\sqrt{|e_+||e_-|} \quad and \quad e^- = -\sqrt{|e_+||e_-|} \quad 2.25$$

It is evident, that such convenient for our presentation exchange of **notations** of charge of particles (e^+) and antiparticles (e^-) do not affect the conventional theories of classical and quantum electrodynamics in any way.

The ratio of *the actual internal charge* $|e_+|$ to *internal complementary* one $|e_-|$ from (2.13) and another form, involving the resulting charge (e), by applying eqs. (2.24a; 2.20 and 2.11a), is:

$$\frac{|e_+|}{|e_-|} = \frac{|m_C^+|v_{gr}^{in}}{|-m_C^-|v_{ph}^{in}} = \frac{|m_C^+|^2(v_{gr}^{in})^2}{m_0^2c^2} \tag{2.26}$$

$$or: \quad \frac{e_+}{e} = \frac{m_C^+v_{gr}^{in}}{m_0c} \quad or: \quad e = e_+\frac{m_0c}{m_C^+v_{gr}^{in}} \tag{2.26a}$$

from the magnetic moments conservation rule (2.13), it follows, that the ratio $\frac{e_+}{m_C^+v_{gr}^{in}} = \frac{e_+}{p_+^{in}}$ is permanent. Consequently, the resulting charge is invariant ($e = const$).

From (2.26), using (2.22 and 2.24a), we get the formula, which will be useful for us later:

$$\left(\frac{e}{e_+}\right)^2 = \frac{e_-}{e_+} = \frac{c^2}{(v_{gr}^{in})^2}\frac{m_0^2}{(m_C^+)^2} = \frac{v_{ph}^{in}}{v_{gr}^{in}}\frac{m_C^-}{m_C^+} = \frac{v_{ph}^{in}}{v_{gr}^{in}}[1-(v/c)^2] \tag{2.27}$$

Each of sub-elementary fermion ($F^{\uparrow}$ and $F^{\downarrow}$) and sub-elementary boson ($B^{\pm}$) has a properties of asymmetric mass-dipole, charge-dipole and magnetic dipole simultaneously.

It is important to note, that positive (2.1) and negative (2.1a) Bivacuum dipoles symmetry shift is accompanied by sub-elementary particles and sub-elementary antiparticles creation, correspondingly.

For sub-elementary particles such characteristics as: mass: $m_C^+ = m_0/[1-(v/c)^2]^{1/2}$, charge ($e^+$) and magnetic moment: $\mu_+ = e^+\hbar/(2m_C^+v_{gr}^{in})$ - are the actual and experimentally measurable parameters. The corresponding complementary characteristics of sub-elementary particles: $m_C^- = i^2m_0[1-(v/c)^2]^{1/2}$; ($e^-$) and $\mu_- = i^2e\hbar/(2m_C^-v_{ph}^{in})$ are inaccessible for direct experimental observation.

For sub-elementary antiparticles the notions of actual and complementary characteristics change their place. The mass of negative realm of Bivacuum became actual and measurable: $m_C^- = m_0/[1-(v/c)^2]^{1/2}$, as well as charge ($e^-$) and magnetic moment ($\mu_-$). The corresponding complementary characteristics of sub-elementary antiparticles in realm of positive energy of Bivacuum: $m_C^+ = i^2m_0[1-(v/c)^2]^{1/2}$; ($e^+$) and ($\mu_+$) turns to inaccessible for direct experiment.

One can see, that the rest mass squared (2.7) and resulting charge squared (2.11a) are not dependent on the external group velocity (v), i.e. they are relativist invariants.

3 Duality, as a Result of Quantum Beats Between the Actual and Complementary States of sub-Elementary Particles

Duality of elementary particles and antiparticles in accordance to Unified model, is a consequence of coherent quantum beats of their sub-elementary particles/antiparticles between two states: the asymmetrically excited state $(BVF^{\updownarrow})^* \equiv \mathbf{F}_{\updownarrow}^{\pm}$ and its symmetric state ($BVF^{\updownarrow}$):

$$\left[\mathbf{F}_{\updownarrow}^{\pm} \overset{CVC}{\rightleftharpoons} BVF^{\updownarrow}\right]^i \tag{3.1}$$

where: i means *three electron's or positron's* generation: $i = e,\mu,\tau$.

These beats are accompanied by [emission $\rightleftharpoons$ absorption] of cumulative virtual cloud (CVC) of sub-quantum particles, representing [W] phase of sub-elementary particle, oscillation of the mass and charge symmetry shift.

As far the energy of symmetric $BVF^{\updownarrow}$ is equal to zero, it means that the energy of corpuscular [C] phase, in form of sub-elementary particle [$\mathbf{F}_{\updownarrow}^{\pm}$] is equal to energy of the wave [W] phase, in form of [CVC]: $E_C = E_W$.

The energy of quantum beats in a course of [$C \rightleftharpoons W$] pulsation of sub-elementary particle is equal to difference of energy between the absolute values of actual (vortex) and complementary (rotor) states. Using eqs. (2.8 and 2.8a), we get the energy of sub-elementary de Broglie wave in [C] and [W] phase, its relation to de Broglie wave frequency $(\omega_0 = \omega_{C\rightleftharpoons W})^i$ and the wave length ($\lambda_{C,W}$), equal in both phase, as a sum of rotational and two translational contributions:

$$[E_{C\rightleftharpoons W} = \hbar\omega_{C\rightleftharpoons W} = E_C = E_W = |m_C^+|c^2 - |m_C^-|c^2]^i_{tot} = [(m_C^+)_{tot}\, v_{res}^2]^i = \quad 3.2$$

$$= [(E_{C,W}^S)_{rot} + (E_{C,W})_{\parallel tr} + (E_{C,W})_{\perp tr}]^i = \quad 32.a$$

$$= |m_C^+ - m_C^-|_{rot}c^2 + |m_C^+ - m_C^-|_{\parallel tr}c^2 + |m_C^+ - m_C^-|_{\perp tr}c^2 = \quad 3.2b$$

$$= m_0c^2 + m_0c^2\frac{(v_\parallel/c)^2}{[1-(v_\parallel/c)^2]^{1/2}} + m_0c^2\frac{(v_\perp/c)^2}{[1-(v_\perp/c)^2]^{1/2}} \quad 3.2c$$

$$or: \quad (E_C = E_W)_{\parallel,\perp tr} = \frac{h^2}{m_C^+\lambda_{\parallel,\perp}^2} \quad where: \quad \lambda_{\parallel,\perp} = \frac{h}{m_C^+ v_{\parallel,\perp tr}} = \frac{h}{|m_C^+ - m_C^-|c^2/v_{\parallel,\perp tr}} \quad 3.2d$$

where: $(m_C^+)_{tot} = m_0 + m_{C\parallel tr}^+ + m_{C\perp tr}^+$; $m_{C\parallel tr}^+ = m_0\frac{1}{[1-(v_\parallel/c)^2]^{1/2}}$; $m_{C\perp tr}^+ = m_0\frac{1}{[1-(v_\perp/c)^2]^{1/2}}$;

v_{res} is the resulting group velocity;

- the rotational (spin) contribution to energy is: $(E_{C,W}^S)_{rot} = m_C^+ v_{rot}^2 = m_0c^2 = m_0\omega_0^2L_0^2$, where the rest mass ($m_0 = |m_C^+ - m_C^-|^\phi$) is determined by difference of the actual vortex mass $|m_C^+|$ and complementary rotor mass $|m_C^-|$ at Golden mean conditions (see section 4.2); the frequency of $[C \rightleftharpoons W]$ pulsation is: $\omega_0 = m_0c^2/\hbar$; the resulting Compton radius of sub-elementary particle is $L_0 = \hbar/m_0c$.

- the translational contribution to the total energy of particle:

$$(E_{C,W})_{tr} = (E_{C,W})_{\parallel tr} + (E_{C,W})_{\perp tr} \cong (E_{C,W})_{\parallel tr}$$

is subdivided to longitudinal ($\parallel$) and transversal ($\perp$) ones, as respect to particle external momentum; $v_{\parallel tr}$ is a longitudinal group velocity of particle's vibrations; $v_{\perp tr}$ is a transversal group velocity of particle's vibrations;

It is important to note, that, as it will be shown in [Section 10.2]:

$$v_{rot} >> v_{\parallel tr} >>> v_{\perp tr} \quad and \quad 3.2e$$

$$(E_{C,W}^S)_{rot} >> (E_{C,W})_{\parallel tr} >>> (E_{C,W})_{\perp tr}$$

The set of these expressions, in fact, unify the extended special theory of relativity with quantum mechanics, elucidating the fundamental root of quantum physics: corpuscle - wave duality of particles.

Our dynamic presentation of duality explains also the elementary particles, as the permanent sources of electromagnetic and gravitational energy. Such a 'perpetual mobile' properties of particles, as a mass, electric and magnetic dipoles, are the result of permanent energy redistribution between the negative and positive vacuums of the asymmetric secondary Bivacuum in a course of dipoles $[C \rightleftharpoons W]$ pulsation.

3.1 The Kangaroo Effect

Propagation of elementary fermion, like electron: $\langle[F_\uparrow^+ \bowtie F_\downarrow^-] + F_\updownarrow^-\rangle^i$, in 3D space, accompanied by $[C \rightleftharpoons W]$ pulsation of all three sub-elementary particles, can be considered as a periodic jumping of its uncompensated sub-elementary particle $[F_\updownarrow^-\rangle$ in form of CVC of [W] phase with light velocity between the "anchor sites"- Bivacuum fermions ($BVF^\updownarrow$), i.e. unexcited double cells. The binding of CVC to the anchor $BVF^\updownarrow$, corresponds to [C] phase restoration, i.e. double cell asymmetric excitation. In general case elementary fermion in [C] phase moves with group velocity (v), lower than light one (c), pertinent for $[W]$ phase. Such jump-way process of particle propagation in space may be termed the KANGAROO EFFECT **[KE]**.

Propagation of symmetrical pair $[\mathbf{F}_\uparrow^+ \bowtie \mathbf{F}_\downarrow^-]^i$ of the electron or positron is realized in form of [emission $\rightleftharpoons$ absorption] of positive (VPW^+) and negative (VPW^-) virtual pressure waves, accompanied their *in-phase* $[C \rightleftharpoons W]$ pulsation. This dynamic wave process is correlated with 'jumps' of uncompensated $[\mathbf{F}_\updownarrow^-\rangle$ in space and time between the 'anchor' sites. The most probable length of 'jumps' is determined by the actual component of de Broglie wave (wave B) length of particle: $\lambda^+ = h/m_C^+ v$. The resulting (concealed) dimension of mass-dipole of [C] phase, which may be considered as the amplitude of [W] phase of sub-elementary particle ($\lambda^\pm$), takes into account the momentums of both states: actual and complementary:

$$\lambda^\pm = h/(|m_C^+ - m_C^-|c) = h/[m_C^+ v(v/c)] \qquad 3.3$$

Consequently, the ratio of CVC (amplitude) to the actual wave B length is:

$$\lambda^\pm/\lambda^+ = c/v \qquad 3.4$$

Propagation of the photon in Bivacuum occur with light velocity in both phase: [W] and [C] due to symmetry of this elementary boson structure, unperturbing Bivacuum symmetry shift.

Our Unified model (UM) has some similarity with theory, developed by Krasnoholvets (2000). He regarded a vacuum also as a cellular space, each cell representing a 'superparticle' with dimension of 10^{-28} cm. Interaction of moving actual particle with superparticles is accompanied by emission and absorption of elementary virtual excitations - *inertons* by particle. Interesting to note, that in his model the ratio of the inertons cloud amplitude to the length of wave B of particle is the same, as the ratio of CVC amplitude to its length in our UM (3.4).

3.2 Spatial images of sub-elementary particles in [C] and [W] phase

The spatial images of sub-elementary wave B in [C] and [W] phase can be analyzed in terms of the wave numbers or energy distribution, if we transform the basic equations for actual and complementary energy, squared (2.23 and 2.23a) to forms:

$$\text{for real } [C^+] \text{ state}: \left(\frac{m_C^+ c}{\hbar}\right)^2 - \left(\frac{m_C^+ v}{\hbar}\right)^2 = \left(\frac{m_0 c}{\hbar}\right)^2 \qquad 3.5$$

$$\text{for complementary } [C^-] \text{ state}: \left(\frac{m_C^- c}{\hbar}\right)^2 + \left(\frac{m_0 v}{\hbar}\right)^2 = \left(\frac{m_0 c}{\hbar}\right)^2 \qquad 3.6$$

The spatial image of energy distribution of **actual** corpuscular state [C$^+$], defined by equation (3.5), corresponds to *equilateral hyperbola* (Fig.2a):

$$[C^+]: \quad X_+^2 - Y_+^2 = a^2 \qquad 3.7$$

where: $X_+ = (k_C^+)_{tot} = m_C^+ c/\hbar; \quad Y_+ = m_C^+ v/\hbar; \quad a = m_0 c/\hbar$

The spatial image of **complementary** [C$^-$] state (3.6) corresponds to *circle* (Fig. 2b), described by equation:

$$X_-^2 + Y_-^2 = R^2 \qquad 3.8$$

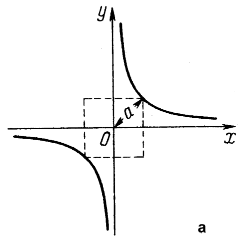
where: $X_- = (k_C^-)_{tot} = m_C^- \cdot c/\hbar; \qquad Y_- = (k_0)_{kin} = m_0 v/\hbar.$

The radius of complementary circle: $R = k_0 = m_0 c/\hbar$ is equal to the axe length of equilateral hyperbola: $R = a$ of actual [C$^+$] state. In fact this circle represents the complementary part of sub-elementary particle or antiparticle ($F_\updownarrow^\pm$).

A spatial image of sub-elementary particle $[\mathbf{F}_\updownarrow^\pm]$ *in corpuscular [C] phase* (Kaivarainen, 2001a) is a correlated pair: *[actual vortex + complementary rotor]* with radiuses of their cross sections, defined, correspondingly, as (L^+) and (L^-): $\left[L^+ = \frac{\hbar}{m_C^+ v_{gr}^{in}}\right]^i$ *and* $\left[L^- = \frac{-\hbar}{-m_C^- v_{ph}^{in}}\right]^i$

$$\textit{the resulting Compton radius vorticity of } [\mathbf{F}_\updownarrow^\pm] \textit{ is}: \left[L_0 = (L^+ L^-)^{1/2} = \frac{\hbar}{m_0 c}\right]^i \qquad 3.9$$

where: m_C^+ and m_C^- are actual (inertial) and complementary (inertialess) effective mass of vortex and rotor of sub-elementary particle, correspondingly; $m_0 = (m_C^+ m_C^-)^{1/2}$ is the rest mass of sub-elementary particle; v_{gr}^{in} and v_{ph}^{in} are the internal group and phase velocities, characterizing collective motion (circulation) of sub-quantum particles, forming actual vortex and complementary rotor (Fig.2).



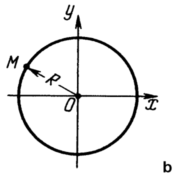


Fig. 2a. Equilateral hyperbola, describing the energy distribution for actual corpuscular state [C$^+$] of sub-elementary particle (positive region) and sub-elementary antiparticle (negative region). The rotation of equilateral hyperbola around common axe of symmetry leads to origination of parted hyperboloid or conjugated pair of paraboloids of revolution. The direction of this rotation as respect to vector of particle propagation in space determines positive or negative spin of sub-elementary fermion ($S = \pm\frac{1}{2}$). This asymmetrically excited [C] state of Bivacuum is responsible also for inertial mass (m_C^+), the internal actual magnetic moment ($\mu_\mp^{in}$) and actual electric component ($e_\mp^{in}$) of elementary charge (Kaivarainen, 2001a).

Fig. 2b. Circle, describing the energy distribution for the *complementary* corpuscular state [C$^-$] of sub-elementary/antiparticles. This state is responsible for inertialess mass (m_C^-), the internal complementary magnetic moment (μ_-) and complementary component (e_-) of elementary charge. Such a rotor is a part, general for Bivacuum fermions (BVF$^\pm_\updownarrow$) and Bivacuum bosons (BVB$^\pm$).

The [W] phase in form of cumulative virtual cloud (CVC) originates as a result of quantum beats between actual and complementary states of [C] phase of elementary wave B. Consequently, the spatial image of CVC energy distribution can be considered as a geometric difference between energetic surfaces of actual [C$^+$] state as an equilateral hyperbola and that of [C$^-$] state as a complementary circle. After subtraction of left and right parts of (3.5 and 3.6) and some reorganization, we get the energetic **spatial image of** $[W]$ **phase or [CVC],** as a geometrical difference of equilateral hyperbola and circle:

$$\frac{(m_C^+)^2}{m_0^2} + \frac{(m_C^-)^2}{m_0^2}\frac{c^2}{v^2} - \frac{(m_C^+)^2}{m_0^2}\frac{c^2}{v^2} = -1 \qquad 3.10$$

This equation in dimensionless form describes the *parted (two-cavity) hyperboloid* (Fig. 3):

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{z^2}{c^2} = -1 \qquad 3.11$$

The (c) is a real semi-axe; a and $b -$ the imaginary ones.

*A spatial image of the wave [W] phase (Fig.*3*), in form of cumulative virtual cloud (CVC) of sub-quantum particles, is a parted hyperboloid* (Kaivarainen, 2001a).

The [W] phase in form of cumulative virtual cloud (CVC) originates as a result of quantum beats between actual and complementary states of [C] phase. Consequently, the spatial image of CVC can be considered as a geometric difference between images of [C$^+$] and [C$^-$] state.

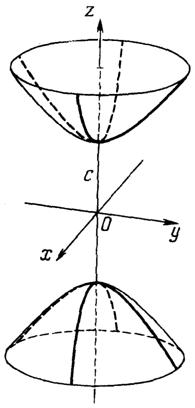


Fig. 3. The parted (two-cavity) hyperboloid is a spatial image of twin cumulative virtual cloud 2[CVC$^{\pm}$], corresponding to [W] phase of sub-elementary particle and sub-elementary antiparticle. It characterize the twofold CVC$^{\pm}$ of positive and negative energy, corresponding to [W] phase of pair (sub-elementary fermion + sub-elementary antifermion) or [$\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}$], as a general symmetric part of the electron, positron, photon and quarks (Kaivarainen, 2001a).

For the external observer, the primordial Bivacuum looks like a isotropic system of 3D double cells with shape of two hemispheres, separated by energetic gap. There are three kinds of like quasi-spherical double cells with three Compton radiuses, corresponding to the rest mass of three **electron's** generation: $i = e, \mu, \tau$ and the external group velocity, equal to zero ($v_{gr}^{ext} \equiv v = 0$). The spatial immobilization of double cells provide their zero external momentum and conditions of virtual Bose condensation in Bivacuum (1.4), related directly to its nonlocal properties. However, the dimensions of double cells are pulsating in a course of virtual clouds (VC$^{\pm}$) exchange and pairs of virtual particles and antiparticles creation and annihilation.

In secondary Bivacuum, in presence of matter and fields, the shape of double cells becomes less symmetrical. When double cell transforms to *sub-elementary* fermion or antifermion as a result of asymmetric excitation, one of two hemispheres deforms towards hemiellipsoid, containing the 3D vortex of *sub-quantum* particles, while the other one keeps its 2D rotor shape (Fig. 4).

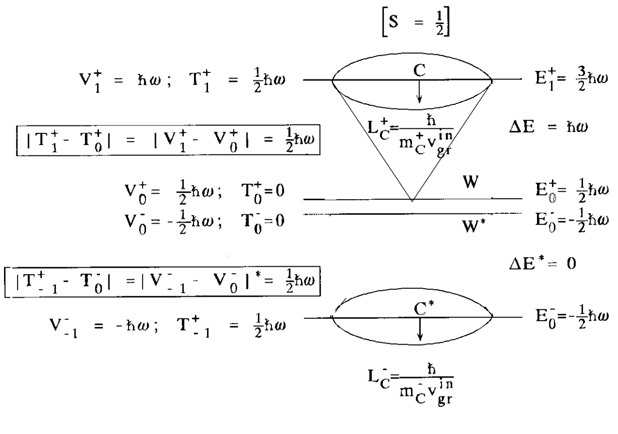


Fig. 4. The spatial image of [C] phase of sub-elementary particle in form of [actual rotor + complementary vortex] dipole, corresponding to the [actual mass (m_C^+)+ complementary mass (m_C^-)] dipole.

Asymmetric double cells in form of [vortex + rotor] dipoles, representing sub-elementary particles, get the ability to move as respect to symmetric ones with external group velocity $v_{gr}^{ext} > 0$. The pulsation between such asymmetric (excited) and former symmetric (ground) shape of double cells represents, in accordance to our Unified model, the [corpuscle (C) $\rightleftharpoons$ wave (W)] transitions. These transitions are accompanied by jump-way propagation of triplets of asymmetrically excited double cells in certain combinations, representing elementary particles.

The existence of different 3D structures of virtual autowaves, formed by $VPW^{\pm}$, modulated by external EM, gravitational fields and matter dynamics, are also the important feature of secondary Bivacuum. The notion of Virtual Replica (VR) of condensed matter is introduced (Kaivarainen, 2001d), as a 3D autowaves in Bivacuum, modulated by matter dynamics.

We may consider the [actual vortex + complementary rotor], corresponding to spatial image of [C] phase of sub-elementary particle (Kaivarainen, 2000; 2001a; 2002), as a two vortices of different shape and frequency (ω_C^+ and ω_C^-). Then, using vector analysis, the energy difference between velocity fields: $\vec{\mathbf{V}}_C^+(r)$ and $\vec{\mathbf{V}}_C^-(r)$, corresponding to the actual and complementary states, can be presented as:

$$E_{C \rightleftharpoons W} = \vec{\mathbf{n}}\hbar\omega_B = \vec{\mathbf{n}}\hbar(\omega_C^+ - \omega_C^-) = \frac{1}{2}\hbar[rot\vec{\mathbf{V}}_C^+(\mathbf{r}) - rot\vec{\mathbf{V}}_C^-(\mathbf{r})] \qquad 3.12$$

where: $\vec{\mathbf{n}}$ is the unit-vector, common for both vortices; $\omega_{CVC} = (\omega_C^+ - \omega_C^-)$ is a beats frequency between actual and complementary states.

In this consideration it is assumed, that all of sub-quantum particles/antiparticles, forming actual and complementary vortices of [C] phase, have the same angle frequency: ω_C^+ and ω_C^-, correspondingly.

4. The Relation Between the External and Internal Parameters of Elementary Particles

Combining (2.3b and 2.9), we get the formula for unification of the internal (v_{gr}^{in}) and external group ($v_{gr}^{ext} \equiv v$) velocities of sub-elementary particles, as the asymmetric Bivacuum dipoles:

$$\frac{c}{v_{gr}^{in}} = \left(\frac{v_{ph}^{in}}{v_{gr}^{in}}\right)^{1/2} = \frac{1}{[1-(v/c)^2]^{1/4}} \qquad 4.1$$

Putting this equation to (2.13b), we come to relation:

$$\frac{e_+}{e} = \frac{1}{[1 - v/v_{ph}]^{1/4}} \qquad 4.2$$

or taking into account (2.3b and 2.11a) we get the important interrelation between the actual and complementary mass and charge of the asymmetric Bivacuum dipoles and dependence of these parameters ratio on their external group velocity (v):

$$\left(\frac{m_C^+}{m_C^-}\right)^{1/2} = \frac{m_C^+}{m_0} = \frac{v_{ph}^{in}}{v_{gr}^{in}} = \left(\frac{c}{v_{gr}^{in}}\right)^2 = \frac{|e_+|}{|e_-|} = \frac{e_+^2}{e^2} = \frac{1}{[1 - v/v_{ph}]^{1/2}} \qquad 4.2a$$

We can see, that at $v = 0$, we have the conditions of symmetric Bivacuum double cells-dipoles, pertinent for primordial Bivacuum in the absence of matter:

$$m_C^+ = m_C^- = m_0; \quad v_{ph}^{in} = v_{gr}^{in} = c; \quad |e_+| = |e_-| = e \qquad 4.2b$$

4.1 Criteria of the Absolute External Velocity and Momentum of Elementary Particle in Bivacuum

It looks that our Unified model makes it possible to introduce the notions of the absolute external velocity and external momentum, independent on the velocity of observer. From (2.9) we get the expression for the absolute external velocity as:

$$v = c\left[1 - \frac{|m_C^-|}{|m_C^+|}\right]^{1/2} \qquad 4.3$$

For the absolute *external* (P^{ext}) and the resulting (P^{res}) momentums from 3.2 and 3.2a, we get, correspondingly:

$$P^{ext} = m_C^+ v = |m_C^+ - m_C^-| c^2/v \qquad 4.3a$$

$$P^{res} = m_C^+ v^2/c = |m_C^+ - m_C^-| c \qquad 4.3b$$

The objective criteria of the external velocity and momentum of elementary particle is the difference between its actual $|m_C^+|$ *and complementary* $|m_C^-|$ *mass*. In accordance to UM, the measurable properties of particles are determined by uncompensated sub-elementary particle $F_\updownarrow^-\rangle$ in triplets $\langle [F_\uparrow^+ \bowtie F_\downarrow^-] + F_\updownarrow^- \rangle$.

4.2 Quantum Roots of Golden Mean

It is shown (Kaivarainen, 1993; 1995; 2002a), that the concealed root of the famous Golden mean, so widely used in Nature, is the conditions of *Concealed Harmony, as equality of the internal* (*in*) *and external* (*ext*) group and phase velocities:

$$[\mathbf{v}_{gr}^{in} = \mathbf{v}_{gr}^{ext} \equiv \mathbf{v}_{gr}] \quad and \quad [\mathbf{v}_{ph}^{in} = \mathbf{v}_{ph}^{ext} \equiv \mathbf{v}_{ph}] \qquad 4.4$$

These Concealed Harmony conditions turns (eq.4.1) to simple quadratic equation:

$$\phi^2 + \phi - 1 = 0 \qquad 4.5$$

$$or: \quad \frac{\phi}{(1-\phi)^{1/2}} = 1 \qquad 4.5a$$

$$where: \quad \phi = \left[\frac{\mathbf{v}}{\mathbf{v}_{ph}}\right]^{ext,in} = \left(\frac{\mathbf{v}^2}{c^2}\right)^{ext,in} = 0.6180339887 \qquad 4.6$$

The positive solution of equation (4.5) is equal to Golden mean ($Psi \equiv \phi = 0.6180339887$).

It is well known, that Golden mean value is related strongly to *Fibonacci series*:

$$n = 1, 2, 3, 5, 8, 13, 21, 34, 55\ldots$$

where the value of next term of series is defined as a sum of two antecedent terms.

The bigger is number of series (n_j), the closer is its ratio to the next one ($n_{j+1} = n_j + n_{j-1}$) to Golden mean:

$$\frac{n_j}{n_{j+1}} \rightarrow 0.6180339887 \quad at \quad j \rightarrow \infty \qquad 4.6a$$

At the Golden mean condition (4.6), taking into account (4.5a), the formula for energy ($E_C^\phi = E_W^\phi$), mass $[m_C^+]^\phi$ and $[m_C^-]^\phi$, velocity (v^ϕ), the *resulting* momentum (P^ϕ) and de Broglie wave radius ($L^\phi = \lambda^\phi/2\pi$) of sub-elementary particle (eqs. 3.2-3.2b) turns to the elegant quantitative shapes:

$$E_W^\phi = \hbar\omega_{C\rightleftharpoons W}^\phi = |m_C^+ - m_C^-|^\phi c^2 = m_0c^2 = m_0\omega_0^2 L_0^2 = \frac{\hbar^2}{m_0 L_0^2} = \qquad 4.7$$

$$= [m_C^+ v^2]^\phi = \frac{\hbar^2}{[m_C^+(L^+)^2]^\phi} = E_C^\phi \qquad 4.7a$$

$$[m_C^+]^\phi = m_0(c/v^\phi)^2 = \frac{m_0}{\phi} \simeq 1.618\, m_0; \qquad 4.7b$$

$$[m_C^-]^\phi = \phi m_0 \simeq 0.618\, m_0 \qquad 4.7c$$

$$\left[\frac{m_0^2}{(m_C^+)^2}\right]^\phi = \left[\frac{m_C^-}{m_C^+}\right]^\phi = \phi^2 = 1-\phi \simeq 0.382 \qquad 4.7d$$

$$v^\phi = c\phi^{1/2} = 0.786151377\, c \qquad 4.7e$$

$$P^\phi = [m_C^+ v^2]^\phi/c = m_0 c \equiv P_0; \quad P_0/(P^+)^\phi = v^\phi/c = \phi^{1/2} \qquad 4.7f$$

$$L^\phi = L_0 = \hbar/P_0 = \hbar/m_0 c; \qquad L_0/(L^+)^\phi = (\lambda^\pm/\lambda^+)^\phi = c/v^\phi = 1/\phi^{1/2} \qquad 4.7g$$

where: $(P^+)^\phi = m_C^+ v^\phi$ and $(\lambda^+)^\phi = 2\pi(L^+)^\phi = h/(m_C^+ v)^\phi$ are the actual momentum and the actual de Broglie wave length of sub-elementary particle at GM conditions.

The mass symmetry shift at Golden mean conditions

We came to important result from (4.7), that at Golden mean (GM) conditions the difference between the actual and complementary mass (the mass symmetry shift) *is equal to the rest mass of sub-elementary elementary particle:*

$$|\Delta m_C|^\phi = |m_C^+ - m_C^-|^\phi = m_0 \qquad 4.8$$

It is true for sub-elementary particles, forming any kind of elementary particles, like electrons, protons, neutrons, etc. The mass of elementary particles, in accordance to our model, is defined by uncompensated sub-elementary particles in triplets (4.7a).

The frequency of particles $[C \rightleftharpoons W]$ pulsation at Golden mean (GM) condition (4.7) is equal to the angle frequency of their spinning (ω_0), providing the rest mass of sub-elementary particles of three generation (m_0^i) :

$$\left[\omega_{C\rightleftharpoons W}^\phi = \frac{|\Delta m_C|^\phi c^2}{\hbar} = \frac{m_0 c^2}{\hbar} = \omega_0\right]^i \qquad 4.8a$$

where (ω_0^i, eq.1.1) are equal to corresponding three fundamental frequencies of Bivacuum.

For the rest mass of the electron, we have: $[\omega_{C\rightleftharpoons W}^\phi]_e = 9.03 \cdot 10^{20}\, s^{-1}$.

Three electrons generation ($i = e, \mu, \tau$) with different rest mass: $m_0^e\,(0.5\,Mev) < m_0^\mu\,(105\,Mev) < m_0^\tau\,(1860\,Mev)$ have correspondingly increasing frequency of $[C \rightleftharpoons W]$ pulsation of each of sub-elementary particle/antiparticle in triplets $\langle[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+] + \mathbf{F}_\updownarrow^\pm\rangle^i$.

The charge symmetry shift at Golden mean conditions

At the GM conditions (4.7b and 4.7e), the ratio of the actual (e_+) and complementary (e_-) charges is equal to ($1/\phi$), as far from (2.13a) we have:

$$\left|\frac{e_+}{e_-}\right|^\phi = \left[\frac{e^2}{|e_-|^2}\right]^\phi = \left[\frac{(m_C^+)^\phi}{m_0}\right]^2 \left[\frac{(v)^\phi}{c}\right]^2 = 1/\phi \qquad 4.9$$

$$i.e. \quad |e_-|^\phi = \phi |e_+|^\phi \qquad 4.9a$$

Using the electromagnetic fine structure constant: $\alpha = e^2/\hbar c = e^2/Q^2$, where $Q = (\hbar c)^{1/2}$ is introduced as a full electromagnetic charge, we get from (4.9) for the actual and complementary charges at GM conditions:

$$|e_+|^\phi = \frac{e^2}{|e_-|^\phi} = \frac{\alpha^{1/2}}{\phi^{1/2}}Q \quad 4.9b$$

$$|e_-|^\phi = (\alpha\phi)^{1/2}Q \quad 4.9c$$

The difference between the absolute values of actual and complementary charges at GM conditions, is:

$$|\Delta e_\pm|^\phi = |e_+|^\phi - |e_-|^\phi = \phi e \quad 4.10$$

It was taken into account here that: $1/\phi - 1 = \phi$.

Dividing the charge symmetry shift (4.10) to the mass symmetry shift (4.8) and using (4.7b), we get the reduced charge symmetry shift at GM conditions, as a constant:

$$\frac{|\Delta e_\pm|^\phi}{|\Delta m_C|^\phi} = \phi\frac{e}{m_0} = \frac{e}{[m_C^+]^\phi} = const \quad 4.11$$

where $[m_C^+]^\phi = m_0/\phi$ is the actual mass of the electron at GM conditions.

We may see, that at GM conditions the amplitude of charge oscillation in the process of $[C \rightleftharpoons W]$ pulsation is equal to (4.10). Consequently the scalar potential of elementary charge is a result of the energy exchange (quantum beats) between the negative and positive vacuums.

The same is true for gravitational potential, defined by the value of the actual mass of particle (4.7b), determined by the mass symmetry shift (4.8).

The ratio of energies at Golden mean conditions

The known formula, unifying the ratio of phase and group velocity of relativist de Broglie wave (v_{ph}/v) with ratio of its potential energy to kinetic one (V_B/T_k) is:

$$2\frac{v_{ph}}{v} - 1 = \frac{V_B}{T_k} \quad 4.12$$

It is easy to see from (4.6 and 4.9), that at GM condition $(v_{ph}/v)^\phi = 1/\phi$, the ratio:

$$(V_B/T_k)^\phi = 2.236 \quad and \quad [T_k/(T_k + V_B)]^\phi = [T_k/E_B]^\phi = 0.309 \quad 4.13$$

The Golden mean (GM) conditions for sub-elementary particles, composing free elementary particles, most probably are the result of their fast rotation at GM frequency, determined by the resonant interaction with Harmonization force of Bivacuum. Such GM spinning of sub-elementary particles in triplets, when their internal and external group and phase velocities coincide, like in eq.(4.4), is responsible for such fundamental parameters as the rest mass of elementary particles, their spin and the actual charge. In our new interpretation the rest mass corresponds to conditions, when the translational external group velocity is equal to zero $(v_{gr}^{ext})_{tr} \equiv (v)_{tr} \to 0$.

However, due to quantum zero-point oscillations, the minimum translational group velocity always is a bit more, than zero (see sections 7 and 10).

We may introduce here the **"Dead mean"** conditions, corresponding to thermal equilibrium and maximum of entropy. At this conditions any system can be described by the number of independent harmonic oscillators, unable to self-organization:

$$\left[\frac{V}{T_k}\right]^D = 1; \qquad \left[\frac{2T_k}{E_B}\right]^D = \left[\frac{T_k + V}{E_B}\right]^D = 1 \quad 4.14$$

The deep quantum roots of Golden mean, reflecting realization of conditions of Hidden Harmony (5.7), leading from our dynamic model of wave-particle duality, explain the universality of this number (S = 0.618).

We put forward a hypothesis, that any kind of selected system, able to self-assembly, self-organization and evolution: from atoms to living organisms or from galactics to Universe -

are tending to conditions of Hidden Harmony, as a background of Golden Mean realization. The less is deviation of ratio of characteristic parameters of system from [$\phi \equiv Phi$], the more advanced is evolution of this system. We have to keep in mind that all forms of matter are composed from hierarchic system of de Broglie waves.

Our statement that tendency of any system (from elementary particle to the Universe) to Hidden Harmony (HH) is a driving force and final goal of evolution is confirmed on the lot of examples (see: http://soulinvitation.com/indexdw.html). The state of system, corresponding to HH, do not coincide in general case with thermal equilibrium state of maximum entropy, as a final one, postulated by classical thermodynamics.

5 Influence of Bivacuum on Matter. Harmonization Force (HaF) of Bivacuum

We define Harmonization force (HaF) of Bivacuum, generated by virtual pressure waves ($\mathrm{VPW}^{\pm}$) of fundamental frequency ($\omega_0{}^i$), as a force, driving the [$C \rightleftharpoons W$] pulsation frequency of the elementary particles (electrons, quarks) of all three generation ($i = e, \mu, \tau$) to the Golden mean (GM) frequency:

$$[\omega^{\phi}_{C\rightleftharpoons W} = \omega_0 = \frac{|m_C^+ - m_C^-|^{\phi} c^2}{\hbar} = m_0 c^2/\hbar]^i \tag{5.1}$$

Consequently, the other parameters of particles, like energy, actual and complementary mass, group and phase velocities, momentum and de Broglie wave length also tend to GM conditions (see eqs. 4.7 - 4.7f).

The mechanism of HaF action on matter is related to induced synchronization/resonance between fundamental frequencies $(\omega_0)^i$ (see eqs.1.1 and 1.1a) of Bivacuum virtual pressure waves ($\mathrm{VPW}^{\pm}$) and frequency of [$C \rightleftharpoons W$] pulsation of symmetric pairs $[\mathbf{F}_\updownarrow^+ \bowtie \mathbf{F}_\updownarrow^-]^i$ of sub-elementary particles of matter, due to [$Bivacuum \rightleftharpoons Matter$] exchange interaction by means of virtual clouds ($\mathrm{VC}^{\pm}$). The strong correlation between [$C \rightleftharpoons W$] dynamics of symmetric pair $[\mathbf{F}_\updownarrow^+ \bowtie \mathbf{F}_\updownarrow^-]^i$ and uncompensated $[F^{\pm}>^i$ sub-elementary particles/antiparticles in triplets $\langle[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+] + \mathbf{F}_\updownarrow^{\pm}\rangle^i$ forming particles, is existing. Consequently, the $\mathrm{VPW}^{\pm}$ of Bivacuum with fundamental quantized Golden mean frequencies:

$$\omega^i_{j-k} = (j-k)\omega^i_0$$

drive the matter properties, determined by $[F^{\pm}>^i$, to Golden mean conditions, as a result of $\mathrm{VPW}^{\pm}$ interaction with $[F_\updownarrow^+ \bowtie F_\updownarrow^-]^i$ pulsation of particles.

The **Harmonization Force (HaF)**, acting on each generation of elementary particles ($i = e, \mu, \tau$), forming atoms and molecules of macroscopic body (section 2.3), we introduce as:

$$F^i_{HaF} = \frac{|\Delta m_C^{\pm} c^2 - m_0 c^2|^i}{\lambda^i_{VPW^{\pm}}} = \frac{|m_C^+ (v_{gr}^{ext})^2 - m_0 c^2|^i}{\lambda^i_{VPW^{\pm}}} = \tag{5.1a}$$

$$\frac{\hbar}{\lambda^i_{VPW^{\pm}}} |\omega_{C\rightleftharpoons W} - \omega_0|^i = \frac{\hbar}{2\pi c}(j-k)\omega^i_0 |\omega_{C\rightleftharpoons W} - \omega_0|^i \tag{5.1b}$$

where: the mass/energy symmetry shift of elementary particles, different from the Golden mean one ($m_0 c^2$, see 4.8) is:

$$\Delta m_C^{\pm} c^2 = |m_C^+ - m_C^-| c^2 = m_C^+ (v_{gr}^{ext})^2 \tag{5.1c}$$

The wave length of most probable Virtual Pressure Waves (VPW^+ and VPW^-), corresponding to transition states between j *and* k sublevels of positive and negative energy of double cells, forming Bivacuum, are:

$$\lambda^i_{VPW^+} = \lambda^i_{VPW^-} = \frac{2\pi c}{(j-k)\omega^i_0} \qquad 5.2$$

Correspondingly, the Harmonization energy (HaE) of Bivacuum, acting on particles of matter, from (5.1a) is:

$$E^i_{HaF} = F^i_{HaF}\lambda^i_{VPW^\pm} = |m^+_C(v^{ext}_{gr})^2 - m_0c^2|^i = \hbar|\omega_{C\rightleftharpoons W} - \omega_0|^i \qquad 5.2a$$

The directed influence of Bivacuum Harmonization Force on dynamics of elementary particles, atoms and molecules - could be a physical background of *Principle of Least Action* realization (see section 6).

It leads from theory of autooscillations of nonlinear systems with many degrees of freedom, like condensed matter, that the *combinational resonance* may take a place not only at the equality of frequency of Bivacuum virtual pressure waves ($\omega^i_{VPW^\pm}$) and that of $[C \rightleftharpoons W]$ pulsation ($\omega^i_{C\rightleftharpoons W}$) of pairs $[\mathbf{F}^-_\uparrow \bowtie \mathbf{F}^+_\downarrow]^i$ of triplets of elementary particles/antiparticles $\langle[\mathbf{F}^-_\uparrow \bowtie \mathbf{F}^+_\downarrow] + \mathbf{F}^\pm_\updownarrow\rangle^i$:

$$\omega^i_{VPW^\pm} = (j-k)^\pm\omega^i_0 = \left[(j-k)^\pm\frac{|m^+_C - m^-_C|^\phi c^2}{\hbar}\right]^i = \omega^i_{C\rightleftharpoons W} \qquad 5.3$$

but also at following *combinations* of Bivacuum ($\omega^i_{VPW^\pm}$) and the matter frequencies:

$$p\omega^i_{VPW} = q\omega^i_{C\rightleftharpoons W} \qquad or: \qquad 5.4$$

$$p\omega^i_{VPW} = q\omega^i_{C\rightleftharpoons W} + r\omega_{rot} + g\omega_{tr} \qquad 5.4a$$

$$p,q,r = 1,2,3\ldots\text{(integer numbers)}$$

where: ω_{rot} *and* ω_{tr} are the rotational and translational frequencies of atoms/molecules.

5.1 New Definition of the Rest Mass of Particles

The HaF of Bivacuum, keeping the particles in GM condition, looks to be one of the main factors, responsible for fundamental properties of elementary particles, like the rest mass, spin, charge and stability of atoms and molecules (see section 10).

We can present the total energy of elementary particle as a sum of rotational and two kinds of translational contributions:

$$E^i_{tot} = |m^+_C - m^-_C|^i c^2 = m^+_C v^2 = [E^S_{rot}]^i + [E^i_{\parallel tr} + E^i_{\perp tr}] = \qquad 5.5$$

$$= [m^+_C v^2_{rot}]^\phi + \left[m^+_C v^2_{\parallel tr} + m^+_C v^2_{\perp tr}\right]^i \qquad 5.5a$$

The *rotational (spin) contribution* is responsible for realization of Golden mean conditions and the **rest mass (m^i_0) emergency:**

$$[E^S_{rot}]^i = m^i_0 c^2 = m^i_0[\omega^2_0 L^2_0]^i = [m^+_C v^2_{rot}]^\phi \qquad 5.6$$

where the resonant angle frequency of HaF of Bivacuum ($\omega^i_0 = m^i_0 c^2/\hbar$) is equal to that of Golden mean (4.8) for three generation ($i = e,\mu,\tau$); the radius of resulting double vortices of uncompensated sub-elementary particle is equal to Compton radius of corresponding electrons generation (L^i_0) see (4.7g);

$v^\phi_{rot} = c\phi^{1/2} = 0.786151377\,c$ is the Golden mean group velocity of particle.

Two types of *translational contributions: longitudinal ($\parallel$ tr) and transverse ($\perp$ tr)* ones are the additional vibration energies to Golden mean rotational kinetic energy. The longitudinal vibrations occur in line with external group velocity of elementary particle. The transverse vibrations occur in direction, normal to longitudinal ones.

It is postulated in our theory, that the energy of longitudinal *($\parallel$ tr)* translational zero-point vibrations of elementary charge is responsible for electromagnetic potential (E_{el}). The energy of its transverse *($\perp$ tr)* zero-point vibrations is responsible for gravitational potential (E_G) :

$$[E^i_{\parallel tr} = E_{el} = m^+_C v^2_{\parallel tr} = m^+_C(\alpha v^2) = \frac{e_+ e_-}{L^\pm} = \alpha(m^+_C - m^-_C)c^2 \tag{5.7}$$

$$[E^i_{\perp tr} = E_G = m^+_C v^2_{\perp tr} = m^+_C(\beta v^2) = G\frac{m^+_C m^-_C}{L^\pm} = \beta(m^+_C - m^-_C)c^2 \tag{5.7a}$$

The actual mass has the relativist dependence on the external resulting rotational-translational external group velocity of the particle $v = f(v_{rot}; v_{\parallel tr}; v_{\perp tr})$:

$$m^+_C = \frac{m_0}{\sqrt{1-(v/c)^2}} \tag{5.7b}$$

In our Unified model, the *rest mass of elementary fermion* of any of three generation is defined in a double way: as a difference between the actual and complementary masses, generated by difference in group and phase velocities, corresponding to Golden mean conditions (4.7a and 4.7e), and the square root of their product:

$$m^i_0 = |m^+_C - m^-_C|^i_\phi \quad at \quad v^\phi = c\phi^{1/2} \tag{5.8}$$

$$m^i_0 = \sqrt{|m^+_C m^-_C|^i_\phi} \tag{5.8a}$$

Our definition of the rest mass differs strongly from the conventional definition of (m_0), based on special relativity theory, leading from (5.7b):

$$m = m_0 \quad at \quad v = 0 \tag{5.9}$$

In accordance to our theory, *at condition (5.9), corresponding to condition of primordial Bivacuum (4.2b) of the ideal symmetry, the matter and fields can't exist at all, as far the energy of beats between the actual and complementary states of double cells-dipoles is equal to zero.*

After Unified model, all deviations of the mass of rest or 'Golden mean mass' and the variation of the de Broglie wave length of elementary particles are the result of their additional translational kinetic energy (E_{tr}, *see* 5.7), provided by zero-point oscillation or the external fields or particles.

It is known, that the competition and synchronization in dissipative nonequilibrium mediums under the influence of external periodical force, like HaF, often leads to spatial and temporal self-organization of these mediums, i.e. crystals, water, etc. (Kaivarainen, 2000).

The HaF may direct the evolution of DNA, proteins, cells and the whole organisms to Golden mean conditions.

It leads from our theory, that the final goal of self-organization and Evolution, corresponding to fulfilment of Golden mean conditions on the all hierarchical levels of matter, differs from state of maximum of entropy and "Thermal Death" of the Universe. The latter corresponds to condition of independent harmonic oscillators, when the average kinetic and potential energy are equal to each other. It is quite different from the ratio: $(V/T_k)^\phi$ =2.236 *of potential energy to kinetic one (see eq.*4.10*), determined by Golden Mean.*

5.2 The Principle of Least Action and the Time Problem

It follows from our model, that the *Action* in Lagrange form can be presented as a difference between external and permanent internal kinetic energy of sub-elementary particles:

$$S = S^{ext} - S^{in} = \left[|m^+_C|(v^{ext}_{gr})^2 - |m^+_C|(v^{in}_{gr})^2\right]t = |m^+_C(v^{ext}_{gr})^2 - m_0c^2|\,t \tag{5.10}$$

The right part of (5.10) we get, as far the **internal** kinetic energies of positive $[m^+_C(v^{in}_{gr})^2]$ and negative $[m^-_C(v^{in}_{ph})^2]$ vortices of sub-elementary particles in [C] phase, in contrast to **external** one $[2T_k = m^+_C(v^{ext}_{gr})^2]$, are permanent and equal to the rest energy of sub-elementary particle (see 2.3):

$$2T_{kin}^{in} = |m_C^+|(v_{gr}^{in})^2 = |-m_C^-|\left(v_{ph}^{in}\right)^2 = m_0c^2 = const \tag{5.11}$$

*Comparing (*5.11*) with our formula for Harmonization force and energy (*5.1*a and* 5.2*a), we can see, that the HaF may be responsible for realization of Principle of Least action.*

Applying of Principle of Least Action, as a minimum of the *S* variation to (5.10) and taking into account that, $\delta[m_0c^2] = 0$, we get the unification of *pace of time* ($\delta t/t$) with pace of external kinetic energy, including pace of actual mass and pace of de Broglie wave (λ^+) length change:

$$\delta S = 0 \quad or: \quad \frac{\delta t}{t} = -\frac{\delta T_k}{T_k} \tag{5.12}$$

$$d\ln t = -d\ln T_k = d\ln m_C^+ + 2d\ln\lambda^+ \tag{5.13}$$

The actual kinetic energy $T_k = h^2/[2m_C^+(\lambda^+)^2]$ is related with space parameter - the de Broglie wave (wave B) length of the particle: $\lambda^+ = \hbar/(m_C^+ v_{gr}^{ext})$.

The differentiation of uncertainty formula in coherent form: $Et = \hbar$, where $E = 2T_k$ get us to the same result for **pace of time** ($dt/t = d\ln t = -d\ln T_k$), as (5.13).

Our understanding of time, based on eq.(5.13), leads to definition: "Time for any closed nonequilibrium or oscillating physical system is a parameter, characterizing the pace of this system kinetic energy change"(Kaivarainen, 2002; 2001). This means that Hierarchy of closed system - from the molecule to Universe determines the corresponding hierarchy of time-scales.

Increasing the external velocity of system, accompanied by increasing of its kinetic energy, corresponds to decreasing of pace of time in total accordance with special theory of relativity.

In accordance to our model, the characteristic time for any closed system (t_i), including the Universe, is positive, if the kinetic energy, including the actual mass of this system M_i and its velocity is decreasing and negative in the opposite case:

$$t_i = -\frac{T_k}{dT_k/dt} = -\frac{1}{d\ln T_k/dt} \tag{5.14}$$

It is important to note, that the entropy of system increasing with temperature is accompanied by the increasing of kinetic energy of its elements/particles. Consequently, in accordance to our approach, dissipation and disorganization of system mean negative course of time. For the other hand, decreasing of kinetic energy of particle with temperature decreasing, usually mean increasing of its potential energy of interaction with each other, leading to particles association and Bose condensation.

We may conclude, that time is positive for selected condensed matter system, if this system is tending to self-organization and evolution, decreasing its internal kinetic energy and increasing potential energy. In the opposite case time for this system is negative. In other words, decreasing of entropy means positive course of time and increasing - the negative course of time. This conclusion do not contradict to Prigogin's concept of time, related to entropy change.

6. The Nature of Uncertainty Principle, Spins and Pauli Principle

In this section such phenomena as uncertainty principle, spin, Pauli principle, the origination of bosons from pairs of fermions will be analyzed.

One of the basic laws of quantum mechanics, the principle of uncertainty, reflecting the corpuscle-wave duality, may be expressed in two forms:

$$(\Delta q)^2(\Delta p)^2 \geq \left(\frac{\hbar}{2}\right)^2 \tag{6.1}$$

$$(\Delta t)^2(\Delta E)^2 \geq \hbar^2 \tag{6.2}$$

where: Δq and Δp are uncertainties in **simultaneous** experimental determinations of the coordinate and momentum of wave B; Δt and ΔE are uncertainties of time and energy of wave B in conditions of their simultaneous experimental evaluation.

The reason of this uncertainty is the incompatibility in time of two parameters in the left parts of (6.1 and 6.2) in a course of $[C \rightleftharpoons W]$ pulsation of sub-elementary particles and perturbation of these parameters in a course of measurements. In the selected [W] and instant [C] phase we cannot detect simultaneously the momentum and position of the electron $[(F_{\uparrow}^{+} \bowtie F_{\downarrow}^{-}) + (\mathbf{F}_{\updownarrow}^{-})]$, as well as its life-time and energy, determined by uncompensated sub-elementary particle $(\mathbf{F}_{\updownarrow}^{-})$.

The notion of time (t) and momentum (p) is pertinent only for corpuscular [C] phase, but not for the [W] phase, because both of them are related with actual mass and velocity measurement.

For the other hand, in [W] phase, realized in form of cumulative virtual cloud (CVC), the energy (E) and wave B length $L^{ext} = \hbar/(m_C^{+}v) \sim q$ display themselves, as a measurable parameters.

The hidden energy of elementary wave B, equal in the [C] and [W] phase, can be expressed as

$$E_C^{\pm} = m_C^{+}v^2 = (m_C^{+} - m_C^{-})c^2 = E_W^{\pm} \qquad 6.2b$$

The external measurable energy of particle is equal to $E^{ext} = m_C^{+}c^2$

In so-called **coherent form**, inequalities (6.1 and 6.2) turns to equality. Using parameters, introduced in our dynamic model, we get the generalized form for (6.2), turning the inequality to equality:

$$(T_{C\rightleftharpoons W})^2\,(E_W)^2 = \left[\frac{\hbar}{m_C^{+}v^2}\right]_C^2 [(m_C^{+} - m_C^{-})c^2]_W^2 = \hbar^2 \qquad 6.2c$$

The uncertainty in definition of hidden complementary mass m_C^{-} turns this equality to inequality (6.2).

The similar replacement of the only external parameters of wave B by their total parameters, including the internal (hidden) ones, turns inequality (6.1) to equality:

$$L_W^2 P_C^2 = \left[\frac{1}{2}\frac{\hbar}{(m_C^{+} - m_C^{-})\,c}\right]_W^2 [m_C^{+}v\,(v/c)]_C^2 = \left(\frac{\hbar}{2}\right)^2 \qquad 6.3$$

where the half - length of mass-dipole (L_W), as a minimum detectable spatial parameter of wave B, can be expressed as:

$$\frac{1}{2}L_W = \frac{1}{2}\frac{\hbar}{P_W} = \frac{1}{2}\frac{\hbar}{(m_C^{+} - m_C^{-})\,c} = \frac{1}{2}\frac{\hbar}{m_C^{+}v\,(v/c)} = \frac{1}{2}L_C \qquad 6.4$$

The resulting implicated momentum of [C] phase of particle as a [actual+complementary] mass-dipole (P_d) and the external one (P^{ext}) (explicated in Bohm's terminology) are correspondingly:

$$P_W^{\pm} = (m_C^{+} - m_C^{-})\,c = m_C^{+}v(v/c) = P_C^{\pm} \qquad 6.5$$

$$and \quad P^{ext} = m_C^{+}v \qquad L^{ext} = \frac{\hbar}{m_C^{+}v} \qquad 6.5a$$

Taking into account (6.4 and 6.5) the uncertainty principle in form of inequality (6.1) turns to equality:

$$\left[\frac{\hbar}{(m_C^{+} - m_C^{-})\,c}\right]_W^2 \left[\frac{1}{2}m_C^{+}v^2/c\right]_C^2 = \left(\frac{\hbar}{2}\right)^2 \qquad 6.6$$

This means that impossibility of simultaneous precise experimental evaluation of the momentum and position of elementary particle is a result of alternation between two time-separated [W] and [C] phase of particle and contribution of hidden parameters of de Broglie wave (wave B).

The elementary particles (fermions like electrons and positrons) in our model are not mathematical points, but can be strongly delocalized in space of Bivacuum.

The uncertainty in definition of particle localization (Δq) is equal to difference between the total $L^{\pm}$ (6.4) and the external wave B length ($L^{ext} = \hbar/m_C^+ v$):

$$\Delta q = L^{\pm} - L^{ext} = \frac{\hbar}{|m_C^+ - m_C^-|c} - \frac{\hbar}{m_C^+ v} = \hbar\frac{c - v}{m_C^+ v^2} = \frac{\hbar}{c^2}\frac{c - v}{|m_C^+ - m_C^-|} \quad 6.6a$$

at the limit case, when the external group velocity $v = 0$, the actual and complementary masses are equal $m_C^+ = m_C^-$ and the spatial uncertainty $\Delta q \to \infty$.

In fact, these conditions coincide with condition of infinitive virtual Bose condensation and nonlocality.

At $v = c$, we have $\Delta q = 0$.

In general case at $c > v > 0$, the nonlocal/non-point properties of particle, i.e. its relatively big hidden dimensions, determines the uncertainty of its localization in space. It is true for the both [C] and [W] phase.

Corresponding uncertainty in definition of momentum of particle is

$$\Delta p = p^{ext} - p^{\pm} = m_C^+ v - m_C^+ v(v/c) = m_C^+ v(1 - v/c) = \\ = m_0 v(1 - v/c)^{1/2} \quad 6.6b$$

at $v = 0$, then $\Delta p = p^{ext} = 0$.

The difference between the total external (E^{ext}) and hidden ($E^{\pm}$) energy of sub-elementary particle is

$$\Delta E = E^{ext} - E^{\pm} = m_C^+ c^2 - (m_C^+ c^2 - m_C^- c^2) = \\ = m_C^- c^2 = m_0 c^2[1 - (v/c)^2]^{1/2} \quad 6.6c$$

at $v \to 0$, we have $\Delta E \to m_0 c^2$.

The period of wave B, corresponding to Golden mean condition, when: $|m_C^+ - m_C^-|^{\phi} = m_0$ is equal to its Golden mean period ($T^{\phi}_{C\rightleftharpoons W}$), defined as:

$$T^{\phi}_{C\rightleftharpoons W} = \frac{\hbar}{\Delta E^{\phi}} = \frac{\hbar}{m_0 c^2} \quad 6.6d$$

The uncertainty, induced by measurement of momentum, is a result of its change in a course of measurement, leading to corresponding change of Wave B length.

6.1 Spins of Fermions and Bosons

Just internal angular momentum of uncompensated sub-elementary particle in form of [actual vortex + complementary rotor] in triplets of elementary particles $[(F_{\uparrow}^+ \bowtie F_{\downarrow}^-) + (\mathbf{F}_{\updownarrow}^-)]$ is responsible for spin of fermions, as far spin is not dependent on external velocity and momentum of particles.

Using the conditions of our model for internal (hidden) actual ($m_C^+ v_{gr}^{\mathrm{in}}$) and complementary ($m_C^- v_{ph}^{\mathrm{in}}$) momentums of uncompensated sub-elementary particles ($F_{\updownarrow}^{\pm}$), which determines the properties of fermions, we can show that the **resulting** internal momentum of the fermion squared $(P_C^{in})^2$ is equal to squared rest mass relativist momentum $(m_0 c)^2$:

$$(P_C^{in})^2 = (m_C^+ v_{gr}^{\mathrm{in}})(m_C^- v_{ph}^{\mathrm{in}}) = m_0^2 c^2 = P_0^2 = const \quad 6.7$$

Where the rest mass squared (m_0^2) and light velocity squared (c^2) can be expressed, in accordance with our model as:

$$m_0^2 = m_C^+ m_C^- \qquad 6.8$$

$$\text{and} \quad c^2 = v_{gr}^{\text{in}} v_{ph}^{\text{in}} \qquad 6.8a$$

From (6.7) it follows, that corresponding internal **resulting** radius of cross-section of sub-elementary particle (L_C^{in}) is a constant, defined by product of radiuses of cross-sections of actual vortex and complementary rotor, representing [C] phase of sub-elementary fermion:

$$(L_C^{in})^2 = \frac{\hbar}{m_C^+ v_{gr}^{\text{in}}} \frac{\hbar}{m_C^- v_{ph}^{\text{in}}} = \frac{\hbar^2}{m_0^2 c^2} = (\hbar/P_0)^2 = L_0^2 = const \qquad 6.9$$

where $L_C^{in} = L_0 = \hbar/m_0 c$ coincides with the Compton wave length of fermions with positive rest mass: $m_0 = (m_C^+ m_C^-)^{1/2}$.

From eqs. (6.7 and 6.9) the resulting internal angular momentum coincides with expression for uncertainty principle in coherent form for uncompensated [actual vortex - complementary rotor] sub-elementary fermion/antifermion at Golden mean condition ($|m_C^+ - m_C^-| = m_0$) :

$$L_0^2 P_0^2 = \left(\frac{\hbar}{2}\right)^2 = const \qquad 6.10$$

Taking a square root from both side of (6.10), we get the values of the internal angular momentum of sub-elementary particle/antiparticle, equal to semi-integral spin values of the fermions, like electrons, protons, neutrino and their antiparticles:

$$L_0 P_0 = \pm\frac{1}{2}\hbar \qquad 6.11$$

In general case **spin** (J) is a quantum number in units of ($\hbar$), reflecting the internal dynamics of elementary particles and number of projections of internal angular momentum on any selected direction of space. The number of corresponding spin states is equal to $2J + 1$. Consequently, at $J = 1/2$ we have two possible states of the fermions. They corresponds to two directions (projections) of round cone rotation (spins) as respect to direction of particle propagation ($S = \pm\frac{1}{2}$), i.e. clockwise and anticlockwise.

Fermions follow Fermi-Dirac's statistics. Our model predicts that all fermions, in contrast to bosons, contain "uncompensated" sub-elementary particle, violating the symmetry of Bivacuum.

The integer spin of boson, like photon, is equal to $J = 1$ and that of π and K –mesons, equal to $J = 0$. Bosons do not violate the Bivacuum symmetry due to "compensating" effect in pairs of coherent [sub-elementary fermion ($F_\updownarrow^-$) + sub-elementary antifermion ($F_\updownarrow^+$)] and follow the Bose-Einstein statistics.

The spin, equal to 1, means that three projections of internal angular momentum on any selected direction of space: +1; 0; -1 are possible.

For bosons with spin $J = 0$, only one situation is possible, when **two** [$vortex - rotor$] dipoles of sub-elementary fermions and sub-elementary antifermion of coherent pair ($F_\updownarrow^- + F_\updownarrow^+$) rotate in antiphase to each other. The projection of internal resulting angular momentum of such pair on any selected direction of space is equal to zero ($S = 0$).

If both [$vortex - rotor$] dipoles, forming coherent pair ($F_\updownarrow^- + F_\updownarrow^+$), rotate in the same directions, we may assume, that the "clock-wise" rotation **of pair** as respect to direction of particle propagation in space corresponds to positive integer spin ($S = +1$) and the "anticlockwise" direction of rotation of this pair corresponds to negative integer spin ($S = -1$).

The influence of bosons on resulting Bivacuum symmetry and resulting virtual pressure ($\Delta VP^{\pm} = |VP^+ - VP^-|$ is absent due to self-compensation of opposite effects on negative and positive realms of Bivacuum, induced by $F_\updownarrow^-$ and $F_\updownarrow^+$ in symmetric pairs ($F_\updownarrow^- + F_\updownarrow^+$). It makes possible Bose condensation (accumulation) of unlimited number of particles in the same state of energy (see Fig. 8), in contrast to situation with fermions.

The **asymmetric pair** of two identical sub-elementary fermions/antifermions: $F_{\uparrow}^{\pm}$ and $F_{\downarrow}^{\pm}$ with opposite half-integral spins: $S = +\frac{1}{2}$ *and* $S = -\frac{1}{2}$, and the same charge e^- or e^+ in triplets of the electron $(2F_{\updownarrow}^{-} + F_{\updownarrow}^{+})$ or positron $(2F_{\updownarrow}^{+} + F_{\updownarrow}^{-})$, can be **spatially compatible,** if we assume that their $[C \rightleftharpoons W]$ pulsations of are counterphase (see Fig.7).

It is known fact, that the total rotating cycle for electron or positron spin is not 360^0, but 720^0, i.e. **double turn** by external magnetic field of special configuration is necessary to bring the electron to the starting state (Davies, 1985).

This surprising result may be a consequence of double spatial structure, like [*vortex* + *rotor*] dipole of [C] phase of **uncompensated** sub-elementary antifermion of the electron/positron, responsible for its charge and spin. For this end we have to assume, that direction of rotation in external magnetic field of both: **actual vortex** and **complementary rotor** of uncompensated $(\mathbf{F}_{\uparrow}^{-})$, that determines a sign of spin, **is changing separately**: one after another with intermediate stage in form of sub-elementary boson $(\mathbf{B}^{\pm})$:

$$[(F_{\uparrow}^{+} \bowtie F_{\downarrow}^{-}) + (\mathbf{F}_{\uparrow}^{-})] \overset{360^0}{\rightarrow} [(F_{\uparrow}^{+} \bowtie F_{\downarrow}^{-}) + (\mathbf{B}^{\pm})] \overset{720^0}{\rightarrow} [(F_{\uparrow}^{+} \bowtie F_{\downarrow}^{-}) + (\mathbf{F}_{\uparrow}^{-})] \qquad 6.11a$$

Then, the full rotation angle of $720^0 = 2 \times 360^0$, necessary for spin change, became understandable.

The another possible explanation of double turn may be a consequence of independence of **two stages**:

1) total spin turn of uncompensated $\left(\mathbf{F}_{\uparrow}^{-} \overset{360^0}{\rightarrow} \mathbf{F}_{\uparrow}^{-}\right)$ sub-elementary antifermion, accompanied by conversion of symmetric pair of sub-elementary fermions to pair of sub-elementary bosons:

$$(F_{\uparrow}^{+} \bowtie F_{\downarrow}^{-}) \overset{360^0}{\rightarrow} (B^{\pm} \bowtie B^{\pm}) \qquad 6.11b$$

2) conversion of pair of sub-elementary bosons back to pair of sub-elementary fermions:

$$(B^{\pm} \bowtie B^{\pm}) \overset{360^0}{\rightarrow} (F_{\uparrow}^{+} \bowtie F_{\downarrow}^{-}) \qquad 6.11c$$

Consequently, in accordance with 2nd mechanism, the total process of the electron's spin rotation represents double stage turn of symmetric pair $(F_{\uparrow}^{+} \bowtie F_{\downarrow}^{-})$ and two normal turns of uncompensated sub-elementary fermion $(\mathbf{F}_{\uparrow}^{-})$:

$$[(F_{\uparrow}^{+} \bowtie F_{\downarrow}^{-}) + (\mathbf{F}_{\uparrow}^{-})] \overset{360^0}{\rightarrow} [(B^{\pm} \bowtie B^{\pm}) + (\mathbf{F}_{\uparrow}^{-})] \overset{720^0}{\rightarrow} [(F_{\uparrow}^{+} \bowtie F_{\downarrow}^{-}) + (\mathbf{F}_{\uparrow}^{-})] \qquad 6.12$$

6.2 Pauli principle: How it works?

Let us consider the reasons why the Pauli principle is "working" for fermions and is not working for bosons. The total energy of sub-elementary particles, forming elementary fermions and bosons does not change in a course of [corpuscle ⇔ wave] transitions:

$$E_B = \hbar\omega_B \qquad 6.13$$

where:

$$\omega_B = (m_C^{+} - m_C^{-})c^2/\hbar \qquad 6.13a$$

is a hidden frequency of de Broglie wave, equal to frequency of quantum beats between actual and complementary states of sub-elementary particles.

In *corpuscular* [C] phase both fermions and bosons, including photons, have spatially localized instant masses (m_C^{+} *and* m_C^{-}) and they do not influence the equilibrium of positive and negative virtual pressure. As a result, the *excessive* virtual pressure $(\Delta VP^{\pm})$ is zero:

$$\Delta VP^{\pm} = VP_C^+ - VP_C^- = 0$$

In contrast to [C] phase, the properties of fermions and bosons in the [W] phase in form of cumulative virtual cloud (CVC) are principally different.

In accordance to our model of elementary particles, the number of sub-elementary fermions and sub-elementary antifermions, forming **bosons, is equal**. Each of sub-elementary fermion and sub-elementary antifermion in symmetric pairs ($\mathbf{F}_{\updownarrow}^{+} + \mathbf{F}_{\updownarrow}^{-}$) of **bosons** change their [corpuscular ⇔ wave] states in the *in-phase manner*. It means that *the density of "positive" and "negative" virtual quanta, related to CVC$^+$ and CVC$^-$ [absorption ⇌ emission], oscillate* ***equally, compensating each other****. Consequently, the symmetry of vacuum energy density remains unperturbed. The kind of* ***"Bivacuum symmetry compensation effect"*** *take a place in a course of* $[C \rightleftharpoons W]$ pulsation of bosons. *The interaction (repulsion) between bosons is small, as far the* ***excessive virtual pressure*** *does not change in a course of their* $[C \rightleftharpoons W]$ pulsation ($\Delta VP^{\pm} = const$).

For the other hand, the number of sub-elementary particles and sub-elementary antiparticles in composition of **fermions is not equal to each other,** in contrast to that of bosons. Consequently, the Bivacuum virtual pressure oscillation in realms of positive and negative vacuum, accompanied the cumulative virtual cloud (CVC) emission/absorption in the process of $[C \rightleftharpoons W]$ pulsation of the excessive sub-elementary fermions/antifermions is not compensated. It leads to asymmetric oscillations of Bivacuum virtual quanta density, pressure and density of virtual energy.

This excessive virtual quanta pressure ($\Delta VP^{\pm}$)*, determines the spatial incompatibility and strong repulsing of two separate fermions with the same spins. To explain this effect, we have to postulate, that the elementary fermions of the same spin have the same phase of* $[C \rightleftharpoons W]$ *pulsation.*

If we accept this postulate, then the Pauli repulsion effect between fermions of the same spins is similar to that of excluded volume, provided by incompatibility of two CVC in space and time. It is a result of the difference between virtual quanta density (pressure) of "positive" and "negative" vacuum in space between fermions of similar spins, violating Bivacuum symmetry.

In accordance to our model, the reason of the electromagnetic repulsion between similar charges (see next Chapter) and Pauli repulsion is the same - asymmetric distribution of positive and negative virtual quanta density, leading to excessive virtual pressure. However, the Pauli repulsion $[\varepsilon_P]$ is much stronger than electromagnetic one $[\varepsilon_{el}]$. Their difference is determined by the ratio of total charge of the electron squared, introduced as $Q^2 = \hbar c$ to electromagnetic charge squared, equal to reciprocal value of fine structure constant:

$$\frac{[\varepsilon_P]}{[\varepsilon_{el}]} = \frac{\hbar c}{e^2} = 1/\alpha \simeq 137 \qquad 6.14$$

For the other hand, if the **spins** of two sub-elementary and elementary fermions **are opposite or they are localized in opposite energetic realms of Bivacuum**, like in elementary bosons (photons), and complex bosons, (atoms), then their $[C \rightleftharpoons W]$ oscillations are counterphase and their CVC do not overlap and the effect of excluded volume is absent. In this situation fermions are spatially compatible. Such dynamic system did not increase the existing already difference between positive and negative virtual quanta density. Also, it did not change the vacuum symmetry shift. Consequently, the Pauli repulsion is absent for this case of Bosons and Cooper pairs.

In composition of elementary neutral boson, like photon, virtual quanta with total energy of CVC: $E_W = (m_C^+ - m_C^-)c^2$, emitted as a result of $C \to W$ transition of one of sub-elementary fermion, is absorbed by sub-elementary antifermion with the opposite spin and charge in a course of its $W \to C$ transition at the same semiperiod. The nonzero momentum of pair ($F_{\uparrow}^{+} \bowtie F_{\uparrow}^{-}$) with **similar** spins of sub-elementary fermions in structure of photon (Fig. 3) could be a driving force of its luminal propagation in Bivacuum.

A sub-elementary fermions of the same spin state, but opposite charge are compatible, because their CVC^{+} and CVC^{-} exist simultaneously, but in opposite realms of positive and negative energy of Bivacuum.

Consequently, the Pauli principle reflects the effect of "excluded volume" and repulsion in a system of fermions with the same spins and in-phase $[C \rightarrow W]$ transitions. It is a result of asymmetric excess of virtual quanta density and pressure in space between fermions as respect to outer space. The fermions of the same spin, but different energy, have different frequency of $[C \rightarrow W]$ pulsation. This decoherence makes possible a compatibility of their CVC in space-time.

6.3 Spatial compatibility of sub-elementary fermions of the same charge and opposite spins

We postulate in our model, that $[C \Leftrightarrow W]$ transitions of two sub-elementary antifermions $[F_{\downarrow}^{-}]^{(1)} + [F_{\uparrow}^{-}]^{(2)}$ with opposite spins in composition of electron $[2F_{\updownarrow}^{-} + F_{\updownarrow}^{+}]$ or $[F_{\downarrow}^{+}]^{(1)} + [F_{\uparrow}^{+}]^{(2)}$ of the positron $[2F_{\updownarrow}^{+} + F_{\updownarrow}^{-}]$ are counterphase (see the upper part of Fig. 5).

In the case of **counterphase** $[C \Leftrightarrow W]$ pulsations of $[F_{\downarrow}^{-}]^{(1)}$ and $[F_{\uparrow}^{-}]^{(2)}$ with **opposite** spins - they are *spatially compatible*, as far their corpuscular [C] and wave [W] phase are realized alternatively in different semi-periods.

The example of such pair in composition of the electron or positron is presented on (Fig.5).

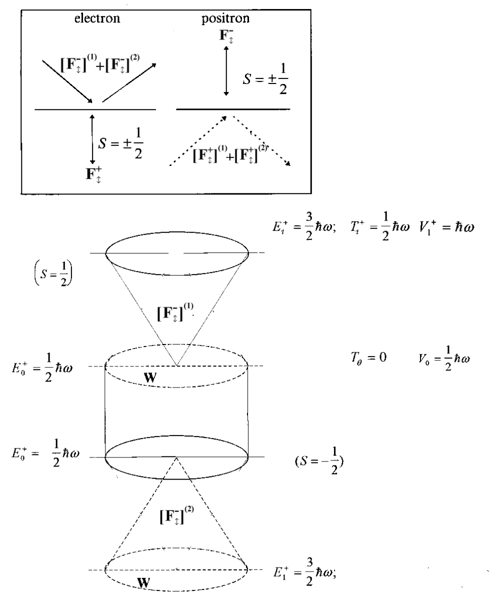


Fig. 5. Schematic representation of pair of a *spatially compatible* sub-elementary fermions as (vortex+rotor) dipoles of the *electron* $[2F_{\updownarrow}^{-} + F_{\updownarrow}^{+}]$, with opposite half-integer spins: $F_{\uparrow}^{-}$ and $F_{\downarrow}^{-}$ and the same charge (e^{-}).
At the counterphase [C ⇔ W] transitions of two sub-elementary fermions with opposite spins, following by quantum beats between actual and complementary corpuscular states, the [C ⇔ W] pulsation of sub-elementary antifermion F^{+} also change its phase and spin. It happens due to exchange interaction (attraction) between sub-elementary particles by means of cumulative virtual cloud (CVC). The spin state change of one uncompensated sub-elementary fermion ($F_{\updownarrow}^{-}$) : $[S = +\frac{1}{2} \rightleftharpoons S = -\frac{1}{2}]$ is accompanied by counterphase change of spins in coherent pair $[F_{\updownarrow}^{-} + F_{\updownarrow}^{+}]$. The similar interrelated spin inversions of sub-elementary particles/antiparticles occur in positron $[2F_{\updownarrow}^{+} + F_{\updownarrow}^{-}]$. In the volume of triplets of electrons and positrons the spin-spin exchange interaction between unipolar sub-elementary particles/antiparticles is stronger, than electromagnetic repulsion.

In accordance to our model, in triplet $[2F_{\updownarrow}^{-} + F_{\updownarrow}^{+}]$, representing the electron, the resulting spin and charge of the electron is determined by "uncompensated" spin of one of two ($F_{\updownarrow}^{-}$), presented on Fig.5. The actual inertial mass (m_C^{+}) of the electron is determined by this uncompensated sub-elementary fermion also.

The dynamics of sub-elementary particles of positron $[2F_{\updownarrow}^{+} + F_{\updownarrow}^{-}]$ is similar to that of electron, determined, however, by uncompensated sub-elementary antifermion.

The complex systems of *different elementary* particles with opposite spins, like [electron + electron], [positron + positron], [electron + proton], [protons and neutrons of heavy nuclears], etc. also could be spatially compatible, if their $[C \rightleftharpoons W]$ pulsations are counterphase and the Pauli repulsion is absent. Such a particles systems have a properties of bosons with $(S = 0)$, like Cooper pairs.

6.4. Bosons as a coherent system of sub-elementary and elementary fermions

The spatial image of the main unit of elementary boson (Fig. 6) could be presented as a superposition of **two** (vortex - rotor) dipoles, representing pair [sub-elementary fermion + sub-elementary antifermion] with opposite charge and the same spin states. In general case the elementary bosons are composed from the integer number of such pairs.

Bosons have a zero or integer spin $(0, 1, 2\ldots)$ in the $\hbar$ units, in contrast to the half integer spins of fermions. In general case, bosons with $S = 1$ include: photons, gluons, mesons and boson resonances, phonons, pairs of elementary fermions with opposite spins (i.e. Cooper pairs under the conditions of Bose-condensation), atoms and molecules.

We subdivide bosons into two types:

1. *Elementary bosons* (like photons), composed from equal number of sub-elementary fermions and antifermions, moving with light velocity in contrast to complex bosons;
2. *Complex bosons*, represent a coherent system of elementary fermions (electrons and nucleons), like neutral atoms and molecules.

Formation of stable complex bosons from elementary fermions of opposite charge and same spins with different actual masses: $(m_C^+)_1 \neq (m_C^+)_2$ is possible due to their electromagnetic attraction. It may occur, if the length of their waves B are the same and equal to distance between them. This former condition may be achieved by difference in their external group velocities, adjusting the momentums to the same value:

$$L_1 = \hbar/(m_C^+ v)_1 = L_2 = \hbar/(m_C^+ v)_2 \ldots = L_n = \hbar/(m_C^+ v)_n \qquad 6.15$$
$$at: \quad v_1/v_n = (m_C^+)_n/(m_C^+)_1$$

The mentioned above conditions are the base for assembly of complex bosons.

The **hydrogen atom**, composing from two fermions: electron and proton is an example of complex microscopic complex bosons. The heavier atoms also must follow the same principle.

Stability of microscopic asymmetric bosons: atoms and molecules is determined by the electromagnetic exchange by virtual photons as a part of CVC, and by the similar wave B length of the electrons and nucleons.

The energies of boson are equal to the sum of the corresponding energies of two constituent fermions, being simultaneously in corpuscular or wave phase (Fig.8).

In accordance with our model, the elementary boson, such as photon, represents dynamic superposition of two triplets of sub-elementary fermions and antifermions (Fig. 3), corresponding to electron and positron structures. Such composition determines the resulting external charge of photon, equal to zero and the value of photon's spin: $J = +1$, 0 or -1.

Stability of all types of *elementary* particles: bosons and fermions (electrons, positrons etc.) is due to exchange and attraction of cumulative virtual clouds (CVC^+ and CVC^-) in the process of $[C \rightleftharpoons W]$ pulsations of sub-elementary particles and sub-elementary antiparticles in pairs, like presented at Figs. 7 and 8, correspondingly.

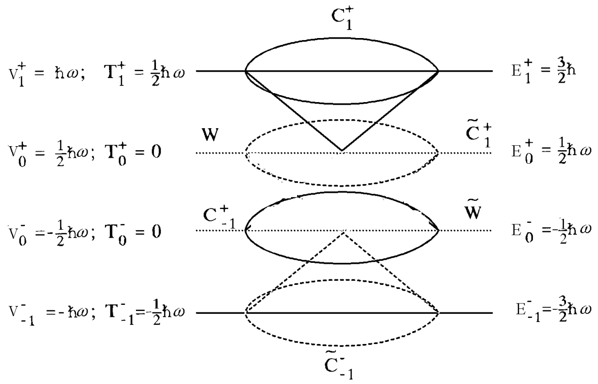


Fig. 6. Schematic representation of symmetric and coherent pair of couple of symmetric [vortex+rotor] ($\mathbf{F}^+ + \mathbf{F}^-$) with boson properties. Two sub-elementary fermions, pulsating in-phase between the corpuscle and wave states compensate the mass, spin and charge of each other. Such a pair is a neutral component of different elementary particles, like electrons, positrons, quarks and others.

Properties of symmetric pair of ($\mathbf{F}^+ + \mathbf{F}^-$):
resulting electric charge is zero;
resulting magnetic charge is zero;
resulting spin: $S_{(\mathbf{F}^+ + \mathbf{F}^-)} = \pm 1, 0$

6.5 Influence of Particles [C $\rightleftharpoons$ W] Pulsation on Bivacuum Properties

It follows from our model of elementary particles and antiparticles, as a triplets of sub-elementary particles: $e^\pm = \langle [\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+] + \mathbf{F}_\updownarrow^\pm \rangle$ and their superposition in quarks (see section 2.2), that just symmetric pairs $[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+]$ in a course of their [C$\rightleftharpoons$ *W*] pulsation are responsible for interaction of matter with positive and negative vacuums . The corresponding *Virtual Replica (VR) of matter* origination is modulated by the external dynamic behavior of uncompensated sub-elementary particle $[\mathbf{F}_\updownarrow^\pm\rangle$, correlated with internal dynamics of $[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+]$.

Our model predicts, that the system of atoms and molecules, generating gravitational (E_G) and electromagnetic (E_{el}) fields may change the properties of Bivacuum and VR of matter in form of standing virtual pressure waves ($VPW^\pm$) because of following interrelated factors:

1. Changing the probability of virtual pressure waves (VPW^+ and VPW^-) excitation due to change of values of $\Delta U = E_{el} + E_G$ and the resonant frequency shift: $\Delta\omega_0^i = \Delta m_0 c^2/\hbar$ (see section 2.4).

The electromagnetic radiation by material object, increasing the virtual particles and antiparticles density, energy and charge, increase also the total virtual energy density: $\varepsilon^{tot} = \varepsilon^+ + \varepsilon^-$ (see eq. A31) and change permittivity (ε_0) and permeability $[\mu_0 = (\varepsilon_0 c^2)^{-1}]$ of Bivacuum. The Coulomb interaction is dependent on these parameters. It may influence polarizability of atoms and molecules of the air around objects and their ionization potential. *Consequently, the characteristics of Kirlian picture (gas discharge) of the object may reflect the properties of its Virtual Replica;*

2. Making the $VPW^\pm$ more uniform due to coherent thermal dynamics of molecules of matter in state of mesoscopic Bose condensation (mBC), providing coherent [$C \rightleftharpoons W$] pulsation of elementary particles, composing these molecules;

3. Changing the asymmetry of virtual energy density $\Delta\varepsilon^{res} = \varepsilon^+ - \varepsilon^-$, as a difference between energy densities of positive (ε^+) and negative (ε^-) vacuum. Changing of Bivacuum symmetry shift (Δm_V) and value of $\Delta\varepsilon^{res} = \pm(\varepsilon^+ - \varepsilon^-)$, related with $[BVF^\uparrow \rightleftharpoons BVF^\downarrow]$ equilibrium shift, may be achieved by influence of magnetic field, radiated by body, on this equilibrium. This difference regulation means possibility of space-time metric engineering;

4. Generation of *Virtual Replica (VR)* of body in form of modulated 3D virtual pressure

waves ($VPW^{\pm}$) by thermal oscillation of the instant kinetic energy of molecules: $2T_k = m_C^+ v^2 = F(\Omega)$ with modulation frequency (Ω) :

$$\Delta\omega_0^i(\Omega) \sim \Delta m_V(\Omega) c^2 = \beta_G \Delta m_C(\Omega) c^2 = \beta_G [m_C^+ v^2](\Omega) \qquad 6.16$$

The molecular coherent dynamics induce the modulation of mass symmetry shift $(\Delta m_C = m_C^+ - m_C^-)^i$ of elementary particles and Golden mean frequency shift $(\Delta\omega_0^i)$.

The $[Matter \rightleftharpoons Bivacuum]$ interaction has been considered in detail in work: "Virtual replica of Bivacuum & possible mechanism of distant mind-matter and mind-mind interaction", located at: http://arXiv.org/abs/physics/0102086.

6.6 The Mystery of Sri Yantra Diagram

In accordance to ancient archetypal ideas, geometry and numbers describe the fundamental energies in course of their dance - dynamics, transitions. For more than ten millenniums it was believed that the famous Tantric diagram-Sri Yantra contains basic functions active in the Universe (Fig. 7).

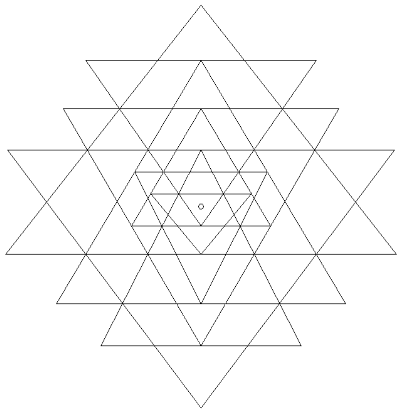
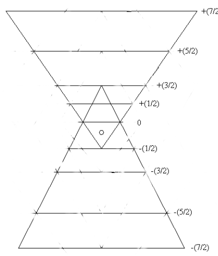


Fig. 7. The Sri Yantra diagram is composed from nine triangles. Four of them are pointed up and five down. Author is grateful to P. Flanagan for submitting of Sri Yantra diagram with precise coordinates of most important points, making it possible the quantitative analysis.

Triangle is a symbol of a three-fold nature. The Christian trinity, the symbol of God may be represented by triangle. In Buddhism-Hindu triangle with **apex up** is a symbol of God-male and that with **apex down** is a symbol of God-female.

We found out that Sri Yantra diagram can be considered as a symbolic language, containing information about the mechanism of corpuscle-wave duality, being the background of all kinds of fundamental interaction. Each of pair of triangles [down+up] in terms of our model corresponds to positive and negative parts of two-cavity hyperboloid (Fig. 4), describing spatial image of [W] phase of the pair of [sub-elementary fermions (F^+) + sub-elementary antifermions (F^-)] in triplets $[(\mathbf{F}_\updownarrow^+ \bowtie \mathbf{F}_\updownarrow^-)_W + (\mathbf{F}_\updownarrow^\pm)_C]$, composing elementary particles, like electron, positron, quarks in different excitation states. The uncompensated sub-elementary particle $(\mathbf{F}_\updownarrow^\pm)$ is always in counterphase with pair $(\mathbf{F}_\updownarrow^+ \bowtie \mathbf{F}_\updownarrow^-)$, in accordance with our model.

In another terms, Fig. 8a, as a part of Sri Yantra, contains information about spatial image of wave B in form of pair of cumulative virtual clouds $(\mathbf{CVC}^+ \bowtie \mathbf{CVC}^-)_W$, corresponding to [W] phase of symmetric pair $(\mathbf{F}_\updownarrow^+ \bowtie \mathbf{F}_\updownarrow^-)_W$ and about their energy quantization.



b

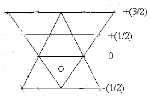


Fig. 8a. Parts of Sri Yantra, representing in accordance to our model a spatial images of pair of [sub-elementary particle $(\mathbf{F}^{-})$ + sub-elementary antiparticle $(\mathbf{F}^{+})$] of different states of excitation, corresponding to WAVE phase [W] as a parted, (double) hyperboloid (Fig. 5 a);
Fig.8b. Corresponding to this phase of triplet $[(\mathbf{F}^{-}\bowtie\ \mathbf{F}^{+})_W + (\mathbf{F}^{\pm})_C]$ the asymmetric Bivacuum ground state.
The numbers near the right side of pictures characterize the energy of positive and negative energy sublevels of Bivacuum excitation: $E_B = \pm\hbar\omega(n+\frac{1}{2}),\ \ where:\ \ n = 0,1,2\ldots$

Other important feature of Sri Yantra, compatible with our model of standing $[(\mathbf{F}^{+}\bowtie\ \mathbf{F}^{-})_W]$ in composition of electron, is Bivacuum symmetry shift, corresponding to this phase of triplet $[(\mathbf{F}^{+}\bowtie\ \mathbf{F}^{-})_W+(\mathbf{F}^{\pm})_C]$.

Asymmetry is obvious from position of central point of diagram, denoted on Figs. (7) and (8a, 8b) as an open circle (o) and diamond shape of its nuclei, composed from two triangles with common base and different height.

It is interesting to note, that spatial position of central point (o), localized in lower triangle of Sri Yantra diamond-nuclei as respect to its base and apex - corresponds to *Golden mean*.

The degree of asymmetry of Sri Yantra decreases with increasing the distance from its central point (o). For example, the shifts of zero-point positive and negative vacuum sublevels, pointed on Fig. 8a:

$$+\frac{1}{2}\hbar\omega\ \ and\ \ -\frac{1}{2}\hbar\omega\ \ \ (n = 0) \tag{6.17}$$

as respect to central point (o) of Sri Yantra are characterized by ratio: **1.77**. It reflects the asymmetry of Bivacuum boson of secondary Bivacuum , perturbed by matter. The less asymmetric shifts of higher sublevels with quantum number: $n = 1,2,3$, corresponding to positive and negative energies of vacuum excitation: $(\pm\mathbf{3/2})\hbar\omega$; $(\pm\mathbf{5/2})\hbar\omega$ and $(\pm\mathbf{7/2})\hbar\omega$ are characterized by the following ratios of their distance from central point: **1.19**; **1.1** and **1.046**.

In terms of our model, this asymmetry of $(\mathbf{F}^{+}\bowtie\ \mathbf{F}^{-})_W$ is related with asymmetry of Bivacuum gap symmetry oscillation (BvSO), accompanied their $[\mathbf{C} \rightleftharpoons \mathbf{W}]$ pulsation. The asymmetry is produced by uncompensated sub-elementary particle in composition of triplets $[(\mathbf{F}^{+}\bowtie\ \mathbf{F}^{-})_W+(\mathbf{F}^{\pm})_C]$.

The analogy between some features of ancient diagram and our wave-corpuscle duality model is surprising indeed.

7 Calculation of Magnetic Moment of the Electron, Based on Unified Model

In this section the quantitative evidence in proof of our Unified model is presented.

We assume, that the difference between the *actual magnetic moment of the electron (see* 2.4*)* $[\mu_e = e^+\hbar/(2m_0c)]$ and the Bohr magneton $[\mu_B = e\hbar/(2m_0c)]$ is defined by small deviation (perturbation) of the actual electric charge (e^+) of Bivacuum fermions ($BVF^\updownarrow$) of secondary Bivacuum from the resulting charge (e). This deviation of the properties of Bivacuum from the neutral ones, pertinent for primordial Bivacuum, is a result of zero-point oscillation of $BVF^\updownarrow$ and the electron. Corresponding asymmetry of the actual and complementary charges of the virtual Bivacuum fermions is responsible for asymmetry of the actual electron magnetic moment and the Bohr magneton.

Using (4.2), the ratio of μ_e to the Bohr magneton μ_B may be presented as:

$$\frac{\mu_e}{\mu_B} = \frac{e_+}{e} = \frac{1}{[1-(v_0/c)^2]^{1/4}} = \frac{1}{[1-z^2]^{1/4}} \gtrsim 1 \qquad 7.1$$

The best coincidence between the experiment and (7.2) theory occurs, if we assume, that zero-point velocity $(v_0/c)^2$ is defined by product of the Golden mean ratio $\phi = (v/c)^2 = 0.6180339887$ and the electromagnetic fine structure constant $\alpha = e^2/\hbar c = 0.0072973506$ in form:

$$z = (\alpha\phi)^{1/2} = (v_0/c) = 0.067156608 \qquad 7.2$$

where **(z)** is a new dimensionless *zero point factor,* introduced in our Unified model.

It looks, that (z) may serve as a new World constant, reflecting the *asymmetric properties of Bivacuum.* In primordial symmetric Bivacuum $v_0 = 0$.

From (7.2) the most probable zero-point velocity of the electron (v_0), characterizing its quantum zero-point oscillation, is related to light velocity as:

$$v_0 = cz = c(\alpha\phi)^{1/2} = 2.99792458 \times 10^8\,\mathrm{m\,s^{-1}} \cdot 0.067156608 = \qquad 7.3$$

$$= 0.201330447 \times 10^8\,\mathrm{m\,s^{-1}} \qquad 7.3a$$

The magnetic moment of the electron, calculated using analytical expressions (7.2 and 7.3) at zero-point condition ($\mu_{UM} = 1.001131\,\mu_B$) coincides with experimental value ($\mu_{\exp} = 1.001159\,\mu_B$) very well. The small difference may be a consequence of screening of the electron's charge by slightly asymmetric virtual Bivacuum fermions ($BVF^\updownarrow$), as far their actual and complementary charges do not totally compensate each other: $|e_+ + e_-| > 0$. The latter effect can be evaluated by quantum electrodynamics (QED), using perturbation theory (Feynman, 1985).

7.1 The Problem of Dirac's Monopole

The Dirac's theory of elementary magnetic charge (g), symmetric to electric one (e), named **monopole**, leads to following relation between the monopole and electric charge:

$$ge = \frac{n}{2}\hbar c \qquad 7.4$$

$$where:\ n\ \ is\ the\ \text{integer}\ number$$

It follows from this definition that minimal magnetic charge ($at\ n = 1$) is as big as $g \cong 67.7e$. The mass of monopole should be huge $\sim 10^{16}\,GeV$. All numerous attempts to reveal such particles in experiment has failed.

Our model does not need monopole for explanation the symmetry of electromagnetism. The notion of monopole is replaced by that of magnetic dipole of sub-elementary particles, symmetric *to their electric dipole (see section 2.2). It is shown in section (8.2), that on the distance, exceeding the dimensions of dipoles, the electromagnetic (EM) field, radiated in a course of sub-elementary particles (as the double - dipoles) $[C \rightleftharpoons W]$ pulsation, represents the spherical wave with vectors $\vec{E}$ and $\vec{H}$, normal to direction of the EM wave propagation.*

8. Electromagnetism and Gravitation in the Framework of Unified Model

It is assumed that the internal electromagnetic and gravitational interactions of sub-elementary particles/antiparticles, as the electric-dipoles and mass-dipoles determine the maximum of corresponding external potentials.

It leads from our theory that the electromagnetic ($\mathbf{E}_{el}$) and gravitational ($\mathbf{E}_G$) potentials of uncompensated sub-elementary particle, derived in Unified model (UM), are dependent on the longitudinal and transverse translational vibrations contributions, correspondingly, to the actual kinetic energy of particle:

$$\mathbf{E}_{el} = \frac{\vec{r_0}}{r}\frac{e_+e_-}{L^\pm} = \left[\frac{\vec{r_0}}{r}\alpha(m_C^+ - m_C^-)c^2 = \frac{\vec{r_0}}{r}\alpha\, m_C^+ v^2 = \alpha 2T_k\right]_{\parallel tr} \qquad 8.1$$

$$\mathbf{E}_G = \frac{\vec{r_0}}{r}G\frac{m_C^+ m_C^-}{L^\pm} = \left[\frac{\vec{r_0}}{r}\beta(m_C^+ - m_C^-)c^2 = \frac{\vec{r_0}}{r}\beta\, m_C^+ v^2\right]_{\perp tr} \qquad 8.2$$

where: $\alpha = e^2/\hbar c$ is the electromagnetic fine structure constant; $\beta = (m_0/M_{Pl})^2$ *is a new gravitational fine structure constant,* introduced in our UM; $M_{Pl} = (\hbar c/G)^{1/2}$ is a Plank mass; $\vec{r_0}$ is a unitary radius-vector and r is a distance between the probe charge and elementary particle; e_+ and e_- are the actual and complementary charges of sub-elementary particles with their product, equal to elementary charge squared (eq. 2.11a):

$$|e_+e_-| = e^2 \qquad 8.2a$$

m_C^+ and m_C^- are the actual and complementary masses of sub-elementary particles with their product, equal to mass of rest squared squared (eq. 2.7):

$$|m_C^+ m_C^-| = m_0^2$$

The Bivacuum dipoles symmetry shift:

$$\Delta m_V = m_V^+ - m_V^- = \beta(m_C^+ - m_C^-) \qquad 8.2b$$

is responsible for gravitation and is related directly to mass symmetry shift: $\Delta m_C = (m_C^+ - m_C^-)$;

$$L^\pm = \hbar/[(m_C^+ - m_C^-)c] \qquad 8.2c$$

is the resulting dimension (amplitude) of sub-elementary particle in form of [vortex-rotor] dipole, equal to that of CVC.

We can see, that only small part of energy $E_{C,W} = (m_C^+ - m_C^-)c^2$ of cumulative virtual cloud (CVC), defined by the value of electromagnetic fine structure constant ($\alpha \simeq 1/137$) is responsible for electromagnetic interaction and even much smaller ($\beta_e = 1.7385 \cdot 10^{-45}$) for gravitation.

The ratio of gravitational and electromagnetic potential, generated by the same particle is:

$$\frac{E_G}{E_{el}} = \frac{\beta}{\alpha} \simeq 2.38 \cdot 10^{-43} \qquad 8.2d$$

The electromagnetic and gravitational interaction energy between two particles (1) and (2) can be presented as:

$$\mathbf{E}_{el}^{1,2} = [\mathbf{E}_{el}^{(1)}\mathbf{E}_{el}^{(2)}]^{1/2} \qquad 8.3$$

$$\mathbf{E}_{G}^{1,2} = [\mathbf{E}_{G}^{(1)}\mathbf{E}_{G}^{(2)}]^{1/2} \qquad 8.3a$$

At Golden mean condition (4.7a), when $(m_C^+ - m_C^-) = m_0$, we have from (8.1-8.2a):

$$\mathbf{E}_{el}^{\phi} = \frac{\overrightarrow{r_0}}{r}\alpha(m_C^+ - m_C^-)^{\phi}c^2 = \frac{\overrightarrow{r_0}}{r}\alpha m_0 c^2 = \frac{\overrightarrow{r_0}}{r}\alpha\frac{\hbar c}{L_0} = \frac{\overrightarrow{r_0}}{r}\frac{\hbar c}{a_B} \qquad 8.4$$

$$\mathbf{E}_{G}^{\phi} = \frac{\overrightarrow{r_0}}{r}\beta(m_C^+ - m_C^-)^{\phi}c^2 = \frac{\overrightarrow{r_0}}{r}\beta m_0 c^2 = \frac{\overrightarrow{r_0}}{r}\beta\frac{\hbar c}{L_0} = \frac{\overrightarrow{r_0}}{r}\frac{\hbar c}{a_G} \qquad 8.4a$$

where: $a_B = L_0/\alpha = \hbar^2/m_0e^2$ is the curvature of the electron's trajectory in self-created electromagnetic field, equal to the Bohr radius of hydrogen atom, and $a_G = L_0/\beta = \hbar M_{Pl}^2/(m_0^3c)$ is the curvature of the electron's in self-created gravitational field; $\hbar c = Q^2$ is defined, as a full charge of sub-elementary fermion.

8.1 Neutrino and Antineutrino in Unified Model

We put forward a conjecture, that the quantized energy of neutrino and antineutrino of three lepton generation, as a stable Bivacuum symmetry excitation, are related to the rest mass of corresponding generations of the electron and positron $(\pm m_0^{e,\mu,\tau})$ in following manner:

$$E_{e,\mu,\tau}^{\nu,\tilde{\nu}} = \pm\Delta(m_V^{e,\mu,\tau})c^2 = \pm\beta_{e,\mu,\tau}(m_0^{e,\mu,\tau})c^2(\frac{1}{2} + n) \qquad 8.5$$

where $(\pm m_0^{e,\mu,\tau})$ are the rest mass of $[e,\mu,\tau]$ generations of electrons and positrons; $\beta_{e,\mu,\tau} = (m_0^{e,\mu,\tau}/M_{Pl})^2$ is a gravitational fine structure constants, introduced in our theory of gravitation.

From (8.4a and 8.4b) one may see, that if our model is correct, the neutrino/antineutrino directly participate in gravitational interaction/repulsion. The energy of such interaction should be dependent on density energy of neutrino and its generation. In accordance to UM, heavy μ *and* τ neutrino are related to gravitational radiation of nuclears, as far the quarks are formed by superposition of corresponding electrons generation (section 2.4), and $e-$ neutrino, to that of the e –electrons.

8.2 Virtual Photons Radiation by the Electrons and Positrons, as a result of their $[C \rightleftharpoons W]$ pulsation

The virtual electromagnetic photons are emitted and absorbed in a course of $[C \rightleftharpoons W]$ pulsation of sub-elementary particle in accordance with known mechanism of the *electric and magnetic dipole radiation, induced by charges acceleration, accompanied the pulsation.*

The intensity of time-averaged *electric dipole radiation of* $[\mathbf{F}_{\updownarrow}^{\pm} >$ may be expressed like (Berestetski, et al., 1989):

$$\varepsilon_{E.dip} = \frac{4e^2}{3c^3}\omega_{C\rightleftharpoons W}^4(L^{\pm})^2 = \frac{4}{3c^3}\omega_{C\rightleftharpoons W}^4 d_{\mathbf{F}_{\updownarrow}^{\pm}}^2 \qquad 8.6$$

where: $e^2 = e^-e^+$ is a resulting charge squared; $\omega_{C\rightleftharpoons W}$ is a frequency of dipole oscillation; the resulting dimension of uncompensated sub-elementary particle $[\mathbf{F}_{\updownarrow}^{\pm} >$ is defined by (3.3) as $L^{\pm} = \hbar/(|m_C^+ - m_C^-|c)$, equal at Golden mean (GM) conditions to Compton's length: $(L^{\pm})^{\phi} = \hbar/(m_0c) = L_0$, and the electric dipole moment $d_{\mathbf{F}_{\updownarrow}^{\pm}} = eL^{\pm}$, equal at GM conditions to

$$\left[d_{\mathbf{F}_{\updownarrow}^{\pm}} = eL^{\pm}\right]^{\phi} = eL_0 = 2\mu_B \qquad 8.7$$

where the Bohr's magneton: $\mu_B = e\hbar/(2m_0c)$

The intensity of $\varepsilon_{E.dip}$ is maximum in direction, normal to direction of $[C \rightleftharpoons W]$ pulsation and zero along this direction.

The formula for time-averaged *magnetic dipole* radiation $(\varepsilon_{M.dip})$ of $[\mathbf{F}_{\updownarrow}^{\pm} >$ has a symmetric to (8.6) form.

After putting to (8.6) the frequency of dipole oscillation, equal to that of $[C \rightleftharpoons W]$ pulsation from (3.2):

$$\omega_{C\rightleftharpoons W} = |m_C^+ - m_C^-|c^2/\hbar = m_C^+ v^2/\hbar \qquad 8.8$$

formula (8.6) transforms to

$$\varepsilon_{EM} = \frac{4}{3}\frac{d^2_{\mathbf{F}_\updownarrow^\pm}}{\hbar^2 c^3}(\hbar\omega_{C\rightleftharpoons W})^2 = \frac{4}{3}\frac{d^2_{\mathbf{F}_\updownarrow^\pm}c}{\hbar^2}|m_C^+ - m_C^-|^2 = \frac{4}{3}\frac{d^2_{\mathbf{F}_\updownarrow^\pm}}{\hbar^2 c^3}m_C^+ v^2 \qquad 8.9$$

At the GM conditions: $|m_C^+ - m_C^-|^\phi = m_0$ (see 4.7a).

The *virtual* photons are the result of dipole radiation, related to $[C \rightleftharpoons W]$ pulsation

The time-averaged *actual* photons radiation intensity of the charged elementary particles is determined by particles external kinetic energy, related to their longitudinal vibrations, i.e. by velocity of electric current and it alternation in time. This result of our UM is in total accordance with conventional radiation theory and experiment.

For the case of actual photons, propagating in space with light velocity, the electric and magnetic dipole radiation intensity of uncompensated pair of sub-elementary particles are equal. The intensity of EM radiation in Bivacuum is defined by the Pointing vector: $\varepsilon_{EM} = \frac{c}{4\pi}[\mathbf{EH}]$.

The total electromagnetic energy of the electron (E_{el}) can be considered as a part of total energy of cumulative virtual cloud (CVC), determined by the fine structure constant ($\alpha = e^2/\hbar c$) as a factor. This means that the notion of the electric and magnetic components of virtual quanta, responsible for interaction between charged particles, looks to be pertinent for the wave [W] phase of particle only. However, the electric and magnetic components of charge are related to [actual vortex + complementary rotor] dipole of corpuscular [C] phase, correspondingly.

The notions of spin, actual mass and time also are pertinent only for [C] phase of particle only.

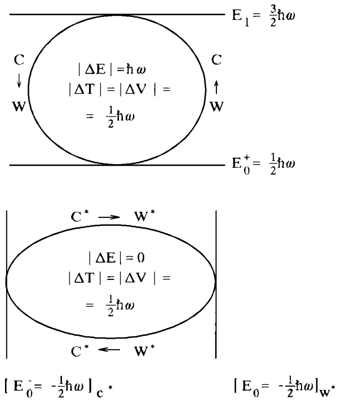


Fig. 9. The in-phase oscillation of the total energy $[E_1 \rightleftharpoons E_0^+]$ (Hamiltonian) of the actual state (upper fig.) and the symmetry oscillation $[|T - V|_C \rightleftharpoons |T - V|_W]$ (Lagrangian) of the complementary state (down) during $[C \rightleftharpoons W]$ transitions of [vortex+rotor] dipole of sub-elementary particle. These two types of oscillation are responsible for electric and magnetic components of the resulting electromagnetic potential, respectively.

8.3 Possible Mechanism of Electromagnetic Interaction

The mechanism of electromagnetic interaction may be demonstrated on example of the electron/positron triplet:

$$\langle[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+] + \mathbf{F}_\updownarrow^\pm\rangle$$

During two semiperiods of triplets $[(F_\uparrow^+ \bowtie F_\downarrow^-) + (\mathbf{F}_\updownarrow^\pm)]$, forming elementary particles, the corpuscular [C] and wave [W] phase of sub-elementary particle and sub-elementary antiparticle in pairs $[F_{\updownarrow}^{-} \bowtie F_{\updownarrow}^{+}]$ are realized in-phase. The $[C \rightleftharpoons W]$ pulsations of 2 standing sub-elementary fermions $(2F_{\updownarrow}^{-})$, forming part of the electron $[2F_{\updownarrow}^{-} + F_{\updownarrow}^{+}]$ are counterphase. It means that when one of them $(F_{\uparrow}^{-})$ is in [C] phase, the other $(F_{\downarrow}^{-})$ is always in the [W] phase.

The charge, energy and momentum of sub-elementary fermions and antifermions in symmetric pairs $[F_{\updownarrow}^{-} \bowtie F_{\updownarrow}^{+}]$ of the electron, positron, quark and other fermions compensate each other. Their in-phase $[C \rightleftharpoons W]$ pulsations are unable to transfer the energy, because their resulting Pointing vector is equal to zero:

$$\vec{P}_{F_{\updownarrow}^{-} \bowtie F_{\updownarrow}^{+}} = \vec{P}_{F_{\updownarrow}^{-}} + \vec{P}_{F_{\updownarrow}^{+}} = 0 \qquad 8.10$$

where:

$$\vec{P}_{F_{\updownarrow}^{-}} = \left[\vec{E} \times \vec{H}\right] \qquad 8.10a$$

$$\vec{P}_{F_{\updownarrow}^{+}} = \left[\vec{H} \times \vec{E}\right] = -\vec{P}_{F_{\updownarrow}^{-}} \qquad 8.10b$$

When pair $[F_{\updownarrow}^{-} \bowtie F_{\updownarrow}^{+}]$ is in the WAVE phase in form of twin cumulative virtual cloud ($2CVC^{\pm}$), it is responsible for pair of symmetrical virtual pressure waves: $[VPW^{+}+VPW^{-}]$ excitation. The strong correlation is existing between parameters of such standing waves and VPW, generated by uncompensated sub-elementary particle, responsible for all detectable properties of elementary particle.

The coherent $[C \rightleftharpoons W]$ pulsations of uncompensated sub-elementary fermions can produce Bivacuum symmetry oscillation (BvSO). The asymmetrical state of electron is related to semiperiods of wave B, when one (unpaired) standing $(F_{\updownarrow}^{-})$ is in Corpuscular state and pair $[F_{\updownarrow}^{-} + F_{\updownarrow}^{+}]$ is in the Wave state.

In contrast to symmetrical $[C \rightleftharpoons W]$ oscillations of $[F_{\updownarrow}^{-} \bowtie F_{\updownarrow}^{+}]$ pairs, the asymmetric ones, related to pulsation of unpaired $(F_{\updownarrow}^{-})$, can be accompanied by energy transfer as far in this case the Pointing vector is nonzero. The same is true for bosons, like photons, when one of $[F_{\updownarrow}^{-} + F_{\updownarrow}^{+}]$ pair have nonzero resulting momentum and spin.

In accordance to our model, the *electromagnetic repulsion and attraction* between two charged particles is a result of tendency of system to minimize the resulting density of energy of their cumulative virtual clouds ($CVC^{\pm} + CVC^{\pm}$), emitted/absorbed in a course of $[C \rightleftharpoons W]$ pulsation of their unpaired sub-elementary fermions: $[\mathbf{F}_{\updownarrow}^{\pm}\rangle \Leftrightarrow [\mathbf{F}_{\updownarrow}^{\pm}\rangle$.

The **repulsion** is a consequence of the **excessive** uncompensated virtual pressure: $\Delta V\mathrm{Pr}^{\pm} = |V\mathrm{Pr}^{+} - V\mathrm{Pr}^{-}|$ between two particle with similar $CVC^{\pm}$ charge (i.e. similar by energy uncompensated sub-elementary particle), as respect to outside virtual pressure. Consequently:

$$EM\ repulsion:\ \ \alpha\frac{\vec{r}}{r}[E_{CVC^{+}} + E_{CVC^{+}}] \to 0,\ \ at\ \ r \to \infty \qquad 8.11$$

The electromagnetic **attraction** is a consequence of the **excessive** uncompensated virtual pressure: $\Delta VP^{\pm} = |VP^{+} - VP^{-}|$ outside two particle with opposite $CVC^{\pm}$ charge (i.e. opposite by energy uncompensated sub-elementary particle), as respect to inside virtual pressure. Consequently:

$$EM\ attraction:\ \ \alpha\frac{\vec{r}}{r}[E_{CVC^{+}} + E_{CVC^{-}}] \to 0,\ \ at\ \ r \to 0 \qquad 8.11a$$

The other possible explanation of the Coulomb attraction and repulsion could be based on Bivacuum *resulting charge conservation law*, related to its symmetry conservation principle (see 2.1a and 11.17) in form:

$$\sum^{n=N} (|m_V^{+} - m_V^{-}|_{el})_n c^2 + \sum^{j=\infty} (\Delta E^{\pm}_{e^{+} \rightleftharpoons e^{-}})_j = 0 \qquad 8.12$$

where using (8.1 and 8.2b), we have for Bivacuum dipoles symmetry shift, induced by one charged particle with local electromagnetic potential (E_{el}):

$$|m_V^+ - m_V^-|_{el}c^2 = \beta|m_C^+ - m_C^-|c^2 = \frac{\beta}{\alpha}E_{el} \qquad 8.13$$

where:

$$E_{el} = \alpha|m_C^+ - m_C^-|c^2 = \frac{\alpha}{\beta}|m_V^+ - m_V^-|_{el}c^2 = \frac{e_+e_-}{L^\pm} \qquad 8.13a$$

and the delocalized Bivacuum dipoles symmetry shift, induced by one asymmetric double cell-dipole ($\mathrm{BVF}^{\updownarrow}$), when its actual and complementary charges do not compensate each other totally: $\Delta e^{\pm}_{BVF} = |e^+ - e^-|_{BVF} > 0$ is defined as:

$$\Delta E^{\pm}_{e^+ \rightleftharpoons e^-} = |m_V^+ - m_V^-|_{BVF^\uparrow \rightleftharpoons BVF^\downarrow}c^2 \qquad 8.14$$

This asymmetry, in accordance to our theory, is related to equilibrium shift between Bivacuum fermions of the opposite spins:

$$\left(\frac{m_V^-}{m_V^+}\right)_{BVF} = \left(\frac{m_C^-}{m_C^+}\right)_{BVF} = \left(\frac{e_-}{e_+}\right)^2 = 1 - \left(\frac{v}{c}\right)^2 \sim K_{BVF^\uparrow \rightleftharpoons BVF^\downarrow} = \frac{n_{BVF^\uparrow}}{n_{BVF^\downarrow}} \qquad 8.15$$

The attraction of the opposite charge and the repulsion of similar is a result of optimization of the contribution of asymmetry of Bivacuum $\sum^{j=\infty} (\Delta E^{\pm}_{e^+ \rightleftharpoons e^-})_j$ in charge and Bivacuum symmetry compensation principle (8.12).

In the case of attraction of the opposite charges, the corresponding Bivacuum symmetry shifts are opposite and nullify each other in the same space volume, when the charges becomes closer.

In the case of repulsion, the increasing the distance between similar charges increase the probability of total compensation of their symmetry shifts by corresponding $BVF^\uparrow \rightleftharpoons BVF^\downarrow$ equilibrium shift.

9. Links Between the Maxwell's Theory of Electromagnetic Field and Unified Model

9.1. The Maxwell's Classical Description

The *force lines* of the permanent electric field have always the starting point and the ending point on different charges. *It means localization of the electrical charges in space.* In contrast to electric field, the permanent magnetic field lines have not the points of the start and that of the end. The corresponding vectorial field, formed by continuous force lines is termed a whirl field.

The notion of an electric field is related to electric charges, localized in space. When charges begin to move, the magnetic field originates. Notwithstanding a big efforts, the magnetic monopoles (positive and negative like charge of positron and electron) was not experimentally found. It looks, that the spatial charge dynamics, like vortex and rotor, representing the collective excitations of sub-quantum particles, could be a source of magnetic poles, as postulated in our model.

The symmetry and difference between the electric and magnetic fields is expressed by four Maxwell's equations for electromagnetic field.

The expressions, interrelating the electric (**E**) and magnetic (**H**) fields tension with scalar potential of electric field ($\phi = -\mathbf{Er}$) and vector potential of magnetic field ($\mathbf{A} = \frac{1}{2}[\mathbf{Hr}]$) are (Landau and Lifshitz, 1988):

$$\mathbf{E} = -\frac{1}{c}\frac{\partial \mathbf{A}}{\partial t} - grad\,\phi \qquad 9.1$$

$$\mathbf{H} = rot\,\mathbf{A} \qquad 9.1a$$

Taking the rotor from (9.1), from the vector analysis we have:

$$rot\mathbf{E} = -\frac{1}{c}\frac{\partial}{\partial t} rot\,\mathbf{A} - rot(grad\,\phi) \qquad 9.1b$$

as far the rotor of any gradient is equal to zero, using (9.1a), we get the 1st Maxwell equation:

$$\text{rot}\,\mathbf{E} = \nabla \times \mathbf{E} = -\frac{1}{c}\frac{\partial \mathbf{H}}{\partial t} \qquad 9.2$$

Taking the divergence of the both parts of (9.1a), keeping in mind that the divergence of the rotor is equal to zero, we get the 2nd Maxwell equation:

$$div\,\mathbf{H} = 0 \qquad 9.2a$$

In the integral form the eqs. 9.2 and 9.2a may be presented as:

$$\oint \mathbf{E}\,d\mathbf{l} = -\frac{1}{c}\frac{\partial}{\partial t}\int \mathbf{H}\,d\mathbf{f} \qquad 9.2b$$

This means that the electromotive force in some contour (left part) is equal to the negative time derivative of magnetic flux throw the surface, bordered by this contour.

The second pair of the Maxwell eqs. can be derived from the principle of least action (Landau, Lifshitz, 1988):

$$div\,\mathbf{E} = 4\pi\rho \qquad 9.3$$

$$rot\,\mathbf{H} = \frac{1}{c}\frac{\partial \mathbf{E}}{\partial t} + \frac{4\pi}{c}\mathbf{j} \qquad 9.3a$$

where: $\mathbf{j} = \rho\mathbf{v}$ is the 3D conducting current density; ρ is a the charge density and $\mathbf{v}$ is the charge group velocity.

In the integral form 9.3a can be presented as:

$$\oint \mathbf{H}\,d\mathbf{l} = \frac{4\pi}{c}\int\left(\mathbf{j} + \frac{1}{4\pi}\frac{\partial \mathbf{E}}{\partial t}\right)d\mathbf{f} \qquad 9.3b$$

It means that the circulation of magnetic field along some contour is equal to sum of currents: the conducting $(\mathbf{j})$ and the displacement current $\left(\frac{1}{4\pi}\frac{\partial \mathbf{E}}{\partial t}\right)$, propagating throw the surface, limited by this contour. The displacement massless current is responsible for for excitation of magnetic field in vacuum, when $\mathbf{j} = \mathbf{0}$.

In the absence of electrical conducting current, when $j = 0$, eq.(9.3a) turns to:

$$rot\,\mathbf{H} = \frac{1}{c}\frac{\partial \mathbf{E}}{\partial t} \qquad 9.4$$

In this form, pertinent for electromagnetic waves in vacuum, the symmetry between the magnetic and electric (9.2) components of EM field is evident.

Let us evaluate the electromagnetic (EM) field density and flux of energy. After multiplying the $(eq.9.3a)$ on $\mathbf{E}$ and $(eq.9.2)$ on $\mathbf{H}$ and adding them to each other, we get:

$$\frac{1}{c}\mathbf{E}\frac{\partial \mathbf{E}}{\partial t} + \frac{1}{c}\mathbf{H}\frac{\partial \mathbf{H}}{\partial t} = -\frac{4\pi}{c}\mathbf{jE} - (\mathbf{H}rot\mathbf{E} - \mathbf{E}rot\mathbf{H}) \qquad 9.5$$

Using the known formula of vector analysis:

$$div[\mathbf{ab}] = \mathbf{b}\,rot\mathbf{a} - \mathbf{a}\,rot\mathbf{b} \qquad 9.5a$$

the (9.5) can be transformed to:

$$\frac{\partial}{\partial t}\frac{E^2+H^2}{8\pi} = \frac{\partial \mathbf{W}}{\partial t} = -\mathbf{jE} - div\,\mathbf{S} \qquad 9.6$$

where:

$$\mathbf{S} = \frac{c}{4\pi}[\mathbf{EH}] \qquad 9.7$$

is a flux of electromagnetic energy, named the *Pointing vector*.
and the density of EM energy is defined as:

$$\mathbf{W} = \frac{E^2+H^2}{8\pi} \qquad 9.8$$

the term $[-\mathbf{jE}]$ is related to kinetic energy of charged particles in EM field and is equal to zero in their absence.

In the regular electromagnetic wave, transferring the momentum and energy: $\vec{E} \perp \vec{H}$. For special condition when $\vec{E} \parallel \vec{H}$, the product of two vectors is equal to zero $\left[\vec{E}\times\vec{H}\right]$ and, consequently, the Pointing vector (9.7) is also equal to zero. However, the pseudoscalar: $\widetilde{Z} = \left(\vec{E}\bullet\vec{H}\right) \neq 0$ is nonzero and have the same dimension as the Pointing vector.
$\widetilde{Z}$ –characterize the scalar standing electromagnetic wave, localized in 3D space without exchange with medium, generated by $[C \rightleftharpoons W]$ pulsation of pairs $[F_{\updownarrow}^{-} \bowtie F_{\updownarrow}^{+}]$ of triplets $<[F_{\updownarrow}^{-} \bowtie F_{\updownarrow}^{+}] + F_{\updownarrow}^{\pm}>$.

The principal difference between the electric and magnetic component of the electromagnetic field follows also from analysis of the *Lorentz force,* acting on moving charge:

$$\mathbf{F} = \mathbf{F}_E + \mathbf{F}_H = q\mathbf{E} + q[\mathbf{vH}] \qquad 9.9$$

where (q) is an elementary charge moving in the electromagnetic field; **E** - electric field tension; **H** - the magnetic field tension; $\vec{v}$ is the charge velocity with *respect to magnetic field.*

The magnetic component of Lorentz force $(\mathbf{F}_H)$ forms a right angle with the vector of charge velocity $(\mathbf{v})$ and, consequently, does no work. It changes the direction of charge movement only, without changing its kinetic energy. The energy of charged particle changes under the action of the electric component of the electromagnetic field alone. This corresponds to the electric contribution $(q\mathbf{E})$ of Lorentz force (9.9) doing work.

9.2 The Dependence of Vector and Scalar Potentials on the Charge Velocity

The Lienor-Vihert *vector potentials*, produced by the *moving elementary charge* with external group velocity $(\vec{v})$ (Landau and Lifshitz, 1988) looks as:

$$\vec{A}_{L-V} = \frac{e\vec{v}}{c\left(R - \frac{v\vec{R}}{c}\right)} \qquad 9.10$$

where $\vec{R}$ is radius - vector from charge to registration point;
The *scalar potential* of the electron is:

$$\phi = \frac{e}{\left(R - \frac{v\vec{R}}{c}\right)} \qquad 9.11$$

It follows from (9.10 and 9.11), that both potentials tend to infinity at velocity of charge tending to the light one $(v \to c)$. *This consequence of electrodynamics is in total accordance with dependence of our electromagnetic potential (*8.10*) of charged particle on the external group velocity and its kinetic energy.*

9.3 The Link Between the Maxwell's Formalism and Unified Model

Using (8.1), the quantization rule for electromagnetic charge energy can be expressed as:

$$nE_{el} = n\hbar\omega_{C\rightleftharpoons W} = \alpha n\hbar[\omega_C^+ - \omega_C^-] = \alpha(m_C^+ - m_C^-)c^2 \qquad 9.12$$

where: $m_C^+c^2 = \hbar\omega_C^+$ *and* $m_C^-c^2 = \hbar\omega_C^-$

From this formula one can see that the electromagnetic energy is a result of quantum beats with frequency ($\omega_{C\rightleftharpoons W}$) between the actual and complementary corpuscular states of sub-quantum particles and antiparticles of the fermions. Such a pulsation represent the reversible jumps from corpuscular [C] phase to the wave [W] phase and back with *emission* $\rightleftharpoons$ *absorption* of cumulative virtual cloud ($CVC^{\pm}$).

We may consider the states of actual vortex and complementary rotor of [C] phase of sub-elementary particle (see Fig.1a,b), as a two vortices of different shape and angle frequency (ω_C^+ and ω_C^-). Then, using vector analysis, the difference of energy between velocity fields: $\vec{\mathbf{V}}_C^+(r)$ and $\vec{\mathbf{V}}_C^-(r)$, characterizing these vortices, equal to energy of de Broglie wave (wave B) of sub-elementary particle, can be presented as (2.2a).

The electromagnetic contribution to the total energy of wave B (2.2a) is defined by the fine structure constant as a factor:

$$E_{el} = \alpha E_{C\rightleftharpoons W} = \alpha\vec{\mathbf{n}}\hbar\omega_B = \alpha\vec{\mathbf{n}}\hbar(\omega_C^+ - \omega_C^-) = \frac{\alpha}{2}\hbar[rot\vec{\mathbf{V}}_C^+(\mathbf{r}) - rot\vec{\mathbf{V}}_C^-(\mathbf{r})] \qquad 9.13$$

where: $\vec{\mathbf{n}}$ is the unit-vector, common for both vortices; $\omega_{CVC} = (\omega_C^+ - \omega_C^-)$ is a beats frequency between actual vortex and complementary rotors.

In this consideration it is assumed, that all of sub-quantum particles/antiparticles, forming actual and complementary vortices of [C] phase of sub-elementary particles, have the same angle frequency: ω_C^+ and ω_C^-, correspondingly.

We can express the divergency of Pointing vector: $\mathbf{P} = (c/4\pi)[\mathbf{EH}]$ via difference of contributions, related to actual vortex and complementary rotors, using known relation of vector analysis:

$$div[\mathbf{EH}] = \frac{4\pi}{c}div\,\mathbf{P} = \mathbf{H}\,rot\mathbf{E} - \mathbf{E}\,rot\mathbf{H} \qquad 9.14$$

where **H** and **E** are the magnetic and electric components of cumulative virtual clouds of sub-quantum particles, radiated and absorbed in a course of correlated $[C \rightleftharpoons W]$ pulsation of two triplets of sub-quantum particles and antiparticles of photon (see 2.15 and 2.15a).

Two structure of photon, corresponding to its two polarization and spin ($S = \pm 1\hbar$), we present as:

$$\langle[2\mathbf{F}_\uparrow^- \bowtie 2\mathbf{F}_\downarrow^+] + [\mathbf{F}_\uparrow^+ + \mathbf{F}_\downarrow^-]\rangle \qquad S = -1 \qquad 9.15$$

$$\langle[2\mathbf{F}_\uparrow^- \bowtie 2\mathbf{F}_\downarrow^+] + [\mathbf{F}_\uparrow^+ + \mathbf{F}_\uparrow^-]\rangle \qquad S = +1 \qquad 9.15a$$

The analogy between (9.13) and (9.14), illustrating the dynamic [vortex+rotor] dipole background, is evident, if we assume:

$$\hbar\omega_C^+ \sim \mathbf{H}\,rot\mathbf{E} \sim \frac{\alpha}{2}\hbar\, rot\vec{\mathbf{V}}_C^+(\mathbf{r}) \qquad 9.16$$

$$\hbar\omega_C^- \sim \mathbf{E}\,rot\mathbf{H} \sim \frac{\alpha}{2}\hbar\, rot\vec{\mathbf{V}}_C^-(\mathbf{r}) \qquad 9.16a$$

Then, the divergence of Pointing vector will take a form:

$$\frac{4\pi}{c}div\,\mathbf{P} = \frac{\alpha}{2}\hbar\left[rot\vec{\mathbf{V}}_C^+(\mathbf{r}) - rot\vec{\mathbf{V}}_C^-(\mathbf{r})\right] \sim \alpha[m_C^+ - m_C^-]c^2 \qquad 9.17$$

We can see from 9.16 and 9.16a, that the properties of both: magnetic and electric fields are implemented in each of our rotor and antirotor of Bivacuum dipoles.

Let us analyze the Maxwell law (9.3a), relating the excitation of magnetic field and charge dynamics: the conducting current (**j**) and displacement current $\frac{1}{4\pi}\frac{\partial \mathbf{E}}{\partial t}$:

$$\oint \mathbf{H}\, d\mathbf{l} = \frac{4\pi}{c}\int\left(\mathbf{j} + \frac{1}{4\pi}\frac{\partial \mathbf{E}}{\partial t}\right) d\mathbf{f} \tag{9.18}$$

The collective excitations of sub-quantum particles in form of charged rotor and antirotor of sub-elementary fermions/antifermions are the carriers of the opposite charges: actual and complementary. In condition of primordial Bivacuum of the ideal symmetry these charges totally compensate each other.

In accordance to our Unified model, the conducting current can be subdivided to three contributions - one rotational and two translational:

$$\mathbf{j} = \mathbf{j}_{rot} + \mathbf{j}_{\|tr} + \mathbf{j}_{\perp tr} \tag{9.18a}$$

The main contribution to conducting current, pertinent for [C] phase of asymmetric Bivacuum sub-elementary fermions only, is a consequence of difference between the actual (e_+) and complementary (e_-) charge of particle due relativist effect, due to difference of rotation velocities of the actual (v_{gr}^{in}) and complementary rotors $|v_{gr}^{in} - v_{ph}^{in}|$ and corresponding relativist difference between the actual and complementary mass :

$$\mathbf{j}_{rot} \sim |e_+ - e_-||v_{gr}^{in} - v_{ph}^{in}|_{rot} \sim m_0\omega_0^2 L_0^2 \tag{9.19}$$

where the **translational** rest mass of sub-elementary particle is related to frequency of double vortices-dipoles rotation (ω_0) and its resulting Compton radius ($L_0 = \hbar/m_0c$), as:

$$\omega_0 = m_0c^2/\hbar = \frac{c}{L_0} \tag{9.19a}$$

Two additional small contributions, related to zero-point longitudinal and translational vibrations of particles are also assumed in our theory:

$$\mathbf{j}_{\|tr} \sim \alpha m_C^+ v^2 = m_C^+ v_{\|tr}^2 \tag{9.20}$$

$$\mathbf{j}_{\perp tr} \sim \beta m_C^+ v^2 = m_C^+ v_{\perp tr}^2 \tag{9.20a}$$

where v is a resulting rotational-translational external group velocity of particle, which determines its relativist actual mass:

$$m_C^+ = \frac{m_0}{\sqrt{1-(v/c)^2}} \tag{9.21}$$

The displacement current may be a consequence of the oscillation of difference between the actual (e_+) and complementary (e_-) charge of sub-elementary fermion and difference of its group and phase velocities in a course of its $[C \rightleftharpoons W]$ pulsation

$$\frac{\partial \mathbf{E}}{\partial t} \sim \frac{\partial\left[|e_+ - e_-||v_{gr}^{in} - v_{ph}^{in}|\right]}{\partial t} \tag{9.22}$$

In such a way we get the interrelation between Maxwell's theory of electromagnetism and our model of elementary particles, as the asymmetric Bivacuum excitations.

We may apply also the Green theorems, interrelating the volume and surface integrals, to our duality model. One of known Green theorems looks like:

$$\int_V (\Psi\nabla^2\Phi - \Phi\nabla^2\Psi)\, dV = \int_S dS \cdot (\Psi\nabla\Phi - \Phi\nabla\Psi)\, dV \tag{9.23}$$

If we define the scalar functions, as the instant energies of the actual and complementary states of [C] phase of sub-elementary particles as $\Phi = m_C^+ c^2$ and $\Psi = m_C^- c^2$, then, taking into account that

$$\nabla^2 \Phi = div\, grad\, \Phi = div\, grad\,(m_C^+ c^2) \qquad 9.24$$

$$\nabla^2 \Psi = div\, grad\, \Psi = div\, grad\,(m_C^- c^2) \qquad 9.24a$$

formula (9.23) can be presented in form:

$$\int_V [(m_C^- c^2)\nabla^2(m_C^+ c^2) - (m_C^+ c^2)\nabla^2(m_C^- c^2)]\, dV = \int_S dS \bullet [(m_C^- c^2)\nabla(m_C^+ c^2) - (m_C^+ c^2)\nabla(m_C^- c^2)]\, dV \qquad 9.25$$

The left part of (9.25) represents the energy of sub-elementary particle in [C] phase and the right part - the energy of cumulative virtual cloud (CVC), corresponding to [W] phase of particle.

10 Possible Role of Golden Mean in the Properties of Atoms.

10.1 New Interpretation of Compton effect

Analyzing the experimental scattering of X-rays on the carbon atoms of paraffin and graphite target, formed by the carbon atoms only, Compton found that the X-rays wave length increasing ($\Delta\lambda = \lambda - \lambda_0$) after scattering on the electrons of carbon has the following dependence on the scattering angle ($\vartheta -$ angle between the incident and scattered beam):

$$\Delta\lambda = 2\frac{h}{m_0 c}\sin^2\vartheta = 2\lambda_C \sin^2\vartheta \qquad 10.1$$

Compton got this formula from the laws of momentum and energy conservation of the system [X-photon + electron in atom] before and after scattering, in form:

$$\hbar\mathbf{k} = \hbar\mathbf{k}' + m\mathbf{v} \quad (the\, wave\, numbers:\; k = \omega/c \;\; and \;\; k = \omega'/c \qquad 10.2$$

$$\hbar\omega + m_0 c^2 = \hbar\omega' + mc^2 \qquad m = m_0/[1-(v/c)^2]^{1/2} \qquad 10.2a$$

However, Compton made a strong assumption, that the electron before energy/momentum exchange with X-photon is in rest, i.e. his group velocity is zero: $v = 0$.

We propose the new interpretation of the Compton experiments, assuming that only translational group velocity of the electron is close to zero: $v_{tr} = 0$, but it is not true for rotational velocity. Such approach do not affect the final relation (10.3), if we suppose, that the rotational dynamics (spinning) of the electrons follows Golden mean.

At the conditions of Golden mean, providing by fast spinning of sub-elementary particles of triplets $<[F_\updownarrow^- \bowtie F_\updownarrow^+] + F_\updownarrow^\pm>$ with frequency $\omega_0 = m_0 c^2/\hbar$, when: $\left[\Delta m_C = m_C^+ - m_C^-\right]_e^\phi = m_0$, the resulting energy and momentum of the electron turns to (see 4.7 and 8.2c):

$$E_C^\phi = E_W^\phi = (m_C^+ - m_C^-)^\phi c^2 = (m_C^+ v^2)^\phi = \qquad 10.3$$

$$= m_0 c^2 = m_0 \omega_0^2 L_0^2$$

$$(P^\pm)^\phi = (m_C^+ - m_C^-)^\phi c = m_0 c = (m_C^+ v^2)^\phi / c \qquad 10.3a$$

The corresponding resulting de Broglie wave length is equal to Compton length of the electron:

$$(\lambda^{res})^\phi = \lambda_C = \frac{h}{m_0 c} = 24 \bullet 10^{-13}\, m \qquad 10.4$$

the Compton radius :

$$(L^{res})^\phi = \lambda_C/2\pi = L_0 = \frac{\hbar}{m_0 c} = 3.82 \bullet 10^{-13}\, m \qquad 10.4a$$

The Compton radius of the proton is equal to:

$$L_P = \frac{\lambda_P}{2\pi} = \frac{\hbar}{m_P c} \simeq 2.1 \cdot 10^{-16} m \qquad 10.5$$

The Compton radius of the electron is about 2000 bigger, than that of proton:

$$L_0 / L_P^{\phi} = m_P / m_0 = 1836.15 \qquad 10.6$$

Scattering of photon on the electron or proton, change their momentum and kinetic energy *related to translations only*, not affecting the parameters of spinning.

New interpretation of the experimental data, obtained by Compton in 1923, confirms the consequence of our UM, that the mass and spin of elementary particles are interrelated parameters, provided by Bivacuum dipoles symmetry shift ($\Delta m_V c^2 = \beta \Delta m_C c^2 \rightarrow \beta m_0 c^2$).

A self-stabilization and self-organization of matter occur under the influence of Harmonization force of Bivacuum, driving the systems on all hierarchical levels (from the elementary particles and atoms to biopolymers and galactics) to Golden mean conditions (4.7-4.10), when $[\Delta m_C = m_C^+ - m_C^-]_{e,P}^{\phi} = (m_0)_{e,P}$.

10.2 The Bohr's Model and the Alternative Duality Model of Hydrogen Atom

The radius of the Hydrogen atom after Bohr can be evaluated from the equality of Coulomb attraction force between proton and electron and centripetal force, acting on the electron, rotating around proton:

$$\frac{e^2}{r^2} = \frac{mv^2}{r} \qquad 10.7$$

It leads from the quantization of the *angular momentum*, that

$$mvr = n\hbar \qquad 10.8$$

$$where \;\; n = 1,2,3\ldots$$

Excluding the velocity (v) from eqs. 10.7 and 10.8, we get the quantized radius of the hydrogen orbit:

$$r_n = \frac{\hbar^2}{me^2} n^2 \qquad 10.9$$

For the 1st stationary orbit ($n = 1$), assuming that the mass of the electron is equal to its rest mass ($m = m_0$), formula (10.9) turns to the Bohr orbit (a_B) :

$$a_B = \frac{\hbar^2}{me^2} = \frac{L_0}{\alpha} = \frac{\hbar}{m_0 c \alpha} \qquad 10.10$$

where the Compton radius of the electron is $L_0 = \frac{\hbar}{m_0 c}$

The energy of the electron on the n – orbit of the hydrogen atom, after Bohr is equal to:

$$E_n = \frac{me^4}{\hbar^2} \frac{1}{n^2} \qquad 10.11$$

In another form this energy can be presented as:

$$E_n = \alpha^2 m_0 c^2 \frac{1}{n^2} \qquad 10.12$$

as far the fine structure constant is $\alpha = e^2/\hbar c \;\; \sim 1/137$.

Let us consider the properties of free electron, based on our duality approach.

We proceed from assumption, that the total energy of the electron (E_e) at Golden mean conditions (4.7-4.7d) in [C] phase, taking into account the contributions of spinning, responsible for the rest mass, the velocities of longitudinal $v_{\|0} = cz = c(\alpha\phi)^{1/2}$ (see 7.3) and transversal $[v_{\perp 0}]$ zero-point oscillations, responsible for electromagnetic (EM) and gravitational (G) potentials, correspondingly:

$$E_e^{[C]} = \left[(E_e^S)_{rot} + (E_e^{el})_{\|tr} + (E_e^G)_{\perp tr} \right]^{[C]} = \qquad 10.13$$

$$= (m_C^+)^\phi (v_{rot}^\phi)^2 + (m_C^+)^\phi v_{\|0}^2 + (m_C^+)^\phi v_{\perp 0}^2 = \qquad 10.13a$$

$$= m_0\omega_0^2 L_0^2 + (m_C^+)^\phi v_{\|0}^2 + (m_C^+)^\phi v_{\perp 0}^2 \qquad 10.13b$$

where: $(m_C^+)^\phi = m_0/\phi$; $\quad (v_{rot}^\phi)^2 = \phi c^2$; $\quad \omega_0 = m_0 c^2/\hbar$; $\quad L_0 = \hbar/m_0 c$

For the other hand, in [W] phase in form of cumulative virtual cloud (CVC), the energy of the electron and proton may be subdivided to sum of two contributions - the nonelectromagnetic spin (rotational) contribution $(E_{e,P}^S)_{rot}$ and the electromagnetic (translational) $(E_{e,P}^{el})_{tr}$ one:

$$E_e^{[W]} = \left[(E_e^S)_{rot} + (E_e^{el})_{tr} + (E_e^G)_{\perp tr} \right]^{[W]} = \qquad 10.14a$$

$$= m_0\omega_0^2 L_0^2 + \frac{e^2}{L_0} + G\frac{m_C^+ m_C^-}{L_0} \qquad 10.14b$$

$$= m_0\omega_0^2 L_0^2 + \alpha m_0 c^2 + \beta m_0 c^2 \qquad 10.14c$$

where: $\omega_0 = m_0 c^2/\hbar$ is the Golden mean frequency of $[C \rightleftharpoons W]$ pulsation, equal to the angle frequency of the sub-elementary particles gyroscopic rotation and $L_0 = \hbar/m_0 c$ is the Compton radius of the electron.

The spin contribution is related to gyration of the uncompensated sub-elementary particle of the electron $< [F_\updownarrow^- \bowtie F_\updownarrow^+] + F^+ >$ around its own center of symmetry in [C] phase and in [W] phase in form of cumulative virtual cloud (CVC), following the Golden mean (GM) conditions (4.7- 4.7g).

We can see from (10.13 and 10.14b), that *the energy of electromagnetic contribution* to the total energy of free electron in [W] phase in GM conditions (see 8.4) is directly related to its *translational* zero-point oscillation in [C] phase:

$$(E_e^{el})_{\|tr}^W = \frac{e^2}{L_0} = \alpha m_0 c^2 \qquad 10.15$$

$$(E_e^{el})_{\|tr}^C = (m_C^+)^\phi v_{\|0}^2 \qquad 10.15a$$

From (10.15 and 4.7b) we can find the most probable velocity ($v_{\|0} \equiv v_{el}$) of zero-point oscillation of the charge, corresponding to its electromagnetic contribution to energy:

$$v_{\|0} \equiv v_{el} = \left[\frac{\alpha m_0 c^2}{(m_C^+)^\phi} \right]^{1/2} = c(\alpha\phi)^{1/2} = cz \qquad 10.16$$

$$\textit{where}: \ z = (\alpha\phi)^{1/2} = 0.0671566 \ \textit{is a longitudinal zero-point factor}\,(7.2); \qquad 10.16a$$

$$(m_C^+)^\phi = m_0/\phi$$

From comparison of (10.16) and (7.3a), we can see, that they are equal. Consequently, just a longitudinal zero-point oscillations of the elementary charge are responsible for its electromagnetic potential at Golden mean (GM) conditions as well, as for deviation of the electron's magnetic moment (μ_e) from the Bohr's magneton (μ_B).

The curvature, characterizing the electromagnetic (EM) contribution to the total energy of the free electron is less, than the Bohr radius (10.10):

$$L_{[W]}^{el} = \frac{\hbar}{(m_C^+)^\phi v_{\|0}} = z\frac{\hbar}{m_0 c\alpha} = z\frac{L_0}{\alpha} = z a_B \qquad 10.16b$$

We made an important assumption, that the virtual photons, responsible for electromagnetic *potential of the free electron ($E^{el}_{[W]} = \alpha m_0 c^2$), are pertinent only for [W] phase of the electron in form of part of cumulative virtual cloud (CVC) and secondary virtual waves, excited in Bivacuum.*

The oscillation of the electron's characteristic radius in a course of [C⇌W] pulsation is equal to difference between (10.16b) and the Compton radius from (10.10):

$$\Delta L_{C\rightleftharpoons W} = L^{el}_{[W]} - L_0 = L_0\left(\frac{z}{\alpha} - 1\right) = L_0\left[\left(\frac{\phi}{\alpha}\right)^{1/2} - 1\right] \simeq 8.2 L_0 \qquad 10.16c$$

The ratio of corresponding characteristic radiuses is

$$\frac{L^{el}_{[W]}}{L_0} = \frac{z}{\alpha} = \left(\frac{\phi}{\alpha}\right)^{1/2} \simeq 9.2 \qquad 10.16d$$

The velocity of transversal zero-point oscillation of the electron ($v_{\perp 0}$), responsible for its gravitational potential, we can find from equality:

$$(E^G_e)_{\perp tr} = (m^+_C)^\phi v^2_{\perp 0} = \beta m_0 c^2$$

as:

$$v_{\perp 0} \equiv v_G = \left[\frac{\beta m_0 c^2}{(m^+_C)^\phi}\right]^{1/2} = [\beta\phi]^{1/2} c = xc \qquad 10.16e$$

where: $x = (\beta\phi)^{1/2} = (1.7385 \cdot 10^{-45} \times 0.618033)^{1/2} = 3.27867 \cdot 10^{-23}$ is a transversal (gravitational) zero-point factor.

Let us consider now the Hydrogen atom

We note here once more, that in accordance to our Unified model, just the GM kinetic energy of elementary particles gyration - spinning, provided by Harmonization force of Bivacuum action, - stands for such invariants, as the rest mass and spin. The *translational* zero-point oscillations and corresponding contribution to kinetic energy of the electron are related to its permanent external electromagnetic potential.

One of conditions of its stability is the *equality of the electron's and proton's electromagnetic potentials.* This means that the kinetic energy of the proton in H-atom, determined by its zero-point oscillations, should be the same as that of electron. For such a case we have the electromagnetic balance equation of H-atom:

$$E^{el}_0 = \alpha m_{e0} c^2 = (m^+_e)^\phi v^2_{e\|0} = \qquad 10.17$$

$$= E^P = \alpha (m^+_P - m^-_P) c^2 = (m^+_P) v^2_{P\|0} \qquad 10.17a$$

where: $(m^+_P - m^-_P) = m_{e0} << (m^+_P - m^-_P)^\phi = (m_P)_0$ is less, than that, corresponding to GM conditions for free proton.

The most probable longitudinal group velocity of the proton vibration in atom from (10.17 and 10.17a) is related to translational longitudinal zero-point velocity of the electron (v_{e0}), vibration like:

$$v_{P\|0} = v_{e\|0}\left[\frac{(m^+_e)^\phi}{m^+_P}\right]^{1/2} = c\,\alpha^{1/2}\left(\frac{m_{e0}}{m^+_P}\right)^{1/2} \qquad 10.18$$

where: $(m^+_e)^\phi = m_{e0}/\phi$ and (m^+_P) is the actual mass of the electron and proton correspondingly.

From (10.17 and 10.17a) we can get also the following ratio of the effective de Broglie radiuses of zero-point oscillations for the electron and proton:

$$\frac{L_{e0}}{L_{P0}} = \frac{(m_C^+)_P^\phi v_P}{(m_C^+)_e^\phi v_{e0}} = \frac{v_{e0}}{v_P} = \left[\frac{m_P}{m_{e0}}\right]^{1/2} \sim 42 \qquad 10.19$$

where: v_{e0} and v_P are the translational zero-point oscillation velocity of the electron and corresponding of proton in the H-atom.

The total electromagnetic energy of the electron in [W] and [C] phase of H-atom may be presented, as a sum of the rotational - gyrational $(E_e^S)_{rot}$, translational (longitudinal) zero-point $(E_e^{el})_{\|tr}$ and the orbital $(E_e^{ext})_{orb}$ contributions, equal to the Bohr energy:

$$(E_H^e)_W = \left[(E_e^S)_{rot} + (E_e^{el})_{\|tr} + (E_e^{ext})_{orb}\right]_{W,C} \qquad 10.20$$

$$= m_{e0}\omega_{e0}^2 L_{e0}^2 + \alpha m_{e0}c^2 + \alpha^2 m_{e0}c^2 = \qquad 10.21$$

$$(E_H^e)_C = (m_C^+)_e^\phi (v_{rot}^\phi)^2 + (m_C^+)_e^\phi v_{e\|0}^2 + (m_C^+)_C^\phi (z v_{e\|0})^2 \qquad 10.21a$$

where $E_H^S = m_0\omega_0^2 L_0^2$ is a contribution of kinetic energy of the electron spinning with GM angle frequency ($\omega_0 = m_0c^2/\hbar$);

$E_H^{in} = \alpha m_0 c^2 = \frac{e^2}{L_0}$ is the *internal* electromagnetic potential of the electron, described by eqs.(10.14 - 10.16) and related to zero-point translational velocity (v_{e0}).

The *external (orbital)* electromagnetic potential of the electron - proton interaction is equal to the Bohr energy for the H-atom:

$$(E_e^{ext})_{orb} = \alpha^2 m_0 c^2 = \qquad 10.22$$

$$= E_B = \frac{e^4 m_0}{\hbar^2}\frac{1}{n^2} = (m_C^+)_e^\phi (z v_{e0})^2 \qquad 10.22a$$

The right part of (10.22a) we get from the condition of H-atom stability. It means a condition of standing wave of the electron in [C] phase on the Bohr orbit. The corresponding group velocity (v_B) of the electron on the 1st Bohr orbit ($n = 1$) can be defined from:

$$L_e^{n=1} = \frac{\hbar}{(m_C^+)^\phi v_B} = a_B = \frac{\hbar}{m_0 c\,\alpha} \qquad 10.23$$

$$v_B = \frac{m_0 c\,\alpha}{(m_C^+)^\phi} = c(\alpha\phi) = cz^2 = z v_{e0} \qquad 10.23a$$

$$\frac{a_B}{L_0} = 1/\alpha \sim 137 \qquad 10.23b$$

where the actual electron's mass at GM conditions (4.7b) is $(m_C^+)^\phi = m_0/\phi$;

$z = (\alpha\phi)^{1/2} = 0.067156608$ is a *zero-point factor*, introduced in this work (see 7.3).

The total energy of the **proton** in hydrogen atom in [C] and [W] phase may be presented as a sum of rotational and two kind of translational contributions - responsible for electromagnetic and gravitational potentials:

$$(E_H^P)_{W,C} = \left[(E_P^S)_{rot} + (E_P^{el})_{\|tr} + (E_P^G)_{\perp tr}\right]_{W,C} = \qquad 10.24$$

$$(E_H^P)_W = m_{P0}\omega_{P0}^2 L_{e0}^2 + \alpha[(m_C^+)_P - (m_C^-)_P]c^2 + \beta[(m_C^+)_P - (m_C^-)_P]c^2 = \qquad 10.24a$$

$$= m_{P0}\omega_{P0}^2 L_{e0}^2 + \alpha m_{0e}c^2 + \beta m_{0e}c^2 = \qquad 10.24b$$

$$(E_H^P)_C = (m_C^+)_P^\phi (v_{rot}^\phi)^2 + (m_C^+)_P^\phi v_{P\|0}^2 + (m_C^+)_P^\phi v_{P\perp 0}^2 \qquad 10.24c$$

The resonant interaction of the atom with *photon* ($\hbar\omega_p$), like its absorption - emission, is accompanied mostly by corresponding change of E_B between quantized states of orbit:

$$E_{tot}^H \pm \hbar\omega_p = \hbar\omega_0 + (E_B \pm \hbar\omega_p)\,\phi^2 \qquad 10.25$$

Our model, like the Bohr's one, explains the spectral series of the hydrogen atom with frequencies (ω_{nl}), corresponding to different values of quantum numbers l *and* n :

$$\omega_{nl} = R(1/l^2 - 1/n^2) \tag{10.26}$$

where (R) is a Ridberg constant: $R = e^4 m_0/\hbar^3$

The spatial image of the hydrogen atom, corresponding to [C] phase of the uncompensated sub-elementary particle of the electron $< [F_\updownarrow^- \bowtie F_\updownarrow^+] + F_\updownarrow^\pm >$ at Golden mean conditions represents the pair of the proton and the electron, each of them characterizing by the rotational-translational dynamics.

The electron in [C] phase with resulting dimension, equal to Compton radius ($L_0 = \hbar/m_0 c$), participate in three dynamic process:

a) fast gyroscopic spinning/rotation with the Golden mean frequency ($\omega_0 = m_0 c^2/\hbar$);

b) zero-point translational oscillations with most probable velocity ($v_0 = cz$) and

c) rotation around the proton along the Bohr radius ($a_B = L_0/\alpha$) of the atom with velocity ($v_B = cz^2$), corresponding to standing wave condition on the stationary orbit.

In [W] phase of the electron, the uncompensated sub-quantum particle of the electron turns to pair [BVF$^\updownarrow$ + cumulative virtual cloud (CVC)].

The [C$\rightleftharpoons$ W] pulsation of pair $[F_\updownarrow^- \bowtie F_\updownarrow^+]$ are exciting the secondary virtual photons in Bivacuum, responsible for electromagnetic interaction.

The most probable radius of part of CVC, as a carrier of EM potential is equal to ($L_{[W]}^{el} = (\phi/\alpha)^{1/2} L_0 = z a_B$), which is about 9 times more than the Compton radius (L_0), pertinent for [C] phase of the electron and about 15 times less, than the Bohr radius.

The proton, pulsating like the electron between [C] and [W] phase, participates only in Golden mean (GM) spinning, providing his mass of rest (m_{0P}) and zero-point oscillation, related to its electromagnetic potential.

The frequency of correlated $[C \rightleftharpoons W]$ pulsation of triplets of sub-elementary particles of τ –generation (see section 2.4), forming quarks of proton is much higher (about 1800 times), than that of the electron:

$$(\omega_{C\rightleftharpoons W})_P = \omega_{0P} = \frac{m_{0P}c^2}{\hbar} >> (\omega_{C\rightleftharpoons W})_e = \omega_{0e} = \frac{m_{0e}c^2}{\hbar} \tag{10.27}$$

There are no charge in [C] phase of the electron and proton and no EM interaction between them in hydrogen atom. So, the EM interaction in H-atom is switched on and off, accompanied by pulsation of the effective dimensions of the electron ($L_0 \rightleftharpoons L_{[W]}^{el}$) in a course their correlated in-phase or anti-phase $[C \rightleftharpoons W]$ pulsation.

As far, the charge density is oscillating as a consequence of $[W \rightleftharpoons C]$ pulsations of the spinning electron and its rotation around nuclear, the interpretation of dispersive Van-der-Waals interaction, as a result of coherently flickering charge of atoms/molecules, remains valid in our model.

In complex neutral atoms, containing the same number of the electrons and protons, the $[C \rightleftharpoons W]$ cycles of each selected [electron + proton] pair - are accompanied by corresponding quantized 3D standing waves formation.

Standing waves, formed by pairs of electrons with opposite spins and counter phase $[C \rightleftharpoons W]$ pulsation, are more symmetric and stable, than in atoms with unpaired electrons.

Unification of atoms in a different chemical reactions, resulting from unification of unpaired electrons and creation of additional symmetrical standing waves B, is energetically favorable. Molecules could be considered as a highly orchestrated dynamic systems, where the $[C \rightleftharpoons W]$ pulsations of all electrons are coherent and occur with Golden mean frequency:

$$\omega_{0e} = \frac{(m_C^+ - m_C^-)^\phi c^2}{\hbar} = \frac{m_{0e}c^2}{\hbar} \qquad 10.28$$

In accordance to our model, $[C \rightleftharpoons W]$ pulsations of all electrons with opposite spins are counterphase. This condition defines their spatial compatibility and stability of [electron-electron] and [electron-proton] pairs.

11 The Difference and Correlation Between the Unified Model (UM) and General Theory of Relativity

11.1 Possible Mechanism of Gravitational Interaction in UM

It can be similar to hydrodynamic Bjorkness interaction between pulsing particles in liquids, radiating acoustic waves. However, in gravitation the role of acoustic waves fulfill the virtual pressure waves in positive and negative realms of Bivacuum (VPW^+ and VPW^-), emitted $\rightleftharpoons$ absorbed in a course of $[C \rightleftharpoons W]$ pulsation of pairs of sub-elementary particles: $[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+]$ of elementary fermions and bosons. The energy of gravitation is determined by small asymmetry of density energy of VPW^+ and VPW^-:

$$\Delta\varepsilon_G^\pm = |\varepsilon_{VPW^+}^+ - \varepsilon_{VPW^-}^-| \sim \beta|m_C^+ - m_C^-|c^2 = |m_V^+ - m_V^-|c^2 \qquad 11.1$$

It is much smaller, than asymmetry of density of virtual energy, related to uncompensated $CVC^\pm$, responsible for electromagnetic interaction:

$$\Delta\varepsilon_{el}^\pm = |\varepsilon_{CVC^+}^+ - \varepsilon_{CVC^-}^-| \sim \alpha|m_C^+ - m_C^-|c^2 \qquad 11.1a$$

By analogy with Bjorkness mechanism, we suppose, that $[C \rightleftharpoons W]$ pulsation of pairs: $[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+]$ are decreasing the excessive virtual quanta pressure between particles ($\Delta\varepsilon_G^\pm$) more than outside of them. This provides the gravitational attraction between particles.

In accordance to theory, the Bjorkness force has a reverse square distance dependence between pulsing bodies in liquid, as ($1/r^2$), like gravitational force. *It is important, that this force could be positive and negative, depending on difference of phase of pulsations.* In turn, this phase shift is dependent on relation of distance between bodies to acoustic (or gravitational in our case) wave length. If the length of acoustic (gravitational) waves, excited by pulsing bodies, is less than the distance between bodies, the Bjorkness (gravitational) force is attractive. If the distance is much bigger than wave length, then the attraction turns to repulsion. This effect means antigravitation.

The large-scale honey-comb structure of the Universe, its huge voids, could be explained by the interplay of gravitational attraction and repulsion between clusters of galactics, depending on the distance between them.

Recently a strong experimental evidence appears, pointing to acceleration of the Universe expansion. This phenomena could be explained by increasing the antigravitation factor with increasing the distance between galactics. It confirms our hydrodynamic model of mechanism of gravitation.

Einstein postulates (1965), that gravitation changes the trajectory of probe body from the straight-line to geodesic one due to curving of conventional two-dimensional surface. The Lobachevskian geometry on curved surface was used in Einstein's classic theory of gravitation. The criteria of surface curvature of sphere is a curvature radius (R), defined as:

$$R = \pm\sqrt{\frac{\mathrm{S}}{\Sigma - \pi}} \qquad 11.2$$

where S is a square of triangle on the flat surface; R is a sphere radius; Σ is a sum of angles in triangle.

The sum of angles in triangle (Σ) on the *flat surface* is equal to $\pi = 180^0$ and curvature

$R = \infty$. For the other hand, on curved surface of radius ($0 < R < \infty$), the sum of angles is

$$\Sigma = \pi + S/R^2 > \pi \qquad 11.2a$$

When $(\Sigma - \pi) > 0$, the curvature $(R > 0)$ is positive; when $(\Sigma - \pi) < 0$, the curvature is imaginary (iR).

In our Gravitation theory instead space-time curvature $[\pm R]$, we introduce Bivacuum Symmetry Curvature $(\pm L_{\mathrm{Cur}})$. It is defined, as a radius of sphere of virtual Bose condensation (VirBC), equal to that of domain of nonlocality in secondary Bivacuum, generated by gravitating particle with mass (m_C^+):

$$\pm R \sim \pm L_{\mathrm{Cur}} = \frac{\hbar}{\pm \Delta m_V c} = \frac{\hbar}{\pm \beta \Delta m_C c} \qquad 11.3$$

where, in accordance to (8.2b):

$$\pm \Delta m_V = \pm(|m_V^+| - |m_V^-|) = \pm \beta \Delta m_C = \pm \beta m_C^+ (v/c)^2 \qquad 11.4$$

is a Bivacuum dipoles symmetry shift, positive for particles and negative for antiparticles, related directly to mass symmetry shift $(\Delta m_C = m_C^+ - m_C^-)$.

In primordial Bivacuum, in the absence of matter, where: $\Delta m_V = \beta \Delta m_C = 0$, the space is flat, as far $L_{\mathrm{Cur}} = \infty$.

From (11.3) the vacuum curvature, induced by particle with mass, equal to that of the electron at Golden mean (GM) condition $(\Delta m_C = m_0 = m_e = 9.1095 \cdot 10^{-31} kg)$ is: $L_{Cur}^e = 3.2288 \cdot 10^{35} m$. For proton at GM condition $(\Delta m_C = m_P = 1.6726 \cdot 10^{-27} kg)$ we have: $L_{Cur}^P = 5.212 \cdot 10^{25} m$.

The analogy between R and L_{Cur} (11.2 and 11.3) is obvious. The more is energy of gravitational field ϵ_G, and actual inertial mass, generating this field (m_C^+), the more is vacuum symmetry shift (Δm_V) and Bivacuum curvature. The bigger is Bivacuum curvature (R or L_{Cur}), i.e. the more flat is the Universe the less is Bivacuum dipoles symmetry shift $|\pm \Delta m_V|$ and corresponding actual mass.

In accordance to our Unified model, the *primary criteria of inertial mass* is a Bivacuum dipoles symmetry shift and corresponding curvature of Bivacuum (L_{Cur}).

In our Unified model the matter and antimatter induce the opposite Bivacuum dipoles symmetry shift. It means that antigravitation should exist between matter and antimatter.

It follows from Bivacuum model, that the spin equilibrium shift between Bivacuum fermions $[BVF^\uparrow \rightleftharpoons BVF^\downarrow]$ with properties of virtual electric and magnetic dipoles, is dependent on external electric and magnetic fields. For the other hand, the shift of this equilibrium influence Bivacuum dipoles symmetry shift $(\pm \Delta m_V \sim E_G)$ like inertial mass. Consequently, electric $(\vec{E})$ and magnetic $(\vec{H})$ fields, as well as antimatter, may be used for regulation of gravitation and Bivacuum-space curvature:

$$[BVF^\uparrow \rightleftharpoons BVF^\downarrow] \sim [F^\downarrow \rightleftharpoons F^\uparrow] = f(\vec{H}) \sim |\Delta m_V| = E_G/c^2 \qquad 11.5$$

This conclusion of our Unified model (UM) is confirmed by known Biefeld-Brown (charged condensers), Searl's effects, N-machine of de Palma and Baurov's device, related to dynamic Stavros experiments.

The photons trajectory reflects the Bivacuum curvature in 3D space. It is a consequence of our model of photon, as a superposition of three pairs of coherent pair $[F^+ \bowtie F^-]$, moving in Bivacuum without its symmetry perturbation.

11.2 The Red Shift of Photons in UM

As well, as General theory of relativity, UM can explain the red shift of photons in gravitational field. The RED, low-frequency shift:

$$\Delta\omega_p^{1,2} = \omega_p^{(1)} - \omega_p^{(2)} \qquad 11.6$$

of photons in gravitation field is a result of deviation of their trajectory from the right line and is a consequence of increasing the vacuum symmetry curvature and corresponding length of its path.

In accordance to our model, red shift has a simple relation to difference of Bivacuum symmetry shifts at point of photon radiation: $\Delta m_V^{(1)} = |m_V^+ - m_V^-|^{(1)}$ and at point of its registration $\Delta m_V^{(2)} = |m_V^+ - m_V^-|^{(2)}$:

$$\Delta\Delta m_V^{1,2} = \Delta m_V^{(1)} - \Delta m_V^{(2)} \qquad 11.7$$

in a form:

$$\hbar\Delta\omega_p^{1,2} = \Delta\Delta m_V^{1,2} c^2 \quad or: \qquad 11.8$$

$$\Delta\omega_p^{1,2} = \frac{\Delta\Delta m_V^{1,2} c^2}{\hbar} = \beta\frac{\Delta\Delta m_C^{1,2} c^2}{\hbar} \qquad 11.9$$

If $\Delta m_V^{(1)} > \Delta m_V^{(2)}$, i.e. gravitation in point of radiation is bigger, than in point of detection, we get the red shift: $\Delta\omega_p^{1,2} > 0$. If $\Delta\Delta m_V^{1,2} = \beta\Delta\Delta m_C^{1,2} = 0$, i.e. gravitational potential is the same in both points, or Bivacuum is flat ($R = \infty$ and $\Delta\Delta m_V^{1,2} = 0$), then $\omega_p^{(1)} = \omega_p^{(2)}$ and red shift is absent.

We may conclude, that our Unified model of Gravitation explains the same phenomena, as do the General theory of relativity, but in terms of vacuum symmetry shift instead of curved space-time. The tensor properties of Bivacuum dipoles symmetry shift is related directly to that of mass symmetry shift:

$$[\Delta m_V = \beta\Delta m_C = \beta m_C^+(\vec{v}/c)^2 = \beta\frac{\vec{p}^{\,2}}{m_C^+ c^2}]_{x,y,z} \qquad 11.10$$

produced by asymmetry of actual momentum $(\vec{p} = m_C^+ v)_{x,y,z}$ dependence on the external group velocity in 3D space $(\vec{v})_{x,y,z}$.

11.3 Unification of Time, Space, Electromagnetism and Gravitation in UM

As a consequence of our Unified model (see eqs. 7.5; 8.1 and 8.2), we got for any closed system a **simple, symmetric and very important formula of UNIFICATION** of pace of time $[d\ln t = dt/t]$ (temporal field), determined by relative change of kinetic energy of system $(d\ln T_k = dT_k/T_k)$, with changes of its electromagnetic and gravitational potential $(dE_{el}/dt = dE_G/dt)$, mass and spatial parameter - de Broglie wave length $(\lambda = h/m_C^+ v)$.

For private case of isolated charged particle we have:

$$d\ln t = -d\ln T_k = d\ln m_C^+ + 2d\ln\lambda = -d\ln E_{el} = -d\ln E_G \qquad 11.11$$

where the kinetic energy: $T_k = h^2/(2m_C^+\lambda^2)$.

This Unification Formula means that the coherent alternating kinetic energy of any closed system: internal, related to $[C \rightleftharpoons W]$ pulsation and external, such as thermal oscillations of atoms/molecules, acceleration of macroscopic bodies - determines its pace of time, change of mass, spatial parameters, electromagnetic and gravitational radiation.

It follows from our approach, that time, like electromagnetic and gravitational fields, has a tensor properties, i.e. it may be spatially anisotropic. The non scalar properties of these fields are related with anisotropy of Bivacuum dipoles symmetry shift:

$$d[\Delta m_V]_{x,y,z} = d\left[\frac{\beta}{c^2} m_C^+ v_{x,y,z}^2\right]_{x,y,z} \qquad 11.12$$

11.4 The new compensation principle of Bivacuum symmetry shifts, induced by matter and fields,

The law of energy conservation keeps the total energy of [secondary Bivacuum + energy of sub-elementary particles] unchanged and equal to zero, like in primordial Bivacuum (see Chapter 2).

The new compensation principle of Bivacuum symmetry shifts, induced by matter and fields can be presented in a following shape:

$$\sum^{n=N}[\mathbf{E}^n_{\mathbf{S}}(F^{\pm}_{\updownarrow})^i + \mathbf{E}^n_{\mathbf{E}}(F^{\pm}_{\updownarrow})^i + \mathbf{E}^n_{\mathbf{G}}(F^{\pm}_{\updownarrow})^i] = \qquad 11.13$$

$$= -\sum^{k=\infty}[\Delta\mathbf{E}^k_{\mathbf{S}(BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow})^i} + \Delta\mathbf{E}^k_{\mathbf{E}(BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow})^i} + \Delta\mathbf{E}^k_{\mathbf{G}(BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow})^i}] = \qquad 11.13a$$

$$= -\beta m_0^i c^2\ \frac{\vec{r}}{r}\sum^{k=\infty}\ln[K_{\mathbf{S}(BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow})^i}K_{\mathbf{E}(BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow})^i}K_{\mathbf{G}(BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow})^i}]^k \qquad 11.13b$$

where: N is a finite number of elementary particles in closed system under consideration;

$k = \infty$ is the infinitive number of asymmetric Bivacuum fermions or antifermions, uncompensated, due to dynamic equilibrium $(BVF^{\uparrow} \rightleftharpoons BVF^{\downarrow})^i$ shift under the influence of magnetic fields, generated by dynamics of charged elementary particles.

This compensation principle propose a new interpretation of potential fields. The basic - spin or torsion field, generating charge, mass of particles and their [C$\rightleftharpoons$ W] pulsation, and its derivatives: electromagnetic and gravitational fields. They are the consequence of Bivacuum fermions and antifermions dynamic equilibrium $(BVF^{\uparrow} \rightleftharpoons BVF^{\downarrow})^i$ shift, compensating the [C$\rightleftharpoons$ W] pulsation, longitudinal and transverse translational vibrations of uncompensated sub-elementary particles.

The corresponding equilibrium shifts occurs, as a result of interaction of equal, but opposite magnetic moments of $BVF^{\uparrow}$ and $BVF^{\downarrow}$ (see section 2.2) with magnetic fields, generated by corresponding three types of charge dynamics, modulated by $[C \rightleftharpoons W]$ pulsations of sub-elementary particles. The longitudinal (z) and transverse (x) translational vibrations occur in direction normal to each other and vector of the particle external group velocity and vector of its uncompensated cumulative virtual cloud (y). The axe (x) coincides with the symmetry axe of pair of the in-phase pulsating sub-elementary particles $[F^-_{\updownarrow} \bowtie F^+_{\updownarrow}]$. The axe (z) coincides with uncompensated dipole $F^{\pm}_{\updownarrow}>$ of triplets $<[F^-_{\updownarrow} \bowtie F^+_{\updownarrow}] + F^{\pm}_{\updownarrow}>$, counterphase to pulsations of pair $[F^-_{\updownarrow} \bowtie F^+_{\updownarrow}]$.

The left part of (11.13) represents the sum of three contributions of *localized* Bivacuum dipoles symmetry shift, induced by three kinds of dynamics of (N) elementary particles: the rotation (spinning) and two kinds of translational vibrations - longitudinal, responsible for electromagnetic field and transversal, responsible for gravitational potential.

Each of these energy contributions can be presented in [C] and [W] phase.

The rotational energy contribution, responsible for mass of rest (m_0) and charge (e_0) origination, satisfies the Golden mean conditions, due to resonant exchange interaction of each lepton generation ($i = e, \mu, \tau$) with Bivacuum (see 4.8 and 4.10):

$$\Delta m_C^{\phi} = |m_C^+ - m_C^-|^{\phi} = m_0 = \phi(m_C^+)^{\phi}$$

$$\Delta e^{\phi} = |e_+ - e_-|^{\phi} = e_0 = \phi e$$

It determines the local potential of spin field, which can be presented as follows:

$$\mathbf{E}^n_{\mathbf{S}}(F^{\pm}_{\updownarrow})^i_{[C]} = \left([m^+_C v^2_{rot}]^{\phi} = [m^+_C]^{\phi}(\phi c)^2_{rot} = \frac{\hbar^2}{\left[m^+_C(L^+_C)^2\right]^{\phi}} = \hbar\omega^{\phi}_{C\rightleftharpoons W} \right)^i_{[C]} \qquad 11.14$$

$$\mathbf{E}^n_{\mathbf{S}}(F^{\pm}_{\updownarrow})^i_{[W]} = \left(|m^+_C - m^-_C|^{\phi} c^2 = m_0 c^2 = \frac{\hbar^2}{m_0 L_0^2} = m_0\omega_0^2 L_0^2 = \hbar\omega_0 \right)^i_{[W]} \qquad 11.14a$$

where the Golden mean angle frequency is $\omega_0 = m_0c^2/\hbar;$ the corresponding Compton radius $L_0 = \hbar/m_0 c$.

The energy contribution of longitudinal translational vibrations, responsible for electric potential of sub-elementary particle at Golden mean conditions is:

$$\mathbf{E}^n_{\mathbf{E}}(F^{\pm}_{\updownarrow})^i_{[C]} = \left[(E^{el}_e)^C_{\parallel tr} = \alpha[m^+_C v^2_{res}]^{\phi} = \left[m^+_C v^2_{\parallel tr}\right]^{\phi} = m^+_C (zc)^2 \right]^i_{[C]} \qquad 11.15$$

$$\mathbf{E}^n_{\mathbf{E}}(F^{\pm}_{\updownarrow})^i_{[W]} = \left[(E^{el}_e)^W_{\parallel tr} = \frac{e_+e_-}{L^{\pm}} = \alpha(m^+_C - m^-_C)^{\phi} c^2 = \alpha m_0 c^2 \right]^i_{[W]} \qquad 11.15a$$

where: v_{res} is the resulting rotational-translational velocity of sub-elementary fermion; $v^{\phi}_{\parallel tr} = zc$ is a velocity of longitudinal translational zero-point vibrations; $z = (\alpha\phi)^{1/2}$ is a longitudinal zero-point factor; $\alpha = e^2/\hbar c$ is the electromagnetic fine structure constant; $L^{\pm} = \hbar/[(m^+_C - m^-_C)^{\phi} c] = L_0$ is a characteristic dimension of asymmetric double cell-dipole separating the actual (e_+) and complementary (e_-) charge of each of three sub-elementary particles of the electron or positron $<[F^-_{\updownarrow} \bowtie F^+_{\updownarrow}] + F^{\pm}_{\updownarrow}>$.

The energy contribution of transversal translational vibrations of triplets $<[F^-_{\updownarrow} \bowtie F^+_{\updownarrow}] + F^{\pm}_{\updownarrow}>$, responsible for gravitational potential at Golden mean conditions is:

$$\mathbf{E}^n_{\mathbf{G}}(F^{\pm}_{\updownarrow})^i_{[C]} = \left[(E^G_e)^C_{\perp tr} = \beta[m^+_C v^2_{res}]^{\phi} = [m^+_C v^2_{\perp tr}]^{\phi} = m^+_C (xc)^2 \right]^i_{[C]} \qquad 11.16$$

$$\mathbf{E}^n_{\mathbf{G}}(F^{\pm}_{\updownarrow})^i_{[W]} = \left[(E^G_e)^W_{\perp tr} = G\frac{m^+_C m^-_C}{L^{\pm}} = \beta(m^+_C - m^-_C)^{\phi} c^2 = \beta m_0 c^2 \right]^i_{[W]} \qquad 11.16a$$

where: v_{res} is the resulting rotational-translational velocity of sub-elementary fermion; $v_{\perp tr} = xc$ is a velocity of transversal translational zero-point vibrations, responsible for gravitation; $x = (\beta\phi)^{1/2}$ is a transversal zero-point factor.

At the conditions of Golden mean, $|m^+_C - m^-_C|^{\phi} = m_0$, the curvature, corresponding to spinning (rotation) of sub-elementary particles, turns to that, equal to Compton radius:

$$(L^{rot}_{C,W})^{\phi} = \frac{\hbar}{|m^+_C - m^-_C|^{\phi} c} = \frac{\hbar}{m_0 c} \equiv L_0 \qquad 11.17$$

It follows from our theory (sections 2.2 and 2.3), that shift of equilibrium $(BVF^{\uparrow} \rightleftharpoons BVF^{\downarrow})^i$ is accompanied by creation of difference between the actual and complementary mass: $|m^+_C - m^-_C| > 0$ and the actual and complementary charge: $|e_+ - e_-| > 0$. However, it much less, than the mass and charge shifts in stable sub-elementary particles.

The curvature of Bivacuum, corresponding to symmetry shift, related to longitudinal zero-point vibrations of elementary particles, which determines the electric potential, can be find from:

$$E_E = \alpha|m^+_C - m^-_C|c^2 = \alpha\frac{\hbar c}{L_0} \qquad 11.18$$

The corresponding to EM potential space curvature at Golden mean conditions is:

$$L^{\phi}_E = \frac{1}{\alpha}\frac{\hbar}{m_0 c} = \frac{1}{\alpha}L_0 \qquad 11.19$$

Comparing (11.19) and (11.17), we can see, that the curvature radius, corresponding to EM potential of particle exceeds its Compton radius to about 137 times:

$$\frac{L_{EM}^{\phi}}{L_0} = \frac{1}{\alpha} \sim 137 \qquad 11.20$$

In similar way, the curvature of Bivacuum, related to transversal zero-point vibrations of elementary particles, which determines gravitation, is:

$$L_G^{\phi} = \frac{1}{\beta}\frac{\hbar}{m_0 c} \qquad 11.21$$

The gravitational curvature radius of Bivacuum symmetry compensation exceeds the Compton radius of the electron to $(1/\beta)$ times:

$$\frac{L_G^{\phi}}{L_0} = \frac{1}{\beta} = \left(\frac{M_{Pl}}{m_0}\right)^2 \sim 10^{45} \qquad 11.22$$

$$or:\ L_G^{\phi} \sim 10^{45} L_0$$

The product of the space curvature, generated by each kind of fields (11.17; 11.19; 11.21), representing their characteristic radius of action, on these fields potentials (11.14a; 11.15a; 11.16a) has a permanent value, equal to full charge squared of particle ($\hbar c = \mathrm{Q}^2 = \alpha e^2$) :

$$L_0 \cdot \mathbf{E_S} = \hbar c \qquad 11.22a$$

$$L_E \cdot \mathbf{E}_E = \hbar c \qquad 11.22b$$

$$L_G \cdot \mathbf{E}_G = \hbar c \qquad 11.22c$$

This new important result may be formulated as: **'The law of momentum of potential fields energy conservation'**. It directly related with law of the angular momentum of potential fields conservation, if we assume, that: $\mathbf{p}_{S,E,G} = \mathbf{E}_{S,E,G}/c$.

Let us consider now the origination of the spin (torsion) field, electromagnetic and gravitational fields, as a gradient of constants of Bivacuum fermions and antifermion dynamic equilibrium $[\mathbf{grad}\,K_{\mathbf{S,E,G}(BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow})^i}]$, induced by different kinds of magnetic fields of elementary charged particles.

It is known from electrodynamics and the first Maxwell equation:

$$rot\,\mathbf{H}_{S,E,G} = \frac{4\pi}{c}\mathbf{j}_{S,E,G} + \frac{1}{c}\left(\frac{\partial \mathbf{D}}{dt}\right)_{S,E,G} \qquad 11.23$$

that each of three kind of dynamics of charged particles, like our sub-elementary particles of charged triplets $<[F_{\updownarrow}^{-} \bowtie F_{\updownarrow}^{+}] + F_{\updownarrow}^{\pm}>$, should generate corresponding kinds of the magnetic field ($\mathbf{H}_{S,E,G}$).

In formula (11.23) the current $[\mathbf{j}_{S,E,G}]$ may reflect the collective excitations of sub-quantum particles, forming sub-elementary particles in [C] phase, participating in **rotation** of uncompensated sub-elementary particle, as [actual vortex + complementary rotor] and its **longitudinal and transversal translations**. The collective dynamics of sub-quantum particles, accompanied the $[C \rightleftharpoons W]$ pulsation of elementary particles, may be described by the **displacement current**, defined by time-dependent change of the electric field:

$$\frac{1}{c}\left(\frac{\partial \mathbf{D}}{dt}\right)_{S,E,G} \qquad 11.23a$$

In turn, interaction of these kinds of magnetic fields ($\mathbf{H}_{S,E,G}$) with Bivacuum dipoles of opposite magnetic moments - will shift the dynamic equilibrium of Bivacuum fermions $[\mathrm{BVF}^{\uparrow} \rightleftharpoons \mathrm{BVF}^{\downarrow}]_{S,E,G}$, correspondingly. The related nonlocal contributions of Bivacuum symmetry shift should compensate the local symmetry shifts, produced by elementary particles.

The right parts of formulae (11.13a; 11.13b) represent the fields contributions, i.e. *nonlocal* symmetry shifts of Bivacuum in form of dynamic [BVF$^\uparrow$ $\rightleftharpoons$BVF$^\downarrow$] equilibrium shifts, compensating the local shifts, induced by the spinning, longitudinal and transverse translational vibrations of the charged triplets $<[F_\updownarrow^- \bowtie F_\updownarrow^+] + F_\updownarrow^\pm >$, like electrons or positrons.

The corresponding three kinds of Bivacuum [BVF$^\uparrow$ $\rightleftharpoons$BVF$^\downarrow$]$_{S,E,G}$ equilibrium constants shifts (11.13b) characterize three fields

- the torsion (spin) field

$$K_{\mathbf{S}(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i} = \exp\left[-\frac{|m_C^+ - m_C^-|_\mathbf{S} c^2}{\beta m_0 c^2}\right] = \exp\left[-\frac{\mathbf{H_S}(\boldsymbol{\mu}_+ - \boldsymbol{\mu}_-)}{\beta m_0 c^2}\right] \quad 11.24$$

- the electromagnetic field

$$K_{\mathbf{E}(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i} = \exp\left[-\frac{\alpha|m_C^+ - m_C^-|_\mathbf{E} c^2}{\beta m_0 c^2}\right] = \exp\left[-\frac{\mathbf{H_E}(\boldsymbol{\mu}_+ - \boldsymbol{\mu}_-)}{\beta m_0 c^2}\right] \quad 11.24a$$

- the gravitational field

$$K_{\mathbf{G}(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i} = \exp\left[-\frac{\beta|m_C^+ - m_C^-|_\mathbf{E} c^2}{\beta m_0 c^2}\right] = \exp\left[-\frac{\mathbf{H_G}(\boldsymbol{\mu}_+ - \boldsymbol{\mu}_-)}{\beta m_0 c^2}\right] \quad 11.25$$

where (see 2.4): $|\boldsymbol{\mu}_+| \equiv |\boldsymbol{\mu}_{BVF^\uparrow}| = |-\boldsymbol{\mu}_-| \equiv |\boldsymbol{\mu}_{BVF^\downarrow}| = \boldsymbol{\mu}_B$ are the opposite magnetic moments of pairs [rotor + antirotor], representing Bivacuum fermions $(BVF^\uparrow)^i$ and Bivacuum antifermions $(BVF^\downarrow)^i$ of secondary Bivacuum, independent on symmetry shift.

We may conclude, that a three types of dynamics of charged elementary fermions in [C] phase are existing:

1. The rotation around (y) axe of triplets $<[F_\updownarrow^- \bowtie F_\updownarrow^+] + F_\updownarrow^\pm >$ with energy:

$$E_S = |m_C^+ - m_C^-|_\mathbf{S} c^2 = m_C^+ \omega_C^2 L_C^2 = \hbar\omega_S \sim \hbar\omega_0 \quad 11.26$$

2. The longitudinal translations along (z) axe of triplets with energy:

$$E_E = \alpha|m_C^+ - m_C^-|_\mathbf{E} c^2 = m_C^+ v_{\parallel tr}^2 = \hbar\omega_E \quad 11.27$$

3. The transversal translations along (x) axe of triplets with energy:

$$E_G = \beta|m_C^+ - m_C^-|_\mathbf{E} c^2 = m_C^+ v_{\perp tr}^2 = \hbar\omega_G \quad 11.28$$

These hierarchy of dynamics of charged particles is a background of corresponding hierarchy of magnetic fields tension [$\mathbf{H}_{S,E,G}$], in accordance to the first Maxwell equation (11.23).

These kind of fields exist in form of different kinds of modulation (hierarchy of modulation) of the resulting constant of [BVF$^\uparrow$ $\rightleftharpoons$BVF$^\downarrow$]$_{S,E,G}$ equilibrium:

$$K^{\mathbf{Res}}_{(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i} = K_{\mathbf{S}(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i} K_{\mathbf{E}(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i} K_{\mathbf{G}(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i} \quad 11.29$$

$$where: \; K_{\mathbf{S}(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i} > K_{\mathbf{E}(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i} >> K_{\mathbf{G}(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i}$$

The frequency of quantum beats, determined by three contributions of elementary fermions dynamics to difference between the actual and complementary states, represent the hierarchy of Golden mean frequency modulation:

$$\omega_0 = m_0 c^2/\hbar = \omega_S^\phi \quad 11.30$$

$$\omega_E = \alpha\omega_0 \quad 11.30a$$

$$\omega_G = \beta\omega_0 \quad 11.30b$$

$$where: \; \omega_0/\omega_E \sim 137 \quad and \quad \omega_0/\omega_G \sim 10^{45} \quad 11.30c$$

Consequently, the electromagnetic and gravitational fields may be defined also, as two hierarchic levels of elementary particles [C$\rightleftharpoons$ W] pulsation carrying frequency ($\omega_0 = \omega_{C\rightleftharpoons W}$) modulation (see 11.26 - 11.28). The electromagnetic field modulation frequency ($\omega_E = \alpha\omega_0$) and gravitational field modulation frequency ($\omega_G = \beta\omega_0$) are, in fact the consequence of corresponding magnetic fields, generated by longitudinal and transversal vibrations of the charged elementary particles. In accordance to our compensation principle, these magnetic fields induce the nonlocal $[\mathrm{BVF}^{\uparrow} \rightleftharpoons \mathrm{BVF}^{\downarrow}]_{E,G}$ dynamic equilibrium shift, opposite to that, generated by elementary particles dynamics themselves.

The new compensation principle of Bivacuum energy symmetry shifts, induced by matter and fields (11.13-11.13b), is a consequence of Bivacuum energy conservation. It can be formulated as follows: *the local Bivacuum dipoles symmetry shift, dependent on kinetic energy of particles and nonlocal resulting symmetry shift, generated by potential fields of these particles, - are opposite and equal to each other.*

12 The mechanism of quantum entanglement between coherent particles

In accordance to our UM, the *nonlocal* interaction (quantum entanglement) between particles with coherent $[C \rightleftharpoons W]$ pulsation is realized via Bivacuum symmetry oscillation (BvSO), modulated the exchange interaction between virtual pressure waves ($\mathrm{VPW}^{\pm}$) of Bivacuum and symmetric pairs $[\mathbf{F}_{\updownarrow}^{-} \bowtie \mathbf{F}_{\updownarrow}^{+}]$ of elementary particles $\langle[\mathbf{F}_{\updownarrow}^{-} \bowtie \mathbf{F}_{\updownarrow}^{+}] + \mathbf{F}_{\updownarrow}^{\pm}\rangle$ in a course of $[C \rightleftharpoons W]$ pulsation of pairs. Experimentally, the quantum entanglement was revealed firstly by Aspect, et al., (1982; 1983).

Such a process is mediated by nonlocal BvSO in the volume of virtual Bose condensate (VirBC), formed by $BVF^{\updownarrow}$ and $BVB^{\pm}$ (see section 1*).*

The BvSO are the consequence of different Bivacuum symmetry shifts, induced by [C] and [W] phase of uncompensated sub-elementary particles. Their values are correspondingly:

$$\left[\Delta m_V^{[C]} = \beta(m_C^+ - m_C^-) = \beta m_C^+(v/c)^2 = \frac{\beta}{c^2}\hbar\omega_{C\rightleftharpoons W}\right]_{x,y,z} \qquad 12.1$$

$$\Delta m_V^{[W]} \cong 0, \qquad as\ far\ in\ [W]\ phase:\ \ m_C^+ \cong m_C^- \qquad 12.1a$$

The Bivacuum dipoles symmetry shift, related to [W] phase, can be exactly equal to zero $\Delta m_V^{[W]} = 0$ only in primordial vacuum. Consequently, $[C \rightleftharpoons W]$ pulsation of uncompensated sub-elementary particle of each elementary particle is accompanied by BvSO with the same frequency ($\omega_{BvSO} = \omega_{C\rightleftharpoons W}$):

$$\omega_{BvSO} = \omega_{C\rightleftharpoons W} = (m_C^+ - m_C^-)c^2/\hbar \qquad 12.2$$

the amplitude of BvSO, generated by pulsation of one uncompensated $\mathbf{F}_{\updownarrow}^{\pm}\rangle$ is equal to difference between (12.1) and (12.1a):

$$\Delta\Delta m_V^{C\rightleftharpoons W} = \Delta m_V^{[C]} - \Delta m_V^{[W]} = \beta m_C^+(v/c)^2 \cong \Delta m_V^{[C]} \qquad 12.3$$

$$or:\ \ \Delta\Delta m_V^{C\rightleftharpoons W} = \frac{\beta}{c^2}2T_k = \frac{\beta}{c^2}\frac{(P^{ext})^2}{m_C^+} = \frac{\beta}{c^2}\frac{\hbar^2}{m_C^+L^2} \qquad 12.4$$

where: $L = \hbar/P^{ext}$ is a actual de Broglie wave of particle.

The anisotropic amplitude probability of resonant exchange interaction between **two** particles: 'sender (S)' and 'receiver (R)' $(A_{C\rightleftharpoons W})_{x,y,z}$ may be qualitatively described, using well known model of **damped harmonic oscillator** interacting with external alternating field:

$$[A_{C\rightleftharpoons W}]_{x,y,z} \sim \frac{1}{(m_C^+)_R}\frac{[F_{BvSO}]_{x,y,z}}{\omega_R^2 - \omega_S^2 + \mathrm{Im}\,\gamma\omega_S} \qquad 12.5$$

where: ω_R and ω_S are the frequencies of $C \rightleftharpoons W$ pulsation of sub-elementary particles of (S) and (R);

γ is a damping coefficient due to exchange interaction of pairs $[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+]$ of triplets $\langle[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+] + \mathbf{F}_\updownarrow^\pm\rangle$ by means of virtual pressure waves ($VPW^\pm$) with Bivacuum. This interaction may induce decoherence in (S) and (R) pulsations due to deviation of ω_R and ω_S from the Golden mean frequency ω_0, being a fundamental frequency of Bivacuum. The local Bivacuum fluctuations nearby [R] or [S] also may be responsible for decoherence and damping of the particles entanglement; $(m_C^+)_R$ is the actual mass of (R).

$[F_{BvSO}]_{x,y,z}$ is a spatially anisotropic *force of matter-induced Bivacuum symmetry oscillation*, related to energy of these asymmetric oscillation $(\Delta\Delta m_V^{C\rightleftharpoons W}c^2)$, number of elementary particles (N), pulsing with frequency (12.2) and radius of action $(L_{BvSO})_{x,y,z}$ of BvSO, induced by $C \rightleftharpoons W$ pulsation of one elementary particle:

$$\left[F_{BvSO} \sim N\frac{\Delta\Delta m_V^{C\rightleftharpoons W}c^2}{L_{BvSO}} = \frac{N^2}{\hbar}\left(\Delta\Delta m_V^{C\rightleftharpoons W}\right)^2 c^3\right]_{x,y,z} \qquad 12.6$$

where radius of BvSO (L_{BvSO}), equal to radius of nonlocality (L_{NL}), generated by N particles, is related directly to Bivacuum dipoles symmetry shift around the system of interacting particles $(\Delta\Delta m_V^{C\rightleftharpoons W})$:

$$\left[L_{BvSO} = L_{NL} = \frac{\hbar}{N\Delta\Delta m_V^{C\rightleftharpoons W}c}\right]_{x,y,z} \qquad 12.7$$

$$where: \left\{N\Delta\Delta m_V^{C\rightleftharpoons W}c = \beta\sum_i^N [m_C^+(v/c)_i^2]\right\}_{x,y,z} \qquad 12.8$$

The effectiveness of nonlocal interaction between two or more separated elementary particles is dependent on synchronization of $[C \rightleftharpoons W]$ pulsations, and correlation of polarization of $(VPW^\pm)_{x,y,z}$ of Bivacuum in the system of interacting particles. It is easy to see from (10.5 and 10.6), that the bigger is Bivacuum dipoles symmetry shift $(\Delta\Delta m_V^{C\rightleftharpoons W})$, induced by sender (S) and the more coherent are $C \rightleftharpoons W$ pulsation of (S) and receiver (R), the less is frequency deviation $\Delta\omega = \omega_R - \omega_S$ and the more effective is quantum entanglement between particles.

Spatial stability of complex systems: atoms, molecules and that of solids means that in these systems superposition of CVC, representing [W] states of uncompensated sub-elementary particles, as well as $VPW^\pm$ of pairs $[\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+]$ forms hologram - like 3D standing virtual waves superposition with location of nodes in the most probable positions of corpuscular phase of the nucleons, electrons, atoms and molecules in condensed matter. The binding of CVC by $BVF^\updownarrow$ restore the [C] phase of particles in positions, close to the most probable ones. So, the coherent atoms/molecules thermal oscillation in composition of clusters, representing mesoscopic Bose condensate (Kaivarainen, 2001b,c), should be strictly correlated with coherent $[C \rightleftharpoons W]$ pulsations of their elementary particles.

The opposite statement also is correct. The $[C \rightleftharpoons W]$ decoherence and spatial disorientation (depolarization) of elementary particles of atoms and molecules in condensed matter, induced, for example by external fields or laser beam, may have a feedback reaction with their random thermal fluctuations.

The mechanism, proposed, may explain the theoretical (Einstein, et all. 1935; Cramer, 2001) and experimental evidence in proof of nonlocal interaction between coherent elementary particles (Aspect, et all. 1982; 1983) and atoms.

Our theory predicts, that the same mechanism may provide the distant quantum entanglement between mesoscopic and macroscopic systems, including biological ones, if $[C \rightleftharpoons W]$ pulsations of their particles are 'tuned' to each other and they have close spatial polarization and symmetry. (Kaivarainen, 2001*d).*

Besides the problems, discussed in this paper, the Unified Model provides a deeper understanding of Pauli and Heizenberg principles. It was shown, using the Virial theorem, that condition of Bose condensation (BC) - actual in matter or virtual in Bivacuum - coincide with condition of nonlocality, as independence of potential on distance. Generalized principle of Le Chatelier, as a resistance of Bivacuum symmetry shift and $[C \rightleftharpoons W]$ pulsation frequency of particles to their acceleration (Kaivarainen, 2000, 2001), has been applied for explanation of inertia.

12.1 Explanation of Two-Slit Experiment in UM

Bohm, like Einstein, rejected the Bohr's statement, that particles can not be considered until they are observed. In his last book, written with Basil Hiley: "THE UNDIVIDED UNIVERSE. An ontological interpretation of quantum theory" (1993), the electron is considered as a particle with well- defined position and momentum which are, however, under influence of special wave (quantum potential). Particle in accordance with this authors is a sequence of incoming and outgoing waves, which are very close to each other. However, particle itself does not have a wave nature after Bohm. Interference pattern in double slit experiment is a result of periodically "bunched" character of quantum potential in Bohm's view.

In accordance to our model, the electron is a triplet $\langle[\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}] + \mathbf{F}_{\downarrow}^{-}\rangle$ formed by two negatively charged sub-elementary fermions of opposite spins ($\mathbf{F}_{\uparrow}^{-}$ and $\mathbf{F}_{\downarrow}^{-}$) and one uncompensated sub-elementary antifermion ($\mathbf{F}_{\downarrow}^{+}$) (see section 1.1). The symmetric pair of standing sub-elementary particle and antiparticle: $[\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}]$ are pulsing between Corpuscular [C] and Wave [W] states in-phase, compensating the influence of energy, spin and charge of each other. The bunched character of the electron's trajectory can be a result of its periodic momentum oscillation, produced by $[\mathbf{C} \rightleftharpoons \mathbf{W}]$ pulsation of uncompensated sub-elementary particle ($\mathbf{F}_{\downarrow}^{-}$).

It leads from our model, that the energy and momentum of the electron and positron are determined mostly by uncompensated sub-elementary particle ($\mathbf{F}_{\updownarrow}^{\pm}$). The parameters of ($\mathbf{F}_{\updownarrow}^{\pm}$) are correlated strictly with similar parameters of pair $[\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}]$ due to conservation of symmetry of properties of sub-elementary particle/antiparticle in triplets. It means, that energy/momentum of uncompensated sub-elementary fermion ($\mathbf{F}_{\updownarrow}^{\pm}$) and, consequently, the whole particle (electron or positron) may be modulated by resonant exchange interaction between Bivacuum gap (see eq. 1.3) oscillations (BvO) and pairs $[\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}]$ of triplets $\langle[\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}] + \mathbf{F}_{\updownarrow}^{\pm}\rangle$, mediated by virtual pressure waves ($\mathrm{VPW}^{\pm}$) of Bivacuum.

Consequently, the bunched character of the electron's trajectory can be explained as a result of alternating momentum of its uncompensated sub-elementary particle ($F_{\downarrow}^{-}$) in a course of $[C \rightleftharpoons W]$ pulsation, accompanied by radiation and absorption of cumulative virtual cloud (CVC), i.e. periodic exchange interaction with Bivacuum.

In turn, the in-phase $[C \rightleftharpoons W]$ pulsation of sub-elementary particle $\mathbf{F}_{\uparrow}^{+}$ and sub-elementary antiparticle $\mathbf{F}_{\downarrow}^{-}$ of pair $[\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}]$ are responsible for excitation of virtual pressure waves: VPW^{+} and VPW^{-} in Bivacuum with the same frequency and wave length as $\mathrm{CVC}^{\pm}$. The interference of $\mathrm{VPW}^{\pm}$, excited by different elementary particles in Bivacuum due to feedback reaction with uncompensated $\mathbf{F}_{\updownarrow}^{\pm}$ induces the wave - like behavior of the whole triplets $\langle[\mathbf{F}_{\uparrow}^{-} \bowtie \mathbf{F}_{\downarrow}^{+}] + \mathbf{F}_{\updownarrow}^{\pm}\rangle$. Just actual mass of *uncompensated* sub-elementary particle determines the observable experimentally properties of elementary particle.

The energy of particle in the both: corpuscular (C) and wave (W) phase (see eq.3.2; 3.2a) may be expressed via its de Broglie wave frequency ($\omega_{C\rightleftharpoons W}$) and length ($\lambda_{C,W}$) as a sum of rotational, following Golden mean conditions, and translational contributions:

$$E_C = E_W = \hbar\omega_{C\rightleftharpoons W} = m_0c^2 + (m_C^+ - m_C^-)_{tr}c^2 = m_0L_0^2w_0^2 + m_C^+v_{tr}^2 = \qquad 12.9$$

$$= \frac{p_0^2}{m_0} + \frac{(p_C^+)_{tr}^2}{m_C^+} = \frac{\hbar^2}{m_0L_0^2} + \frac{h^2}{m_C^+\lambda_{tr}^2} \qquad 12.9a$$

where the value of actual momentum ($p_C^+ = m_C^+v$) determines the actual value of de Broglie wave (wave B) length of particle, related to its translational velocity:

$$\lambda_{tr} = \frac{h}{m_C^+ v_{tr}} \qquad 12.10$$

In accordance to our model, the reversible [$\mathbf{C} \rightleftharpoons \mathbf{W}$] pulsations are accompanied by outgoing and incoming Cumulative Virtual Cloud (CVC), composed from sub-quantum particles (see section 2.2).

Another factor of bunched trajectory is the interaction of pair [$\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+$] of the electron with nonlocal Bivacuum gap oscillation (BvO), generated by [$\mathbf{C} \rightleftharpoons \mathbf{W}$] oscillation of other particles of medium at certain quantum boundary conditions. The mechanism of such effect, leading from our model, is that the actual kinetic energy of elementary particles (electron, photon,etc.) and their actual momentum, which are determined by uncompensated sub-elementary particles, change in similar way, as the same parameters of pair [$\mathbf{F}_\uparrow^- \bowtie \mathbf{F}_\downarrow^+$] due to symmetry of triplet properties conservation. This means that properties of ($\mathbf{F}_\downarrow^-$) may be modulated by external Bivacuum gap oscillation (BvO), affecting the properties of symmetric pair.

We can see, that our model do not needs the Bohmian ”quantum potential” or ”pilot wave” for explanation of two-slit experiment. For the general case of ensembles of particles, the explanation can be related to interference of their [W] phase in form of cumulative virtual clouds (CVC) with most probable wave length, determined by the most probable actual momentum of particles in a beam. For other hand, the ability of symmetric pair of sub-elementary fermions [$F^- \bowtie F^+$] in composition of elementary particle to activate nonlocal Bivacuum gap oscillation (BvO) as well as similar pairs in any target, due to their [$C \rightleftharpoons W$] pulsation may be responsible for interference of BvO, even in the case of single electron or photon.

Scattering of photons on free electrons will affect their momentum, mass, wave B length and, consequently, the interference picture. Only [C] phase of particle, but not its [W] phase can be registered by detectors of particles. *Such a consequences of our dynamic duality model can explain all details of well known and still mysterious double slit experiment.*

The interference between VPW^+ and VPW^-, generated by sub-elementary particles of the different electrons of beam with $VPW^\pm$, excited by electrons of screen, also can contribute to results of two-slit experiment.

13 Free energy machines: the Searl’s Magneto-Gravitational Convertor

13.1 The Source of Free Energy of Bivacuum

In accordance to our Unified model, the Coulomb and gravitational potentials of elementary particles are determined by the difference of the actual and complementary masses (mass symmetry shift Δm_C) in [C] phase and corresponding Bivacuum dipoles symmetry shift in [W] phase of sub-elementary particles.

The energy exchange between the positive and negative energetic compartments of the asymmetric double cells-dipoles (sub-elementary particles) occur in form of quantum beats between the actual ($m_C^+ c^2$) and complementary ($m_C^- c^2$) states of the corpuscular [C] phase of sub-elementary particle or antiparticle. These beats are accompanied by the [$emission \rightleftharpoons absorption$] of cumulative virtual cloud (CVC) of sub-quantum particles, representing the [W] phase of sub-elementary particle. This is a way of [$C \rightleftharpoons W$] duality realization in our Unified model (UM).

In the **additional** permanent gravitational (E_G), electric (E_{El}) or magnetic fields, the additional Bivacuum dipoles symmetry shift occur, as compared to that, pertinent for unperturbed space.

Consequently the local Bivacuum dipoles symmetry shift, induced artificially by strong permanent magnets, electric condensers and rotation of matter, could be used via [$C \rightleftharpoons W$] duality of the electrons, quarks to convert this additional symmetry shift to different form of energy, like electromagnetic and gravitational ones.

The source of 'free energy', consequently, is the additional shift of Bivacuum fermions and antifermions equilibrium in the some selected area of space:

$$BVF^{\uparrow}_{S=1/2}(\vec{\mu}_{+}) \rightleftharpoons BVF^{\downarrow}_{S=-1/2}(\vec{\mu}_{-}) \qquad 13.1$$

where corresponding equilibrium constant (see eq.:

$$K^{i}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}} = \exp\left[-\frac{\vec{H}(\vec{\mu}_{BVF^{\uparrow}} - \vec{\mu}_{BVF^{\downarrow}})}{\beta m_0^i c^2} \right] \qquad 13.1a$$

In accordance to the resulting Bivacuum symmetry conservation principle (11.17), introduced in our work, this local additional equilibrium shift, i.e. induced by artificial permanent gravitational, magnetic or electric fields, should be compensated by the opposite equilibrium shift in the other parts of space.

The Searl effect, confirmed recently in experiments of Roshin and Godin (2000), displays itself in decreasing or increasing weight of rotating permanent magnets, depending on direction of their rotation as respect to Earth gravity vector: clockwise or anticlockwise and self-acceleration of rotation after overcoming of certain speed threshold. The latter effect was explained already in Section 5, as a result of pull-in range and combinational resonance of $[C \rightleftharpoons W]$ pulsation of particles of rotating body with Harmonization force (HaF) of Bivacuum.

The setup (convertor) of Roshin and Godin is comprised by immobile stator and rotor, carrying magnetic rollers and moving around the stator. The diameter of rotor is about 1 m. The stator (weight 110 kg) and magnetic rollers (total weight 115 kg) were manufactured from separate magnetized segments with residual magnetization of 0.85 T, a coercive force of [Hc] ~600 kA/m and a specific magnetic energy of [W] ~150 J/m^3. The stator and rotor were assembled on a single platform made of nonmagnetic material.

13.1 The Mechanism of Self-Acceleration in Searl Effect

The resonant energy exchange between Bivacuum and interrelated elements of nonlinear systems with many degrees of freedom, i.e. between nuclears and electrons, atoms and molecules of condensed matter, may occur under the influence of Harmonization Force (HaF) of Bivacuum (see Section 5*).* The energy exchange between different degrees of freedom of matter with Bivacuum at conditions of combinational resonance may induce finally even **self-acceleration of macroscopic body of rotation.**

Such dynamic Bivacuum - Matter interaction may explain the Searl effect, confirmed by Baurov and Ogarkov (1994), Roshin and Godin (2000). It occur, if the amplitude of virtual pressure waves (VPW$^{\pm}$) and asymmetry of virtual pressure of positive and negative vacuum: $\mathbf{\Delta V}\,\mathrm{Pr}^{\pm} = |\mathbf{V}\,\mathrm{Pr}^{+} - \mathbf{V}\,\mathrm{Pr}^{-}|$ (Kaivarainen, 2001d), overcome certain threshold. Corresponding conditions in the *autooscillating nonlinear systems* may result from amplification of VPW$^{\pm}$, frequency and uncompensated virtual density energy of Bivacuum by magnetic field, generated by magnetized solid of revolution.

Self-acceleration starts, if the *pull-in range* becomes sufficiently wide for synchronization of external and internal frequencies after overcoming certain speed of body rotation. This is accompanied by enhancement of degree of its particles $[C \rightleftharpoons W]$ pulsation coherency and improving the conditions for combinational resonance of matter with HaF of Bivacuum.

Our calculations show, that for magneto-gravitational convertor, with diameter of about 1m and critical rotor speed of 550 rpm, the corresponding collective linear velocity of particles, composing surface of magnetic rollers, is about $5 \cdot 10^3$ cm/s. This value is pretty close to the most probable velocity of molecules, related to their thermal translational vibrations, simulated for ice at -100 ^{0}C (Kaivarainen, 1995; 2001). The average velocity of atoms of rotating magnets may have the same order.

In accordance to our theory of wave-particle duality (see eqs. 3.2; 3.2a), the equal kinetic energy of similar particles corresponds to equal frequency of their $[C \rightleftharpoons W]$ pulsation ($\omega_{C\rightleftharpoons W}$).

Out of pull-in range of stable generation, the *quantum beats* between the fundamental modes of Bivacuum and modes of particles of condensed matter oscillation should take a place. These beats may display themselves in form of electromagnetic (radiated by matter) and $VPW^{\pm}$ waves with corresponding frequency.

13.2 The Variation of Weight of Rotating Magnets

This effect, starting before self-acceleration, can be explained in the framework of UM by the influence of curled magnetic field on dynamic equilibrium of Bivacuum fermions with opposite spins and magnetic moments (eqs. 1.6 and 2.4 and 13.1b).

The resulting constant of this equilibrium $[K^{res}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(r)]$ we introduce as a product of equilibrium constant, determined by gravitation $[K^{G}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(r)]$ and that, determined by magnetic field influence $[K^{H}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(r)]$. The resulting constant define the resulting Bivacuum dipoles symmetry shift and value and direction of resulting gravitational potential ($\overrightarrow{E}_G^{res}$), which may coincide or be opposite with the Earth gravity vector:

$$K^{res}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(\overrightarrow{E}_G,\overrightarrow{E}_H) = K^{G}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(r)\,K^{H}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(r) = \exp\left[-\frac{\overrightarrow{r_0}}{r}\frac{\sum(m_V^+ - m_V^-)^{res}c^2}{\beta m_0^i c^2 + \Delta U^{G,EM}}\right] \qquad 13.2$$

$$= \exp\left[-\frac{\overrightarrow{r_0}}{r}\frac{\overrightarrow{E}_G^{res}}{\beta m_0^i c^2 + \Delta U^{G,EM}}\right] \qquad 13.2a$$

where:

$$K^{G}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(r) = \exp\left[-\frac{\overrightarrow{r_0}}{r}\frac{\sum\beta(m_C^+ - m_C^-)c^2}{\beta m_0^i c^2 + \Delta U^{G,EM}}\right] = \exp\left[-\frac{\overrightarrow{r_0}}{r}\frac{\sum(m_V^+ - m_V^-)^G c^2}{\beta m_0^i c^2 + \Delta U^{G,EM}}\right] \qquad 13.3$$

and

$$K^{H}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(r) = \exp\left[-\frac{\overrightarrow{r_0}}{r}\frac{\sum\overrightarrow{H}(\overrightarrow{\mu}_{BVF^{\uparrow}} - \overrightarrow{\mu}_{BVF^{\downarrow}})}{\beta m_0^i c^2 + \Delta U^{G,EM}} = \exp\left[-\frac{\overrightarrow{r_0}}{r}\frac{\sum(m_V^+ - m_V^-)^H c^2}{\beta m_0^i c^2 + \Delta U^{G,EM}}\right]\right] \qquad 13.4$$

here: kT_R is the equilibrium thermal energy of Bivacuum, defined by the energy of relict radiation ($T_R \simeq 3K$); $\Delta U^{G,H} = \Delta U^G + \Delta U^{EM}$ is the increment of Bivacuum equilibrium density energy, determined by the external electromagnetic and gravitational fields. $\overrightarrow{r_0}$ is the unitary radius vector; r is a distance between a source of gravitational and magnetic field radiation and point of the effect observation.

For the case of alternating electromagnetic field, the volume density of its energy in Bivacuum is

$$\Delta U^{EM} = \overline{W} = [\epsilon E^2 + \mu H^2]/2 \qquad 13.5$$

where ϵ and μ are Bivacuum permittivity and permeability, correspondingly, depending on density of resulting virtual charge in given point of space.

The resulting value of gravitational potential we get from (13.2a-13.4), as

$$\overrightarrow{E}_G^{res}(r) = \frac{\overrightarrow{r_0}}{r}\left(\overrightarrow{E}_G^{res}\right)^{\max} = -(\beta m_0^i c^2 + \Delta U^{G,EM})\ln\left[K^{res}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(\overrightarrow{E}_G,\overrightarrow{E}_H)\right] = \qquad 13.6$$

$$= \frac{\overrightarrow{r_0}}{r}c^2\sum^N(m_V^+ - m_V^-)^{res} = \frac{\overrightarrow{r_0}}{r}c^2\sum^N(m_V^+ - m_V^-)^G + \frac{\overrightarrow{r_0}}{r}c^2\sum^N(m_V^+ - m_V^-)^H \qquad 13.6a$$

where: N is a number of Bivacuum fermions ($BVF^{\updownarrow}$) with non equal external group velocity ($v^{ext}_{BVF} > 0$) affected by curling magnetic field, generated by rotation magnets;
$\Delta m_V^G = (m_V^+ - m_V^-)^G = \beta(m_C^+ - m_C^+)$ is a Bivacuum dipoles symmetry shift, generated by gravitational potential of body;

$$\Delta m_V^H = (m_V^+ - m_V^-)^H = \beta(m_C^+ - m_C^-)^H = [\vec{H}/c^2](\vec{\mu}_{BVF\uparrow} - \vec{\mu}_{BVF\downarrow}) \qquad 13.7$$

is a Bivacuum dipoles symmetry shift, generated by curled magnetic field, related with mass symmetry shift (see 8.2b).

In permanent gravitational potential of the Earth the positive or negative values of resulting equilibrium constant: $K^{res}_{BVF\uparrow\rightleftharpoons BVF\downarrow}(\vec{E}_G, \vec{E}_H)$ and resulting gravitational potential $[\vec{E}_G^{res}(r)]$ is dependent on the intensity and vector of the curled magnetic field, generated by rotating magnet (clockwise or anticlockwise). These consequence of our theory is in total accordance with experiment (Roshin and Godin, 2000), showing that the weight of their rotating magnetic system increases or decreases on 30-35%, depending on the direction of rotation.

We can see, from this formula, that if the resulting equilibrium constant of Bivacuum fermions $K^{res}_{BVF\uparrow\rightleftharpoons BVF\downarrow}(\vec{E}_G, \vec{E}_H)$ is less than [1] and $(\Delta m_V^G + \Delta m_V^H) > 0$, the resulting gravitational potential is positive (attraction). If it is bigger, than [1] and $(\Delta m_V^G + \Delta m_V^H) < 0$, the value of $\vec{E}_G^{res}$ is negative (repulsion). If the influence of magnetic field and gravitation on Bivacuum symmetry compensate each other $\Delta m_V^G = -\Delta m_V^H$, the resulting gravitational attraction of rotating magnets to Earth is zero ($\vec{E}_G^{res} = 0$).

The shift of dynamic equilibrium (13.1) and corresponding Bivacuum symmetry, induced by rotating magnetic field, in accordance to our model, should be accompanied by corresponding mass ($\Delta m_C = m_C^+ - m_C^-$) and charge ($\Delta e_\pm = e_+ - e_-$) symmetry shift of Bivacuum double cells-dipoles (eq. 4.2b), followed by activation of their external movement with group velocity ($v > 0$).

At this condition the actual charge of asymmetric Bivacuum fermions becomes bigger, than the complementary one: $e_+ > e_-$ and the difference between them $\Delta e_\pm = e_+ - e_-$ determines the induced by rotating magnetic field uncompensated charge of BVF.

The motion of charged particles in electric and magnetic field turns their trajectory under the influence of Lorentz force:

$$\mathbf{F} = e\mathbf{E} + \frac{e}{c}[\mathbf{vH}] \qquad 13.8$$

In the absence of electric field $\mathbf{E} = \mathbf{0}$, the Lorentz force is:

$$\mathbf{F} = \frac{e}{c}[\mathbf{vH}] \qquad 13.9$$
$$|F| = \frac{e}{c} vH \sin\alpha$$

where α is the angle between vectors (**v**) and (**F**).

The module of Lorentz force $|F|$ at $E = 0$ is maximum at $\alpha = 90^0$ and is equal to zero at $\alpha = 0^0$.

As far the Lorentz force is normal to vectors **v** and **H** and do not produce a work, but only change the trajectory of charged particle to screw curvature. This curvature is a result of superposition of movement with velocity ($v_\parallel$), parallel to **H** and uniform rotational movement in direction normal to **H** with velocity ($v_\perp$).

The Lorentz force, acting on asymmetric Bivacuum fermions with uncompensated charge $\Delta e_\pm = |e_+| - |e_-|$, moving in magnetic field (**H**) with velocity (**v**) by screw curvature, is:

$$|F|_\pm = \frac{\Delta e_\pm}{c} vH \sin\alpha \qquad 13.10$$

13.3 The Nature of Magnetic Shells Around the Convertor

One more unusual effect, discovered in work of Roshin and Godin (2000), is the appearance of the vertical 'magnetic walls' - zones of increased magnetic field strength, as compared to field strength between them, arranged coaxially to the rotor center. We explain this, as a result of ability of slowly moving under the influence of curled magnetic field the excessive Bivacuum fermions ($BVF^{\uparrow}$ or $BVF^{\downarrow}$) to form the quantized virtual standing waves around rotating magnets.

To quantify our explanation, we proceed from the consequence of our model, that the constant of resulting equilibrium between the actual and complementary states of $BVF^{\updownarrow}$, $(K^{res}_{m^+\rightleftharpoons m^-})$, dependent on the external group velocity (v), is equal to constant of equilibrium $[K^{res}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(\vec{E}_G,\vec{E}_H)]$ between magnetic moments of $BVF^{\uparrow}$ or $BVF^{\downarrow}$ of opposite magnetic moments and spin.

Then formula (2.9) can be presented as:

$$K^{res}_{m^+\rightleftharpoons m^-}(v) = K^{res}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(\vec{E}_G,\vec{E}_H) = \frac{|m_C^-|c^2}{|m_C^+|c^2} = 1-(v/c)^2 \quad 13.11$$

From eqs. 3.2 and 3.2a, we get:

$$|m_C^+|c^2 = |m_C^+|v^2 + |m_C^-|c^2 \quad 13.12$$

Putting (13.12) to (13.11) after simple transformation, taking into account (2.7), we get:

$$\frac{\hbar^2|m_C^+|^2v^2}{\hbar^2 m_0^2c^2} = \frac{L_0^2}{(L_C^{ext})^2} = \frac{1}{K^{res}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(\vec{E}_G,\vec{E}_H)} - 1 \quad 13.13$$

where the resulting quantized radius of $BVF^{\updownarrow}$, equal to that of sub-elementary fermion (see 1.3b) is dependent on quantum number (n) like:

$$L^{(n)}_{BVF^{\updownarrow}} = \frac{\hbar}{m_0c(2n+1)} \quad 13.14$$

and the radius of standing waves, formed by uncompensated/asymmetric $BVF^{\uparrow}$ or $BVF^{\uparrow}$ with nonzero external group velocity $(v>0)$ and $|m_C^+|>|m_C^-|$:

$$L_C^{ext} = \frac{\hbar}{m_C^+ v} \quad 13.15$$

As far:

$$1/K^{res}_{BVF^{\uparrow}\rightleftharpoons BVF^{\downarrow}}(\vec{E}_G,\vec{E}_H) = K^{res}_{BVF^{\downarrow}\rightleftharpoons BVF^{\uparrow}}(\vec{E}_G,\vec{E}_H) \quad 13.15a$$

we get from (13.13) and (13.14) the dependence of external radius of standing virtual de Broglie wave of asymmetric BVF on quantum number (n):

$$L_C^{ext}(n) = \frac{\hbar}{m_0c(2n+1)} \cdot \frac{1}{[K^{res}_{BVF^{\downarrow}\rightleftharpoons BVF^{\uparrow}}(\vec{E}_G,\vec{E}_H)-1]^{1/2}} \quad 13.16$$

The series of standing waves, formed by asymmetric uncompensated Bivacuum fermions (BVF), corresponding to quantum numbers: $n = 0,1,2,3,4,5,6,7,8,9,10,11,12\ldots$, in accordance to our theory, is responsible for vertical magnetic walls around the rotor with increased magnetic field strength (0.05T) and decreased temperature (6-8 C^0), revealed experimentally by Roshin and Godin (2000).

The maximum of registered walls radius is about 1500 cm, however it leads from our calculations, that the ground $(L_0^e)^{ext}$ radius at $n=0$ may be of L_C^+ =7500 cm or even bigger. Such a walls were not revealed in experiment due to technical difficulties. Assuming that m_0 is a rest mass of most common $e-electron$, it is possible to calculate the value of equilibrium constant $K^{res}_{BVF^{\downarrow}\rightleftharpoons BVF^{\uparrow}}(\vec{E}_G,\vec{E}_H)$, for the latter condition ($n=0$, L_C^+ =7500 cm) from (13.13), as:

$$K^{res}_{BVF^{\downarrow}\rightleftharpoons BVF^{\uparrow}}(\vec{E}_G,\vec{E}_H) = 1 + \left(\frac{L_0}{L_C^+}\right)^2_{n=0} \geqq 1 \quad 13.17$$

It is obvious, that $\left(\frac{L_0}{L_C^+}\right)^2_{n=0} << 1$ and $K^{res}_{BVF^\downarrow \rightleftharpoons BVF^\uparrow}(\vec{E}_G, \vec{E}_H)$ is very close to 1.

From (10.11), knowing $K^{res}_{BVF^\downarrow \rightleftharpoons BVF^\uparrow}(\vec{E}_G, \vec{E}_H) = 1/K^{res}_{BVF^\uparrow \rightleftharpoons BVF^\downarrow}(\vec{E}_G, \vec{E}_H)$ it is easy to calculate the external group velocity of asymmetric/uncompensated BVF, forming 'magnetic walls around convertor under the Lorentz force action:

$$v = c[1 - K^{res}_{BVF^\uparrow \rightleftharpoons BVF^\downarrow}(\vec{E}_G, \vec{E}_H)]^{1/2} \qquad 13.18$$

Corresponding external group velocity of asymmetric BVF, forming walls, evaluated from (13.17 and 13.18), is very low: (20-5)•10^{-5} cm/s.

The average experimental distance between 11 registered magnetic walls:

$$\Delta L_C^{ext} = [L_C^{ext}(n-1) - L_C^{ext}(n)] \sim (50 \div 80)\, cm \qquad 13.19$$

calculated from (13.16) is about 50 cm, increasing from the center to periphery.

The thickness of magnetic walls was about 5-8 cm and their height more than 500 cm. The lower temperature inside the walls, as compared to temperature between them (i.e. the lower kinetic energy of the air molecules), may be a result of increasing of potential energy of electromagnetic Van der Waals interaction between the air molecules due to decreasing of Bivacuum electric permeability (ε_0) in the volume of magnetic walls. The (ε_0) decreasing is a consequence of virtual charge density increasing, defined by enhanced density of asymmetric Bivacuum fermions with uncompensated charge in the volume of their standing waves around rotating magnets. The additional increasing of the intermolecular interaction potential and decreasing of ionization potential in magnetic walls could be a consequence of the air molecules polarizability elevation due to enhanced screening effect of Coulomb interaction between the electrons and protons of the air molecules by charged Bivacuum excitations (asymmetric BVF). The spontaneous [ionization ⇌ recombination] of the air molecules in magnetic walls, as a result of (ε_0) decreasing, may explain the visible photons emission in the region around converter. It is important to note, that in this case the ionization is not induced by collision of molecules or strong external electric potential, like at corona discharge.

The development of technology, based on Searl effect, could be used in future for extraction of 'free energy' of Bivacuum, utilizing its Harmonization force, and for creation of new principles of space propulsion. Consequently, the Searl effect is a result of combination of two relatively independent mechanisms of the convertor interaction with Bivacuum. The self-acceleration is provided by harmonization force of Bivacuum in conditions of pull-in range, close to that of combinational resonance. The weight of convertor decreasing/increasing is a consequence of corresponding Bivacuum dipoles symmetry shift, induced by interaction of rotating magnetic field with Bivacuum fermions and antifermions of opposite magnetic moments and spins. This symmetry shift, in accordance to our theory, is responsible for gravitational interaction.

The ability of our Unified Model to clarify the phenomena, like Searl effect, can be considered, as a criteria of model validity.

14 The Bearden Free Energy Collector

Good descriptions of the Tom Bearden (2000 - 2002) free energy collector, as a part of motionless electromagnetic generator (MEG) action principle, has been presented by Naudin (2001) and by Squires (2000).

The interesting attempt for theoretical background of extracting energy from vacuum has been done in work of Myron Evans (2002), using Sachs theory of electrodynamics (Sachs, 2002), unifying the gravitational and electromagnetic fields. In this theory both fields are their own sources of energy: the equivalent to mass and equivalent to 4-cuurrent, correspondingly. The electromagnetic field influence the gravitational field and vice versa. The Sachs theory cannot be reduced to the Maxwell-Heviside theory. The Evans (2002) comes to conclusion that just because of existence of space-time curvature (always pertinent for our secondary Bivacuum), any kind of dipole (like our sub-elementary particles F$^{\updownarrow}$) can be used for extracting of energy from space. The idea of dipole, as a free energy transmitter, has been developed by Bearden (2000).

In accordance to our Unified model (UM), origination of the rest mass (m_0^i), is a result of Bivacuum dipoles symmetry shift due to their spinning with angle frequency, equal to that of Golden mean: $\omega_0^i = m_0^i c^2/\hbar$.

The energy of quantum beats between corresponding actual and complementary states is:

$$E_0 = \hbar\omega_0 = (m_C^+ - m_C^-)^\phi c^2 = m_0 c^2 = (2T_k)_{rot}^\phi = m_0\omega_0^2 L_0^2 \qquad 14.1$$

the source of free energy is the Bivacuum dipoles symmetry shift, induced by their longitudinal and transverse vibrations, responsible, correspondingly for electromagnetic and gravitational interaction (see Chapter 8):

$$E_{el} = \alpha(m_C^+ - m_C^-)_{\|tr} c^2 = (2T_k)_{\|tr} = m_C^+(v^2)_{\|tr} \qquad 14.1a$$

$$E_G = \beta(m_C^+ - m_C^-)_{\perp tr} c^2 = (2T_k)_{\perp tr} = m_C^+(v^2)_{\perp tr} \qquad 14.1b$$

where: $\alpha = e^2/\hbar c$ and $\beta = (m/M_{Pl})^2$ are the electromagnetic and gravitational fine structure constants, correspondingly (8.2b).

For Bearden MEG, like for Searl machine the formulae (13.1-13.1a) are valid.

The energy conservation law in form of compensation principle of Bivacuum symmetry shifts, generated by particles and fields has a shape (11.17):

$$\sum^{n=N} [m_C^+\omega_{rot}^2 L_{rot}^2]_n^i + \sum^{n=N} \left[m_C^+ v_{\|tr}^2 \right]_n^i + \sum^{n=N} [m_C^+ v_{\perp tr}^2]_n^i \qquad 14.2$$

$$= -\sum^{k=\infty} [\Delta m_V^S c^2]_k^i + \sum^{k=\infty} [\Delta m_V^E c^2]_k^i + \sum^{k=\infty} [\Delta m_V^G c^2]_k^i = \qquad 14.2a$$

$$= - = -\beta m_0^i c^2 \sum^{k=\infty} \ln[K_{\mathbf{S}(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i} K_{\mathbf{E}(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i} K_{\mathbf{G}(BVF^\uparrow \rightleftharpoons BVF^\downarrow)^i}] \qquad 14.2b$$

The Harmonization energy (E_{HaE}^i) and force (F_{HaF}^i), responsible for realization of the principle of least action, when the actual kinetic energy of particles tends to Golden mean condition: $|m_C^+(v_{gr}^{ext})^2 - m_0 c^2|^i \to 0$ (see Chapter 5 and 6), can be expressed as:

$$E_{HaE}^i = F_{HaF}^i \lambda_{VPW^\pm}^i = |m_C^+(v_{gr}^{ext})^2 - m_0 c^2|^i = \hbar|\omega_{C\rightleftharpoons W} - \omega_0|^i \qquad 14.3$$

Let us analyze, how the enhancement of Bivacuum dipoles symmetry shift ($\Delta m_C = |m_C^+ - m_C^-|$), generated by the local permanent magnetic, electric and gravitational fields (see section 13.1*) can increase the electric current, as it follows from our Unified model:*

1. By increasing the conducting electrons resulting group velocity (v) and their kinetic energy ($m_C^+ v^2$), as far from (14.1a):

$$E_{el} = \left[\alpha\Delta m_C c^2 = \alpha m_C^+ v^2 = \frac{\alpha m_0 v^2}{[1-(v/c)^2]^{1/2}} \right]_{\|tr} \qquad 14.4$$

2. By increasing the actual electric charge (e_+), with resulting group velocity (v) increasing, as far from (4.2):

$$\frac{e_+}{e} = \frac{1}{[1-(v/c)^2]^{1/4}} \qquad 14.5$$

3. By increasing the frequency of the dipoles: $[e_+ + e_-]$ and $[\mu_+ + \mu_-]$ radiation, equal to frequency of $[C \rightleftharpoons W]$ pulsation (see 3.2 and 14.1):

$$\omega_{C \rightleftharpoons W} = \frac{|m_C^+ - m_C^-|_{rot} c^2}{\hbar} \quad 14.6$$

4. Decreasing of the electrons entropy, dissipation process and, consequently, resistance, as result of the [electrons + ion lattice] of the conductor or semiconductor dynamics coherency increasing. This may happens under the Harmonization force (HaF) influence on matter, improving the conditions for Bose condensation of the electrons of Cooper pairs and ions in form of coherent clusters. The latter phenomena has been discussed in our Hierarchic theory of superconductivity (Kaivarainen, 2000).

In MEG the activation of the [electrons+ions] of 'collector' - degenerate semi-conductor occur in short-living nonequilibrium states, induced by periodic action of the ramp generator in combination with permanent magnetic field action. Such asymmetry of Bivacuum and nonequilibrium of matter is necessary for MEG action with coefficient of performance: COP>1 (Naudin, 2001; Bearden, 2002). The MEG works on the principle water-mill, using the gravitational potential, related directly to Bivacuum asymmetry.

The COP is not the same as *efficiency*, which is always less, than 100%. It means, that the 'free energy' devices are not violating the law of energy conservation and have nothing common with *perpetual mobile*.

15 Conclusion

Unified Model (UM) represents the next stage of our efforts for unification of vacuum, matter and fields from few ground postulates. New concept of Bivacuum is introduced, as a dynamic matrix of the Universe with superfluid and nonlocal properties, composed from non mixing *microscopic* sub-quantum particles of the opposite energies. The *mesoscopic* structure of Bivacuum is presented by infinitive number of three-dimensional (3D) *double cells*, each cell containing a pair of correlated rotors and antirotors: (V^+) and (V^-) of the opposite quantized energy, virtual mass, spin, charge and magnetic moments.

Bivacuum has a properties of the active medium with double cells, as the active elements. In such a medium the Virtual Pressure Waves (VPW^+ and VPW^-) can behave as the autowaves, able to different kinds of self-organization under the influence of Virtual replica (VR) of matter, including biological systems.

The matter in form of sub-elementary particles/antiparticles is a result of Bivacuum cells symmetry shift towards the positive or negative energy, correspondingly. Certain combinations of triplets of sub-elementary particles/antiparticles form elementary particles and antiparticles, like electrons, positrons, photons and quarks. The [corpuscle (C) - wave (W)] duality is a result of quantum beats between the 'actual' and 'complementary' states of sub-elementary particles/antiparticles. The [C] phase represents mass, electric and magnetic dipoles. The [W] phase exists in form of Cumulative virtual cloud (CVC) of sub-quantum particles. The energy and momentum of [C] and [W] phase are equal. The part of CVC energy, determined by fine structure constant, stands for virtual photons, responsible for interaction between charged particles (i.e. electrons, positrons). They are result of dipole radiation, generated by $[C \rightleftharpoons W]$ oscillation of uncompensated sub-elementary particles and antiparticles if triplets. The Virtual Replica (VR) of matter is a result of nonlinear interaction of $\mathrm{VPW}^\pm$ of Bivacuum with those, generated by $[C \rightleftharpoons W]$ pulsation of elementary particles, forming atoms and molecules of matter.

"Harmonization influence" of Bivacuum on matter properties is a result of induced resonance between virtual pressure waves ($\mathrm{VPW}^\pm$) of positive and negative vacuum and $[C \rightleftharpoons W]$ pulsation of symmetric pairs of sub-elementary particles and antiparticles, forming electrons, positrons, quarks, etc. The fundamental Harmonization frequencies of $\mathrm{VPW}^\pm$ are defined by the rest mass of the electrons of three electron generation: $\omega_0^{e,\mu,\tau} = m_0^{e,\mu,\tau} c^2/\hbar$, as postulated in UM. For the other hand, it is shown in our work, that the energy of sub-elementary particles, defined by the rest mass of the electrons of three generation $(E_C = E_W = m_0 c^2 = \hbar\omega_0)^{e,\mu,\tau}$, correspond to Golden mean conditions, when the ratio of external group velocity to the light one is:

$(v^{\phi}/c)^2 = \phi = 0.618$.

It is demonstrated also, that realization of principle of Least action can be a result of Bivacuum Harmonization force action on particles dynamics. It is shown, that the pace of time for any closed system is determined by pace of kinetic energy change of this system, i.e. by change of its mass and spatial characteristics in accordance to special theory of relativity. The time oscillation (temporal field) is related in elegant symmetrical way to oscillation of electromagnetic and gravitational fields.

It is useful to summarize the properties of *symmetric primordial Bivacuum and asymmetric secondary Bivacuum*, existing in presence of matter and fields. *The primordial Bivacuum* is formed by symmetric double cells dipoles, each pole representing the Compton radius vortex . The external group velocity of Bivacuum dipoles is zero, making possible their infinitive virtual Bose condensation, providing nonlocal properties of Bivacuum. The internal group and phase velocity of sub-quantum particles and sub-quantum antiparticles, composing each dipole, are equal to light velocity. The difference between the actual (m_C^+) and complementary (m_C^-) mass is zero, consequently the frequency of quantum beats between corresponding states also is zero.

The difference between the actual and complementary charge and between corresponding magnetic moments of symmetric Bivacuum dipoles are also zero. As a consequence, no rest mass, no electromagnetic and gravitational fields exists in primordial Bivacuum.

For the other hand, the situation in secondary Bivacuum is different. It is formed by strongly and locally asymmetric cell-dipoles, representing sub-elementary particles and antiparticles and their coherent triplets. The local asymmetry of matter is compensated by non-local and opposite asymmetry of Bivacuum fermions and Bivacuum antifermions and shift of their dynamic equilibrium:

$$BVF^{\uparrow} \rightleftharpoons BVF^{\downarrow} \qquad 15.1$$

The internal circulation group and phase velocities of the actual vortex and complementary rotor of sub-elementary fermions/antifermions are equal to external ones, providing the Hidden harmony and Golden mean conditions (section 4.2):

$$v_{gr}^{in} = v_{gr}^{ext}; \quad v_{ph}^{in} = v_{ph}^{ext}; \quad (v_{gr}^{\phi}/c)^2 = (v_{gr}/v_{ph})^{\phi} = \phi \qquad 15.2$$

This condition determines the difference between the actual and complementary mass/energy, equal to the rest mass of elementary particle and frequency of [C$\rightleftharpoons$ *W*] pulsation, corresponding to resonant interaction with fundamental oscillation of Bivacuum:

$$|m_C^+ - m_C^-|^{\phi}c^2 = m_0c^2 = \hbar\omega_0 \qquad 15.3$$

the difference between the actual and complementary charge at Golden mean conditions (15.2) is:

$$|e_+ - e_-|^{\phi} = \phi e \qquad 15.4$$

However, the difference between the actual and complementary magnetic moments remains unchanged and equal to zero, like in primordial Bivacuum dipoles. Due to symmetry compensation mechanisms, the total energy of secondary Bivacuum, like in primordial one also keeps unchanged and equal to zero.

The nonlocal quantum entanglement between particles of coherent $[C \rightleftharpoons W]$ pulsation has a mechanism of resonant exchange interaction, mediated by nonlocal Bivacuum symmetry oscillations, accompanied the pulsation. The correctness of our UM is confirmed by good coincidence between calculated and experimental values of magnetic moments of the electron. In accordance to UM, a small deviation from the Bohr's magneton is due to longitudinal zero-point oscillation and corresponding group velocity ($v_{\|0}$) of the electron. The new physical constant *"longitudinal zero-point factor"*: $z = (\alpha\phi)^{1/2} = (v_{\|0}/c) = 0.06715608$, where $\alpha = e^2/\hbar c = 0.0072973$ is the electromagnetic fine structure constant and $(\phi = 0.618)$ is Golden mean, has been introduced.

The longitudinal zero-point oscillations of elementary charges are responsible for electromagnetism and transversal zero-point oscillations for gravitation in contrast to their rotation, creating the rest mass at Golden mean conditions.

The explanation of Searl and Bearden 'free' energy machines action, compatible with energy conservation law, is proposed.

Acknowledgements.

I am grateful to Prof. Erkki Soini and Prof. Jyrki Kauppinen (University of Turku, Finland) for support during preparation of this upgraded version of Unified model. My appreciation also to Dr. S. Godin (Moscow) for additional information, related to experimental verification of the Searl effect.

References

Aspect A., Dalibard J. and Roger G. (1982). Phys.Rev.Lett. , 49, 1804.

Aspect A. and Grangier P. (1983). Experiments on Einstein-Podolsky-Rosen type correlations with pairs of visible photons. In: Quantum Theory and Measurement. Eds. Wheeler J.A., Zurek W.H. Princeton University Press.

Barut A. O. and Bracken A.J., Phys. Rev. D. 23, (10), 1981.

Baurov A. Yu., Ogarkov B.M. (1994) Method of generating mechanical and embodiments of a device for carrying outside method. The international application PCT/RU/94/00135 from 23.06.94.

Bearden T.E. (2001). Extracting and using electromagnetic energy from the active vacuum. In: Modern nonlinear optics, 2nd ed. M.W. Evans (ed), Wiley, vol. 2, p. 639-698.

Berestetski V., Lifshitz E., Pitaevskii L. (1989). Quantum electrodynamics. Nauka, Moscow (in Russian).

Bohm D. (1987). Hidden variables and the implicate order. In: Quantum implications, ed Basil J. Hiley and F.D.Peat, London: Routledge & Kegan Paul.

Bohm D. and Hiley B.J. (1993). The Undivided Universe. An ontological interpretation of quantum theory. Routledge. London, New York.

Cramer J.G. (2001). The transactional interpretation of quantum mechanics. In: Computing Anticipatory Systems, CASYS'2000, 4th International conference, ed by D.M. Dubois, AIP, Conference Proceedings, v.573, pp. 132-138.

Dirac P. (1958). The Principles of Quantum Mechanics, Claredon Press, Oxford.

Dubois D. (1999). Computational derivation of quantum and relativist systems with forward-backward space-time shifts. In: Computing anticipatory systems. CASYS'98, 2nd International conference, ed. by D.M. Dubois, AIP, Woodbury, New York, Conference Proceedings, pp.435-456; CASYS'99, 3d International conference, ed by D.M. Dubois, AIP, Conference Proceedings, 2000.

Einstein A. (1965). Collection of works. Nauka, Moscow (in Russian).

Einstein A., Podolsky B. and Rosen N. (1935). Phys. Rev., 47, 777.

Evans M.W. (2002). The link between the Sachs and 0(3) theories of electrodynamics. ISBN 0-471-38931-5.

Evans M.W., Anastasovski P.K., Bearden T.E., et al., (2001). Explanation of the motionless electromagnetic with the Sachs theory of electrodynamics. Foundations of physics letters, 14(4), 387-393.

Feynman R. (1985). QED - The strange theory of light and matter. Princeton University Press, Princeton, New Jersey.

Glansdorf P., Prigogine I. Thermodynamic theory of structure, stability and fluctuations. Wiley and Sons, N.Y., 1971.

Grawford F.S. Waves. Berkley Physics Course. Vol.3. McGraw- Hill Book Co., N.Y., 1973.

Haake F. Quantum signatures of chaos. Springer, Berlin, 1991.

Haisch B., Rueda A. and Puthoff H.E. Physics of the zero-point field: Implications for inertia, gravitation and mass. Speculations in science and technology, vol.20, pp. 99-114.

Haken H. Synergetics, computers and cognition. Springer, Berlin, 1990.

Hawking S.W. A brief history of time. Bantam Press, Toronto, N.Y., London, 1988.

Hestenes D. Found of Phys, 20(10), 1990.

Jin D.Z., Dubin D.H. E. (2000). Characteristics of two-dimensional turbulence that self-organizes into vortex crystals. Phys. Rev. Lett., 84(7), 1443-1447.

Kaivarainen A. (1993). Dynamic model of wave-particle duality and Grand unification. University

of Joensuu, Finland, 118 p.
Kaivarainen A. (1995). Hierarchic Concept of Matter and Field. Water, biosystems and elementary particles. New York, NY, pp. 485, ISBN 0-9642557-0-7.
Kaivarainen A. (2001a). Bivacuum, sub-elementary particles and dynamic model of corpuscle-wave duality.
CASYS: Int. J. of Computing Anticipatory Systems, (ed. D. Dubois) v.10, 121-142.
Kaivarainen A. (2001b). New Hierarchic theory of condensed matter and its computerized application to water and ice. In the Archives of Los-Alamos:
http://arXiv.org/abs/physics/0102086.
Kaivarainen A. (2001c). Hierarchic theory of matter, general for liquids and solids: ice, water and phase transitions. American Institute of Physics (AIP) Conference Proceedings (ed. D.Dubois), vol. 573, 181-200.
Kaivarainen A. (2001d), Unified Model of Bivacuum, Matter & Fields, as a Background for Quantum Psi Phenomena. Archives of Los-Alamos: http://arXiv.org/abs/physics/0103031.
Kaivarainen A. (2002a). Unified Model of Bivacuum, Corpuscle - Wave Duality, Electromagnetism, Gravitation & Time. Archives of Los-Alamos:
http://arXiv.org/abs/physics/0112027
Kiehn R.M. (1998). The Falaco Soliton: Cosmic strings in a swimming pool ;
Coherent structures in fluids are deformable topological torsion defects. At: IUTAM-SMFLO conf. at DTU, Denmark, May 25, 1997; URL: http://www.uh.edu/~rkiehn
Krasnoholovets V. On the nature of spin, inertia and gravity of a moving canonical particle. Indian journal of theoretical physics, 48, no.2, pp. 97-132, 2000.
von Neuman J. (1955). Mathematical foundations of quantum mechanics, chapter 4, Princeton University Press, Princeton.
Naudin J–L. (2001) The Tom Bearden free energy collector principle. JLN Labs.
Patrick S., Bearden T., Hayes J., Moore K., Kenny J. (March, 2002), US Patent 6,362,718: Motionless Electromagnetic Generator MEG).
Penrose R. The Emperor's New Mind. Oxford University Press, London. 1989.
Penrose R. Shadows of the Mind. Oxford University Press, London, 1994.
Peres A. Quantum theory: Concepts and Methods. Kluwer Acad. Publ. Dordrecht, 1993.
Puthoff H.E. (1989a). Gravity as a Zero-Point-Fluctuation Force. Phys.Rev.A., 39(5), 2333.
Puthoff H.E. (1989b). Source of vacuum electromagnetic zero-point energy.
Phys.Rev.A., 40(9), 4857.
Roshin V.V. and Godin S.M. (2000). An experimental investigation of the physical effects in dynamic magnetic system. Technical Physics Letters, 26, (5), pp.1105-1107.
Rueda A., Haish B. (2001). A vacuum-generated inertia reaction force. In: Computing Anticipatory Systems, CASYS'2000, 4th International conference, ed by D.M. Dubois, AIP, Conference Proceedings, v.573, pp. 89-97.
Schecter D. A. and Dubin D. (1999). Vortex motion driven by background vorticity gradient. Phys. Rev. Lett., 83 (11), 2191-2193.
Sidharth B.G. The Universe of Fluctuations: http://xxx.lanl.gov/abs/quant-ph/9808031;
The Universe of Chaos and Quanta: http://xxx.lanl.gov/abs/quant-ph/9902028
Smith T. Compton Radius Vortex in: http://www.innerx.net/personal/tsmith/TShome.html