4 Excited states of spherical vacuum formation cores

Basics of stochastic (quantum) metaphysics

4.1 Introduction

From the standpoint of the Algebra of Signatures and light-geometry of the vacuum presented in the previous Chapters, in this Chapter the following results are obtained:

- the excited states of cores of spherically symmetric vacuum formations are considered;
- the principles of Stochastic (quantum) metaphysics in the framework of the full geometrization of the physical views of the Clifford - Einstein - Wheeler are laid down.
- metric-statistical model representations of the second and third generations of the "leptons" ("muons", τ -"leptons") and *c, s, t, b* - "quarks" are proposed.

Fig. 4.1.1. Fractal illustration of the core (nucleus) of a spherically symmetric vacuum formation

Recall that in the Algebra of Signatures (Alsigna), particle names are given in angle quotation marks (guillemets), for example, «electron», «muon», etc. because metric-dynamic models of these vacuum formations in the light-geometry of the Alsigna are considerably different from those of the Standard Model or String Theory. Further explanation is given in the Appendix ("Definitions of the stochastic metaphysics"), which contains explanations of other special terms and notation used in this paper.

4.2 States of internal "particelle" inside the core of a vacuum formation

Let's first consider the behavior of an internal "particelle" inside the core of a spherical vacuum formation, for example, an «electron» (Figures 2.6.3, 3.2 or 4.2.1).

Note that in the Algebra of Signatures metric-dynamic model of a free «electron» (or e$^-$-«quark») is defined by a set of metrics (4.2.1) {see (2.6.22)}, which are solutions of Einstein's field equations (2.6.21).

«ELECTRON» (4.2.1)

"Convex" multilayer vacuum formation with signature (+ – – –)
consisting of:

The outer shell of the "electron"
(in the interval [r_1, r_6], Fig. 4.2.1),
defined by a set of four metrics

$$ds_1^{(+---)2} = \left(1 - \frac{r_6}{r} + \frac{r^2}{r_1^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_6}{r} + \frac{r^2}{r_1^2}\right)} - r^2\left(d\theta^2 + \sin^2\theta\, d\varphi^2\right),$$

$$ds_2^{(+---)2} = \left(1 + \frac{r_6}{r} - \frac{r^2}{r_1^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_6}{r} - \frac{r^2}{r_1^2}\right)} - r^2\left(d\theta^2 + \sin^2\theta\, d\varphi^2\right),$$

$$ds_3^{(+---)2} = \left(1 - \frac{r_6}{r} - \frac{r^2}{r_1^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_6}{r} - \frac{r^2}{r_1^2}\right)} - r^2\left(d\theta^2 + \sin^2\theta\, d\varphi^2\right),$$

$$ds_4^{(+---)2} = \left(1 + \frac{r_6}{r} + \frac{r^2}{r_1^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_6}{r} + \frac{r^2}{r_1^2}\right)} - r^2\left(d\theta^2 + \sin^2\theta\, d\varphi^2\right).$$

The core of the «electron»
(in the interval [r_6, r_7], Fig. 4.2.1),
defined by a set of four metrics

$$ds_1^{(+---)2} = \left(1 - \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} - r^2\left(d\theta^2 + \sin^2\theta\, d\varphi^2\right),$$

$$ds_2^{(+---)2} = \left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} - r^2\left(d\theta^2 + \sin^2\theta\, d\varphi^2\right),$$

$$ds_3^{(+---)2} = \left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} - r^2\left(d\theta^2 + \sin^2\theta\, d\varphi^2\right),$$

$$ds_4^{(+---)2} = \left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} - r^2\left(d\theta^2 + \sin^2\theta\, d\varphi^2\right).$$

The scope of the «electron»
in the interval [0, ∞] (Fig. 4.2.1)

$$ds_5^{(+---)2} = c^2dt^2 - dr^2 - r^2\left(d\theta^2 + \sin^2\theta\, d\varphi^2\right).$$

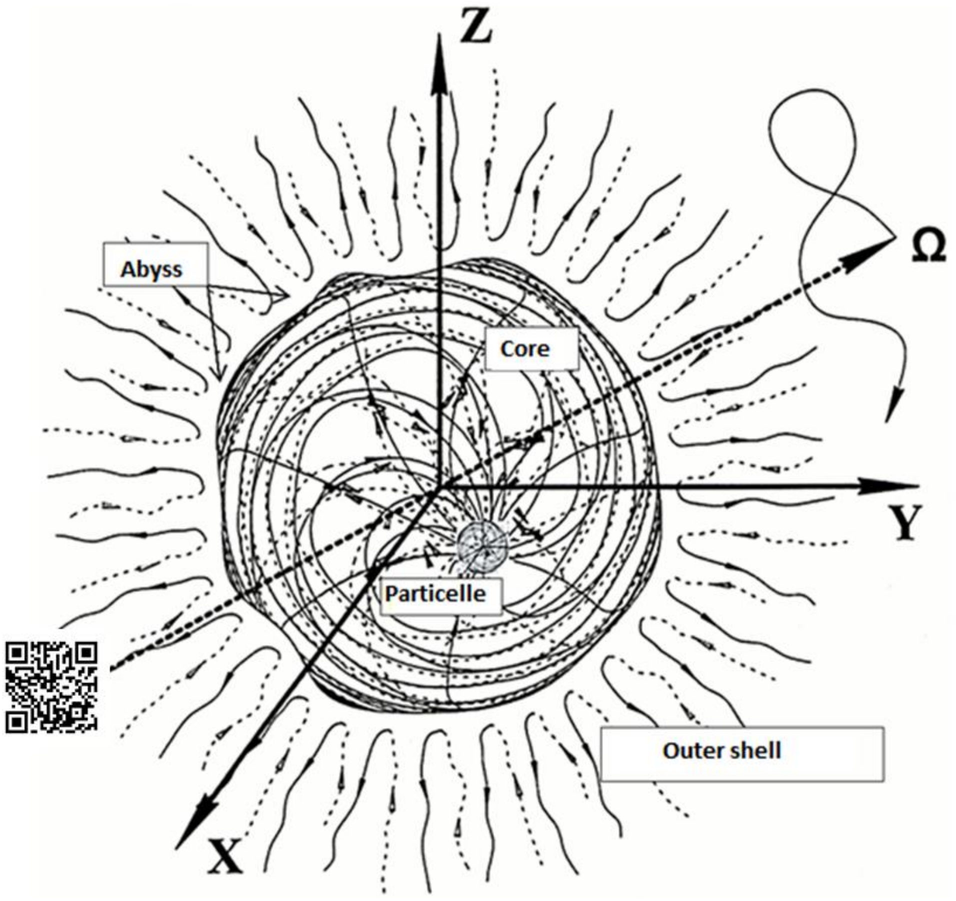


Fig. 4.2.1. 3D-image of a free «electron», where, in line with the terms of the hierarchy (2.6.20):
– The core of the «electron» is a closed spherical vacuum formation with radius $r_6 \sim 1.7 \cdot 10^{-13}$ cm;
– The outer shell of the «electron» is a radially deformed spherically symmetric vacuum formation, extending from the «electron's» core to the boundary of inner core of the Universe with radius $r_1 \sim 3.4 \cdot 10^{39}$ cm;
– The internal particle is the core of a "protoquark" (a minuscule analogue of the «electron's» core) with radius $r_7 \sim 5.8 \cdot 10^{-24}$ cm, which is located inside the core of the «electron»;
– The abyss is a multilayer boundary between the outer shell and the core of the «electron»;
– The scope is a kind of memory of the undeformed state of the vacuum area considered here.

Figure 4.2.1 presents a 3D metric-dynamic image of the core of «electron» (i.e. a closed spherical vacuum formation) and its surroundings (outer vacuum shell), which was created in Chapter 2 (see Figure 2.6.3) and earlier in [20, 22] by analyzing a set of metrics (4.2.1).

Let's assume that the internal "particelle" (the size of which can be neglected here) is in a continuous chaotic motion around the center of the core of the «electron», which in our case coincides with the origin of the coordinate system *XYZ* (Figure 4.2.1). The probable cause of such chaotic motion of the internal "particelle" can be inherent vacuum perturbations, which permanently influence the jellylike core of the «electron».

Chaotic motion of the internal "particelle" is incessant since its total mechanical energy, E_p, remains, on the average, constant {*see (3.6) and (3.15)*}:

$$<E_p> = <T_p\,(x,y,z,t)> \; + \; <U_p\,(x,y,z,t)> = const, \tag{4.2.2}$$

where

$<T_p(x,y,z,t)>$ – average kinetic energy of the internal “particelle” associated with its speed;

$<U_p(x,y,z,t)>$ – average potential energy of the internal “particelle” associated with the vacuum's elastic properties; the zero potential is in the center of the «electron's» core.

Analysis of the internal particelle's chaotic motion in Chapter 3 led to the derivation of the generalized Schrödinger equation (3.102)

$$i\frac{\partial\psi(\vec{r},t)}{\partial t} = -\frac{\eta_{par}}{2}\frac{\partial^2\psi(\vec{r},t)}{\partial r^2} + U(\vec{r},t)\,\psi(\vec{r},t)\ , \tag{4.2.3}$$

where $\psi(\vec{r},t) = \psi(x,y,z,t)$ – a wave function, the squared modulus of which is a function of the probability density of the location of a wandering internal “particelle”;

$U(\vec{r},t) = <Up(x,y,z,t)>$ – average potential energy of an internal “particelle”;

$$\eta_{par} = \frac{2\sigma^2_{par,r}}{\tau_{par,r}} = \frac{\hbar}{m_p} \text{ – inertia factor of internal particelle (3.103),} \tag{4.2.4}$$

$\hbar = 1.055\cdot10^{-34}$ J·s – Planck's constant;

m_p – mass of the internal particelle.

whereby

$$\sigma_{par,r} = \frac{1}{3}\sqrt{\sigma^2_{par,x} + \sigma^2_{par,y} + \sigma^2_{par,z}} \tag{4.2.5}$$

is the mean standard deviation of the positions of particles (material "points") in chaotic motion around the point of reference acting as "center" (Figures 4.2.1 and 4.2.2), while

$$\tau_{par,r} = \frac{1}{3}(\tau_{par,x} + \tau_{par,y} + \tau_{par,z})$$

is the mean correlation (or rather autocorrelation) radius of this stochastic process.

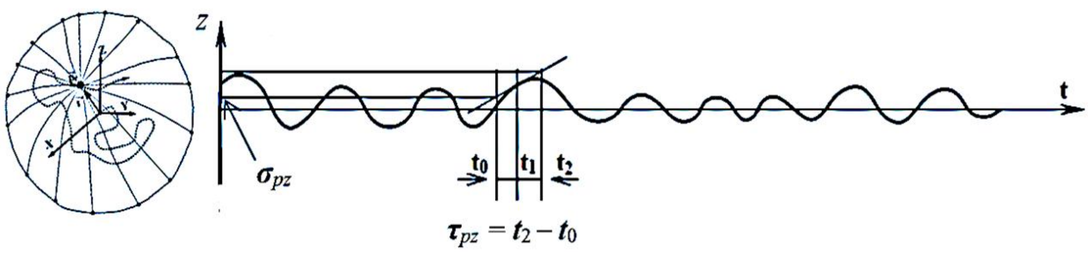


Fig. 4.2.2. Projections of a chaotically wandering internal “particelle” plotted on the Z axis against time *t*, where $\sigma_{par\,z}$, $\tau_{par\,z}$ are the root-mean-square deviation and autocorrelation radius, resp., of this random process

Furthermore, E_p, T_p and U_p, i.e. values expressed in terms of mass units, are replaced with the following massless values in the Algebra of Signatures:

$\varepsilon_P = \frac{E_p}{m_p}$ – total mechanical *energium* of the internal particelle; (4.2.6)

$t_P = \frac{T_p}{m_p}$ – kinetic *energium* of the internal particelle; (4.2.7)

$u_P = \frac{U_p}{m_p}$ – potential *energium* of the internal particelle. (4.2.8)

In this case, equation (4.2.2) can be rewritten as follows:

$$<\varepsilon_p> = <t_p\,(x,y,z,t)> + <u_p\,(x,y,z,t)> = const\,, \tag{4.2.9}$$

and the Schrödinger equation (4.2.3), taking (4.2.8) into account, becomes massless

$$i\frac{\partial\psi(\vec{r},t)}{\partial t} = -\frac{\eta_{par}}{2}\frac{\partial^2\psi(\vec{r},t)}{\partial r^2} + <u_p(\vec{r},t)>\psi(\vec{r},t). \tag{4.2.10}$$

In line with the initial condition (4.2.9), we consider a stationary case where an internal "particelle" is moving around the center of the core of the «electron» and where all average characteristics of this random process, including σ_{par} and τ_{par}, are time-independent. Therefore, the wave function of the internal "particelle" can be expressed as follows:

$$\psi(\vec{r},t) = \psi(x,y,z)\exp\left\{-i\frac{E_p t}{\hbar}\right\} = \psi(\vec{r})\exp\left\{-i\frac{m_p\varepsilon_p t}{\hbar}\right\} = \psi(\vec{r})\exp\left\{-i\frac{\varepsilon_p t}{\eta_{par}}\right\}, \tag{4.2.11}$$

in this case, the massless Schrödinger equation (4.2.10) is simplified to

$$\varepsilon_p\psi(\vec{r}) = -\frac{\eta_{par}^2}{2}\frac{\partial^2\psi(\vec{r})}{\partial r^2} + <u_p(\vec{r})>\psi(\vec{r}), \tag{4.2.12}$$

where $<u_p(\vec{r})>$ is the average time independent potential *energium* of the internal "particelle".

Equations similar to (4.2.12) are well known in quantum mechanics. For convenience, we will present its solutions, referring to monographs [13, 37].

4.3 Internal "particelle" in a potential well

Within the framework of the model considered here, an internal "particelle" with radius $r_7 \sim 5.8\cdot10^{-24}$ cm is confined inside the core of the «electron» with radius $r_6 \sim 1.7\cdot10^{-13}$ cm (Figure 4.2.1). Therefore, the average potential *energium* of the internal "particelle" can be expressed as a "potential well."

$$< u_p\,(\vec{r}) >= \begin{cases} 0\,, & for\; 0 \le r \le 2r_6, \\ \infty, & for\; r > 0\; or\;\; r > 2r_6\,. \end{cases} \tag{4.3.1}$$

Analyzing equation (4.2.12) by taking (4.3.1) into account, we obtain the following discrete sequence of eigenvalues of total mechanical *energium* of the internal “particelle” [13]

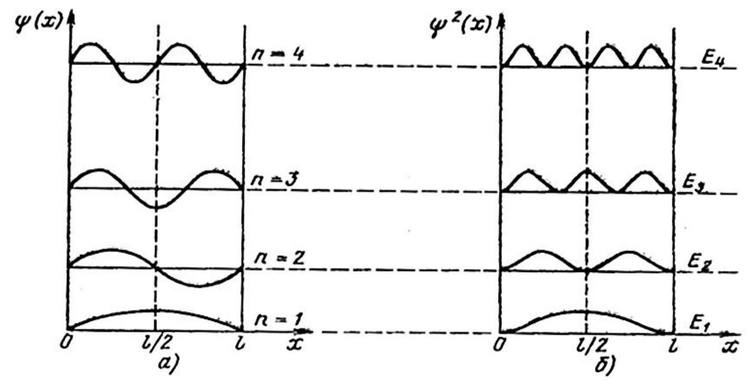
$$\varepsilon_{pn} = \frac{\pi^2 \eta_p^2}{8 r_6^2} n^2 \text{ , (Figure 4.3.1 c)} \tag{4.3.2}$$

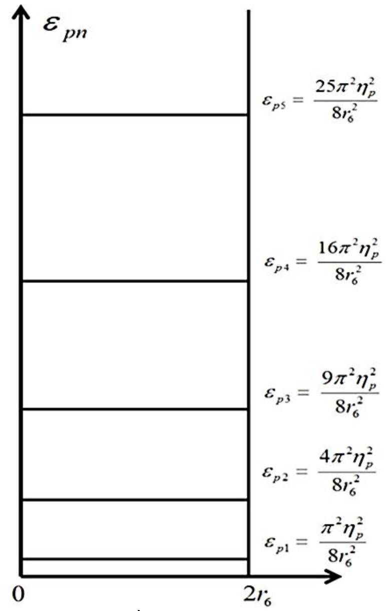
where n = 1, 2, 3, ... is the principal quantum number.

Eigenfunctions for the respective *energium* levels (4.3.2), i.e. solutions of equation (4.2.12) with average potential *energium* (4.3.1), will be the same as in [13]

$$\psi_n(r) = \sqrt{\frac{1}{r_6}} \sin\left(\frac{n\pi r}{2r_6}\right). \tag{4.3.3}$$

Graphs of functions (4.3.3) and graphs of their squared moduli are given in Figure 4.3.1 *(a,b)*





c)

Fig. 4.3.1. *a*) Wave functions for different excited states of the internal “particelle” in the core of the «electron», where $l = 2r_6$; *b*) The squared modulus of the wave function, i.e. the probability density of the internal “particelle's” location inside the core of the «electron» for its different excited states; c) levels of the internal “particelle's” total mechanical *energium* in a potential well

As follows from the functions illustrated in Figure 4.3.1 *b*, the center of the core of the «electron» is the most probable location of the internal “particelle” for n = 1. However, in an excited state, for example, when n = 2, the internal “particelle” is most likely located at an definite distance from the center of the «electron's» core.

4.4 Internal particelle in elastically strained vacuum environment

Let's consider the second case, when removing an internal “particelle” from the center of the "electron’s" core in the surrounding it vacuum there are elastic "tension", which tend to return internal “particelle” to the original center (rice. 4.2.1).

In the massless metraphysics developed herein, the notion of “tension” of a vacuum area corresponds to the post-Newtonian notion of “strain” in a limited area of a continuous medium. It is im-

portant to note that the dimensionality of geometrized "tension" does not include a unit of mass (kilogram).

Assume that the elastic vacuum tensions, σ_v, increase, on the average, proportionally to the "particelle's" distance from the center of the «electron's» core

$$< \sigma_v(\vec{r}) > \approx k_u r, \tag{4.4.1}$$

where k_u is a massless factor of the vacuum's elastic tension. Then, the "particelle's" average potential *energium* can be approximated as

$$< u_p(\vec{r}) > \approx \int k_u r dr = \frac{1}{2} k_u r^2. \tag{4.4.2}$$

Substituting (4.4.2) into (4.2.12), we obtain the well-known "quantum harmonic oscillator" equation

$$\varepsilon_p \psi(\vec{r}) = -\frac{\eta_{par}^2}{2} \frac{\partial^2 \psi(\vec{r})}{\partial r^2} + \frac{k_u r^2}{2} \psi(\vec{r}). \tag{4.4.3}$$

Study of that equation leads to the following discrete expansion of eigenvalues of the "particelle's" total mechanical *energium* [13]:

$$\varepsilon_{pn} = \eta_{par} \sqrt{\frac{1}{k_u}} \left(n + \frac{1}{2} \right), \text{ (Figure 4.4.1)} \tag{4.4.4}$$

where n = 1, 2, 3, ... is the principal quantum number. Corresponding to each discrete value of total mechanical energium (4.4.4) is a specific eigenfunction [13]:

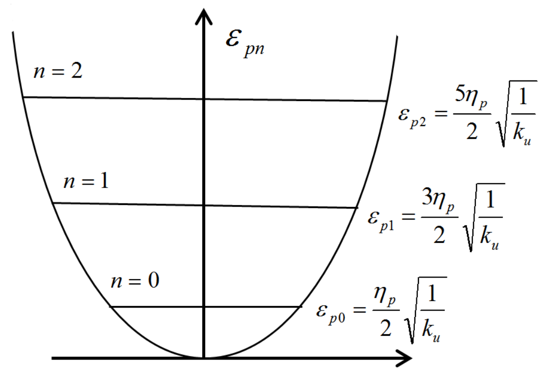


Fig. 4.4.1. Equidistant levels of the total mechanical energy of the ε_{pn} quantum harmonic oscillator

$$\psi_n(r) = \frac{1}{\sqrt{\lambda_0}} \exp\left\{ -\frac{r^2}{2} \right\} H_n(r), \tag{4.4.5}$$

where

$$H_n(r) = \frac{(-1)^n}{\sqrt{2^n n! \sqrt{\pi}}} e^{r^2} \frac{\partial^n e^{-r^2}}{\partial r^n} \tag{4.4.6}$$

is a n^{th} degree Chebychev-Hermite polynomial, where λ_0 is equal to

$$\lambda_0 = \sqrt{\frac{\eta_{par}}{k_u}}. \tag{4.4.7}$$

Now, let's define several eigenfunctions (4.4.5), describing various average behaviors of a randomly wandering "particelle", whose deviations from the center of the «electron's» core (Figure 4.2.1) cause elastic tensions in the surrounding vacuum [13, 37]

$$\psi_0(r)=\frac{1}{\sqrt{\lambda_0\sqrt{\pi}}}\exp\left\{-\frac{r^2}{2\lambda_0^2}\right\}, \quad where \quad n=0; \tag{4.4.8}$$

$$\psi_1(r)=\frac{1}{\sqrt{2\lambda_0\sqrt{\pi}}}\exp\left\{-\frac{r^2}{2\lambda_0^2}\right\}\frac{2r}{\lambda_0}, \quad where \quad n=1; \tag{4.4.9}$$

$$\psi_2(r)=\frac{1}{\sqrt{8\lambda_0\sqrt{\pi}}}\exp\left\{-\frac{r^2}{2\lambda_0^2}\right\}(\frac{4r^2}{\lambda_0^2}-2), \quad where \quad n=2. \tag{4.4.10}$$

Function forms ψ_n (4.4.9) through (4.4.10) and their squared moduli $|\psi_n|^2$ are shown on Figure 4.4.2.

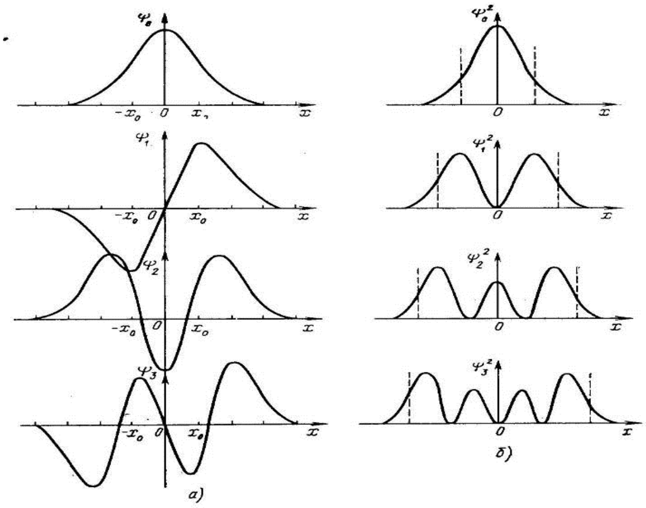


Fig. 4.4.2. *a*) Wave functions for various average states of the "particelle's" wandering within an elastically-deformed vacuum; *b*) Probability distribution densities of "particelle" locations in the vicinity of the «electron's» core center in the case considered here [13]

It follows from equation (4.4.4), in this particular case, that even in a non-excited state (i.e. with n = 0), the "particelle's" total mechanical *energium* is not equal to zero:

$$\varepsilon_{p0}=\frac{\eta_p}{2}\sqrt{\frac{1}{k_u}}, \tag{4.4.11}$$

the "particelle" will be permanently wandering around of the center of «electron's» core, and, therefore, the probability distribution density of finding it in that area will be described by a Gaussian function

$$|\psi_0(r)|^2=\frac{1}{\lambda_0\sqrt{\pi}}\exp\left\{-\frac{r^2}{\lambda_0^2}\right\}, \tag{4.4.12}$$

(Figure 4.4.2 *b*, upper plot).

Consequently, the root-mean-square deviation of a "particelle", which wanders chaotically around of the center of «electron's» core, by taking (4.4.7) into account, is equal to:

$$\sigma_{pr}=\frac{1}{\sqrt{2}}\lambda_0=\sqrt{\frac{\eta_{par}}{2k_n}}. \tag{4.4.13}$$

By comparing (4.4.13) with (4.2.4), we discover that the massless factor of vacuum elastic tension, k_n, is inversely proportional to the average autocorrelation factor of the random process $\tau_{par,r}$ examined here:

$$k_n = \frac{1}{\tau_{par,r}}, \tag{4.4.14}$$

which corresponds to the eigenfrequency of this "quantum harmonic oscillator" $k_n = f_0$.

4.5 Angular quantum characteristics of a wandering "particelle"

While "particelle" moving chaotically around of the center of «electron's» core, it permanently changes the direction of its movement (Figures 4.2.1 and 4.2.2). Therefore, from the viewpoint of classical mechanics, such a "particelle" possesses a certain angular momentum

$$\vec{L} = \vec{r} \times \vec{p}, \tag{4.5.1}$$

where r is the distance between the "particelle" and the the center of «electron's» core (the "particelle's" own radius is neglected here, and $\vec{p} = m_p\vec{v}$ is the "particelle's" immediate momentum value.

Let's present vector equation (4.5.1) in component form:

$$L_x = yp_z - zp_y, \quad L_y = zp_x - xp_z, \quad L_z = xp_y - yp_x. \tag{4.5.2}$$

In classical mechanics, the squared modulus of the "particelle's" momentum will be equal to

$$L^2 = L_x^2 + L_y^2 + L_z^2. \tag{4.5.3}$$

Applying a well-known quantum mechanics procedure, let's re-write the operators of the "particelle's" momentum components (4.5.2) [37]

$$\hat{L}_x = \frac{\hbar}{i}\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right), \quad \hat{L}_y = \frac{\hbar}{i}\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right), \quad \hat{L}_z = \frac{\hbar}{i}\left(x\frac{\partial}{\partial y} - y\frac{\partial}{\partial x}\right). \tag{4.5.4}$$

In order to obtain massless operators, let's divide both members of (4.5.4) by m_p

$$\frac{\hat{L}_x}{m_p} = \frac{\hbar}{m_p i}\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right), \quad \frac{\hat{L}_y}{m_p} = \frac{\hbar}{m_p i}\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right), \quad \frac{\hat{L}_z}{m_p} = \frac{\hbar}{m_p i}\left(x\frac{\partial}{\partial y} - y\frac{\partial}{\partial x}\right). \tag{4.5.5}$$

As a result, by taking (4.2.4) into account, we obtain

$$\hat{l}_x = \frac{\eta_{par}}{i}\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right), \quad \hat{l}_y = \frac{\eta_{par}}{i}\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right), \quad \hat{l}_z = \frac{\eta_{par}}{i}\left(x\frac{\partial}{\partial y} - y\frac{\partial}{\partial x}\right). \tag{4.5.6}$$

where $\hat{l}_x$, $\hat{l}_y$, $\hat{l}_z$ are components of the "particelle's" specific relative angular momentum operator, since $l = \dfrac{L}{m_p} = \vec{r} \times \vec{v}$.

In the spherical system of coordinates, massless operators (4.5.6) are expressed as follows

$$\hat{l}_x = \frac{\eta_{par}}{i}\left(\sin\varphi\frac{\partial}{\partial\theta} - ctg\theta\cos\varphi\frac{\partial}{\partial\varphi}\right),$$

$$\hat{l}_y = \frac{\eta_{par}}{i}\left(\cos\varphi\frac{\partial}{\partial\theta} - ctg\theta\sin\varphi\frac{\partial}{\partial\varphi}\right), \tag{4.5.7}$$

$$\hat{l}_z = \frac{\eta_{par}}{i}\frac{\partial}{\partial\varphi}.$$

The operator corresponding to the square of the modulus of the specific relative angular momentum, that is, corresponding to expression (4.5.3), is equal to

$$\hat{l}^2 = \hat{l}_x^2 + \hat{l}_y^2 + \hat{l}_z^2 = -\eta_{par}^2\nabla_{\theta,\varphi}^2, \tag{4.5.8}$$

where
$$\nabla_{\theta,\varphi}^2 = \frac{1}{\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial}{\partial\theta}\right) + \frac{1}{\sin^2\theta}\frac{\partial^2}{\partial\varphi^2}. \tag{4.5.9}$$

The generalized Schrödinger equation (4.2.12) can be presented in the following form [37]

$$\nabla^2\psi(\vec{r}) + \frac{2}{\eta_{par}^2}\left[\varepsilon_p - <u_p(\vec{r})>\right]\psi(\vec{r}) = 0, \tag{4.5.10}$$

where the Laplace operator, ∇^2, takes the following form in spherical coordinates

$$\nabla^2 = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial}{\partial r}\right) + \frac{\nabla_{\theta,\varphi}^2}{r^2}, \tag{4.5.11}$$

while the $\nabla_{\theta,\varphi}^2$ operator is defined by equation (4.5.9).

Substituting (4.5.11) into the massless Schrödinger equation (4.5.10), and assuming

$$\psi(r,\theta,\varphi) = R(r)Y(\theta,\varphi), \tag{4.5.12}$$

we obtain

$$\frac{1}{R^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial R}{\partial r}\right) + \frac{2}{\eta_{par}^2}r^2\left[\varepsilon_p - <u_p(\vec{r})>\right] = -\frac{1}{Y}\nabla_{\theta,\varphi}^2 Y. \tag{4.5.13}$$

Since the left and the right members (4.5.13) depend on different independent variables when considered separately, they should be equal to one and the same constant, λ. Therefore, we have two separate equations for the radial function $R(r)$ and the spherical function $Y(\theta,\varphi)$, [37]

$$\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial R}{\partial r}\right) + \left\{\frac{2}{\eta_{par}^2}\left[\varepsilon_p - <u_p(\vec{r})>\right] - \frac{\lambda}{r^2}\right\}R = 0, \tag{4.5.14}$$

$$\frac{1}{\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial Y}{\partial\theta}\right) + \frac{1}{\sin^2\theta}\frac{\partial^2 Y}{\partial\varphi^2} + \lambda Y = 0. \tag{4.5.15}$$

The radial function $R(r)$ and the eigenvalues of the “particelle's” total mechanical energium, ε_{pn}, are determined by the specific kind of the average potential energium, $<u_p(\vec{r})>$. In particular, the radial functions (4.3.3) and (4.4.5) were presented above when $<u_p(\vec{r})>$ given by the expressions (4.3.1) or (4.4.2) respectively.

Solutions of equation (4.5.15) is well-known in quantum physics; they take on the following appearance [37]:

$$Y_l^m(\theta,\varphi) = \left[\frac{(2l+1)(l-m)!}{4\pi(l+m)!}\right]^{\frac{1}{2}} e^{im\varphi} P_l^m(\cos\theta)\,, \qquad (4.5.16)$$

where $P_l^m(\cos\theta) = \frac{d}{2^l l!}\left(1-\xi^2\right)^{m/2}\frac{d^{l+m}}{d\xi^{l+m}} + \left(\xi^2-1\right)^l$ are the associated Legendre functions,

l and m are the orbital and magnetic quantum numbers respectively, and $\xi = \cos\theta$.

Functions (4.5.16) are suitable for describing the average orbital component of the motion of a "particelle" that moves chaotically around of the center of «electron's» core, for any average potential energium $<u_p(\vec{r})>$ distributed symmetrically around the center.

Given in Table 4.5.1 are several functions $Y_l^m(\theta,\varphi)$ from (4.5.16) together with their corresponding probability densities of the angular distribution of a "particelle's" location in the vicinity of "electron's" core center $|Y_l^m(\theta,\varphi)|^2$ [37].

Table 4.5.1

Quantum numbers	$Y_l^m(\theta,\varphi)$	$\lvert Y_l^m(\theta,\varphi)\rvert^2$
$l = 0, m = 0$	$Y_0^0 = [1/(4\pi)]^{1/2}$	$\lvert Y_0^0)\rvert^2 = 1/(4\pi)$
$l = 1, m = 0$	$Y_1^0 = [3/(4\pi)]^{1/2}\cos\theta$	$\lvert Y_1^0)\rvert^2 = [3/(4\pi)]\cos^2\theta$
$l = 1, m = 1$	$Y_1^1 = -[3/(8\pi)]^{1/2}\sin\theta\, e^{i\varphi}$	$\lvert Y_1^1)\rvert^2 = [3/(8\pi)]\sin^2\theta$
$l = 1, m = -1$	$Y_1^{-1} = [3/(8\pi)]^{1/2}\sin\theta\, e^{-i\varphi}$	$\lvert Y_1^{-1})\rvert^2 = [3/(8\pi)]\sin^2\theta$
$l = 2, m = 0$	$Y_2^0 = [5/(4\pi)]^{1/2}\,[(3/2)\cos^2\theta - 1/2]$	$\lvert Y_2^0)\rvert^2 = [5/(4\pi)][(3/2)\cos^2\theta - 1/2]^2$
$l = 2, m = 1$	$Y_2^1 = -[15/(8\pi)]^{1/2}\sin\theta\cos\theta\, e^{i\varphi}$	$\lvert Y_2^1)\rvert^2 = [15/(8\pi)]\sin^2\theta\cos^2\theta$
$l = 2, m = -1$	$Y_2^{-1} = [15/(8\pi)]^{1/2}\sin\theta\cos\theta\, e^{-i\varphi}$	$\lvert Y_2^{-1})\rvert^2 = [15/(8\pi)]\sin^2\theta\cos^2\theta$
$l = 2, m = 2$	$Y_2^2 = [15/(32\pi)]^{1/2}\sin^2\theta\, e^{2i\varphi}$	$\lvert Y_2^2)\rvert^2 = [15/(32\pi)]\sin^4\theta$
$l = 2, m = -2$	$Y_2^{-2} = [15/(32\pi)]^{1/2}\sin^2\theta\, e^{-2i\varphi}$	$\lvert Y_2^{-2})\rvert^2 = [15/(32\pi)]\sin^4\theta$

Types of angular distributions $|Y_l^m(\theta,\varphi)|^2$ for different values of orbital l and magnetic m quantum numbers are shown on Figure 4.5.1

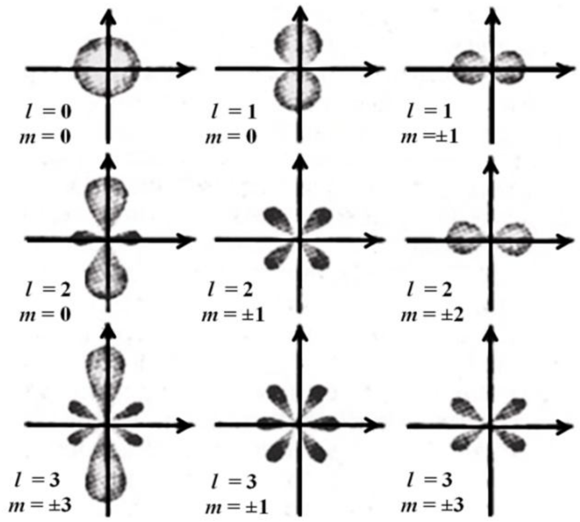


Fig. 4.5.1. Probability densities of angular distribution of “particelle’s” location in the vicinity of the «electron's» core center $|Y_l^m(\theta,\varphi)|^2$ for different values of orbital, *l*, and magnetic, *m*, quantum numbers

The average behavior of a chaotically wandering “particelle” described by a probability distribution density

$$|\psi(x,y,z)|^2 = |\psi(r,\theta,\varphi)|^2 = |R^n(r)Y_l^m(\theta,\varphi)|^2$$

leads to the curving of the vacuum area around such “particelle” with the formation of stable convex-concave features inside the core of the “electron” (Figure 4.5.2).

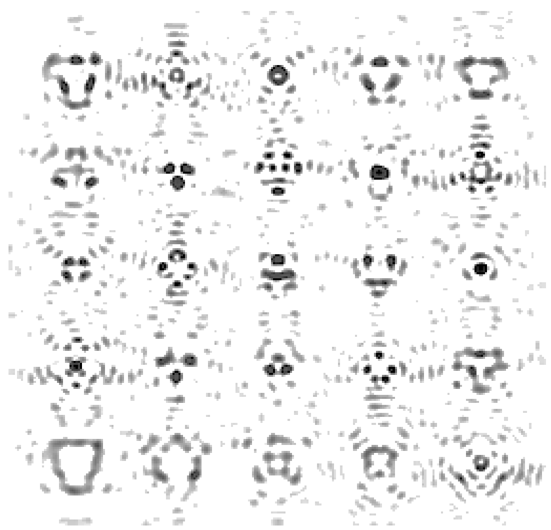


Fig. 4.5.2. Examples of averaged convex-concave features of the vacuum area within the «electron's» core connected with various probability distribution densities of the “particelle” location $|\psi(x,y,z)|^2 = |R^n(r)Y_l^m(\theta,\varphi)|^2$ associated with different values of the three quantum numbers *n, m* and *l*.

Therefore, without going beyond classical logic, the geometric and quantum mechanics presentations appear to be closely interrelated within a common statistical (quantum) metraphysics.

Such considerations of the averaged discrete (quantum) sets of metric-dynamic "particelle" states within the «electron's» core may carry over into considerations of other similar local vacuum formations of various scales. Therefore, the logical and mathematical apparatus of statistical (quantum) metraphysics proposed here can be applied to the study of the following phenomena, among others: the wobbling of a biological «cell's» inner core, the oscillation of a «planet's» inner core, motions of an «embryo» in a womb, behavior of a fly in a jar or a tiger in a cell, a «galaxy» within a «metagalaxy», etc.

Let's select as example any set of two nested spherical vacuum formations from the hierarchy (2.6.20):

core: – a biological «cell's» inner core with $r_5 \sim 4.9 \cdot 10^{-3}$ cm;

"particelle": – the core of an «electron» with $r_6 \sim 1.7 \cdot 10^{-13}$ cm,

or

core: – the core of a «galaxy» with $r_3 \sim 4 \cdot 10^{18}$ cm;

"particelle": – the core of a «star» or a «planet» with $r_4 \sim 1.4 \cdot 10^{8}$ cm,

or

core: – a core of a «metagalaxy» with $r_2 \sim 1.2 \cdot 10^{29}$ cm;

a "particelle": – a core of a «galaxy» with $r_3 \sim 4 \cdot 10^{18}$ cm.

For each of these mutually mobile "core - particelle" combinations it is possible to derive discrete (quantum) sets of averaged metric-dynamic states similar to the states of a "particelle" within the core of an «electron». The difference between them will lie basically in the value of the "particelle's" inertial factor, η_x (4.2.4), which depends on the scale of the phenomenon under consideration.

As an example, let's evaluate the inertial factor of the core of the «electron» wandering chaotically around the core of a "hydrogen atom" (Figure 4.5.3).

$$\eta_e = \frac{2\sigma_{er}^2}{\tau_{er}}, \qquad (4.5.32)$$

where σ_{er}, τ_{er} are the root-mean-square deviation and autocorrelation radius, respectively, of a random process related to the chaotic wandering of the «electron's» core around the «atom's» core.

The following equation is known in modern physics:

$$\frac{\hbar}{m_e} = 1.055 \cdot 10^{-34}\,\text{Js} / 9.1 \cdot 10^{-31}\text{kg} \approx 10^{-4}\,\text{m}^2/\text{s}, \qquad (4.5.33)$$

where m_e is the mass of an electron. According to (4.2.4), the "electron's" core inertial factor can be assigned the value

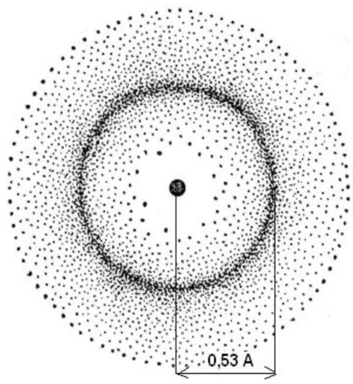


Fig. 4.5.3. Probability density distribution of the location of the «electron's» core center inside a hydrogen atom. The maximum of this distribution is known to correspond to $r \sim 0.5\text{A} = 0.5 \cdot 10^{-10}$ m

$$\eta_e = \frac{2\sigma_{er}^2}{\tau_{er}} = \frac{\hbar}{m_e} \approx 10^{-4}\ \mathrm{m^2/s}. \tag{4.5.34}$$

Assuming that the root-mean-square deviation σ_{er} of the «electron's» core's chaotic motion in the vicinity of the «hydrogen atom» center is roughly equal to $\sigma_{er} \sim 10^{-10}$ m (Figure 4.5.3), it follows from equation (4.5.34) that

$$10^{-4} \approx 2\cdot 10^{-20}/10^{-4} = 2\cdot 10^{-16}\ \mathrm{s}. \tag{4.5.35}$$

It is possible to derive the average velocity of the «electron's» core motion in the case under consideration: $\langle v_e \rangle = \sigma_{er}/\tau_{er} = 10^{-10}/2\cdot 10^{-16} = 0.5\cdot 10^6$ m/s.

For comparison, let's evaluate the inertial factor of a fly, η_m, moving chaotically inside a 3-liter closed glass jar. In that case, the root-mean-square deviation of the fly from the jar's center, η_m, and the correlation factor of this random process, τ_{mr}, will be roughly equal to: $\sigma_{mr} \sim 5$ cm = 0.05 m, $\tau_{mr} \sim 1.3$ s, respectively. Therefore

$$\eta_m = \frac{2\sigma_{mr}^2}{\tau_{mr}} = \frac{0.005}{1.3} = 0.0038\ m^2/\mathrm{s}, \tag{4.5.36}$$

while the average velocity of its chaotic motion $\langle v_m \rangle \approx \sigma_{mr}/\tau_{mr} \approx 0.05/1.3 \approx 0.038$ m/s.

Eigenvalues of the total mechanical energium of a fly confined in a jar (potential well) can be defined by equation (4.3.2)

$$\varepsilon_{mn} = \frac{\pi^2 \eta_m^2}{8 r_b^2} n^2, \tag{4.5.37}$$

where $r_b = 0.12$ m is the jar's radius, while the eigenfunctions for the total *energium* levels (4.5.37) are expressed by (4.3.3)

$$\psi_n(r) = \sqrt{\frac{1}{r_b}} \sin\left(\frac{n\pi r}{2r_b}\right). \tag{4.5.38}$$

This conclusion is experimentally verifiable. If we film a fly in a jar and play the film back at a higher speed, we will be able to see the distribution of the fly's average positions in the jar. Then the experiment can be repeated with different input conditions, such as temperature or pressure. In that case, under the predictions of Alsigna, different average distributions of the fly's locations will be obtained. Of course, such atrocious treatment of animals, even for research purposes, is not in line with the moral principles of the Algebra of Signatures [17].

In our third example, let's consider a biological "cell." Chaotic movements of its "core" may have the following average characteristics: $\sigma_{hr} \sim 3.5\cdot 10^{-5}$ m, $\tau_{hr} \sim 1.2\cdot 10^{-3}$ s, and, consequently, $\eta_h \approx 20.4\cdot 10^{-2}$ m^2/s. In this example, however, the oscillating "core" is linked with the "cell's" cytoplasm. Therefore, the "core's" deviation from its initial position in the cytoplasm leads to the buildup of elastic tensions pulling it back. Therefore, the eigenvalues of such a biological "cell's" total mechanical *energium* can be approximately defined by expression (4.4.4)

$$\varepsilon_{hn} = \eta_h \sqrt{\frac{1}{k_h}} \left(n + \frac{1}{2} \right), \tag{4.5.39}$$

while the eigenfunctions for these *energium* levels are described by Expressions (4.4.5)

$$\psi_n(r) = \frac{1}{\sqrt{\lambda_0}} \exp\left\{ -\frac{r^2}{2} \right\} H_n(r), \tag{4.5.40}$$

where $\lambda_0 = \sqrt{\frac{\eta_h}{k_h}}$, where k_h is the massless factor of elastic tension of a biological "cell's" cytoplasm.

It is also known that tree boughs move according to the Lissajous curves under the influence of wind (Figure 4.5.4).

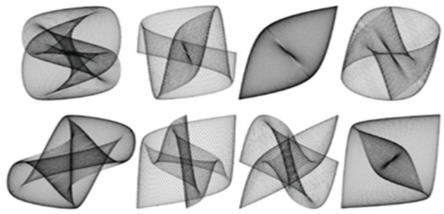


Fig. 4.5.4. Discrete set of 3D Lissajous curves

Therefore, the Statistical metraphysics and the Algebra of Signatures argues that the average behavior of macro objects is basically similar to that of microworld objects provided that conditions are equal. Which means that in certain cases the methods and mathematical tools of quantum physics can be applied for describing discrete sequences of average states of macroscopic objects.

There are five quantum numbers: *f*, *n*, *l*, *m*, *s,* in the Statistical (quantum) metraphysics that largely determine the scale and discrete variants of average manifestations (configurations) of each stable spherical vacuum formation since all of them are in permanent chaotic motion (Figure 4.5.5).

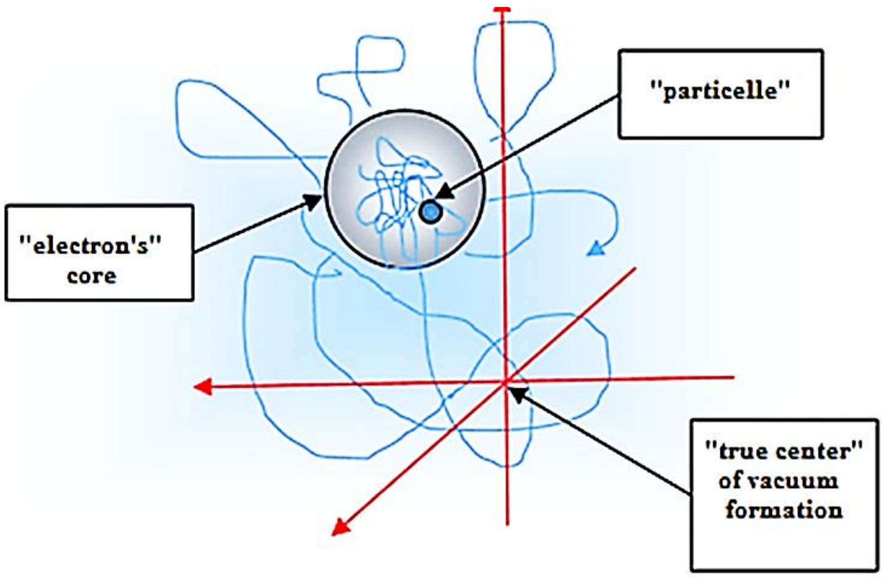


Fig. 4.5.5. Chaotically wandering "core" of a vacuum formation with a "particelle" chaotically wandering inside the core

4.6 «Muons», τ-«leptons» and *c*, *s*, *t*, *b*-«quarks»

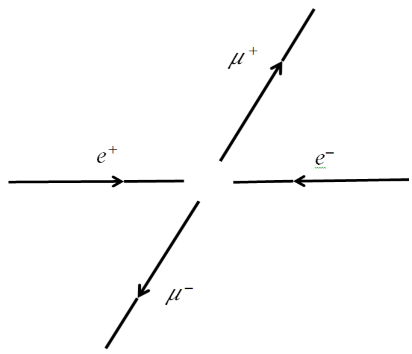


Fig. 4.6.1. Collision of accelerated electron and positron sometimes leads to the birth of muon - antimuon or τ^+ - lepton – τ^--antilepton pair

As is known, collisions of elementary particles moving at high speeds lead to the birth of pairs of new particles – antiparticles.

For example, let's consider the birth of a muon - antimuon pair and a τ^+-lepton-τ^--antilepton, which form upon the collision of an electron and a positron (Figure 4.6.1):

$$e^+e^- \to \mu^+\mu^-, \qquad e^+e^- \to \tau^+\tau^-. \tag{4.6.1}$$

The muon and τ-lepton are different from electrons only in terms of mass:

$$m_e = 0.511 \text{ MeV}, \qquad m_\mu = 105.658 \text{ MeV}, \qquad m_\tau = 1.984 \text{ GeV}, \tag{4.6.2}$$

while all their other characteristics (charge, spin, lepton number, etc.) remain the same.

Many researchers considered muons and τ-leptons so “redundant” in the structure of material world that they could not help asking: “Why did nature need these particles?”

The Statistical metraphysics, developed here, believes that «muons», τ^+-«leptons», «antimuons» and τ^-- «antileptons» are not new particles, but the same "electrons" and "positrons" with excited states of their cores. In other words, in terms the “muon” and τ^+- “lepton” are, respectively, the first (n = 1) and the second (n = 2) excited states of a free «electron», while the «antimuon» and τ^--«antilepton» are, respectively, the first (n = 1) and the second (n = 2) excited states of a free «positron».

The same refers to «quarks», introduced in Charter 2, *c*- and *t*-«quarks» are the first and the second excited states of a *u*-«quark», while *s*- and *b*-«quarks» are the first and the second excited states of a *d*-«quark».

To test the hypothesis presented here, it is proposed to hold a certain volume of electron plasma in a magnetic trap and irradiate it with hard radiation. It is possible that at the same time clamped to each other the cores of "electrons" can go into the excited state. In this case, the entire volume of irradiated electron plasma can acquire other physical properties.

Another confirmation of the validity of the foundations of the Statistical (quantum) metraphysics presented here can be the production of «leptons» and «quarks» of the fourth, fifth, etc. generations, since according to (4.3.2) and (4.4.4) levels of energy of the nucleolus of $\varepsilon_{pn.}$ more than three.

The reason for the higher “inertia” [in massless Statistical metraphysics, the analogue of mass (4.6.2)] of «muons» and τ-«leptons» is likely to be related to the complication of the average metric - dynamic configuration of the vacuum area both inside and outside of their excited cores. Metric-dynamic aspects of “inertia” of elementary «particles» will be considered in the following Chapters.

It is interesting to experimentally check whether the «muon» and «antimuon» created by the collision of an «electron» and a «positron» (Figure 4.6.1) remain in an "entangled" state. For this purpose it will be necessary to find out if the «muon's» transition into «electron» automatically leads to the «antimuon's» transition into a "positron", or whether nature allows asymmetry in the number of simultaneously existing «muons» and «antimuons».

4.7 Conclusions on Chapter 4

In Charter 2 we introduced metric-dynamic models of 16 types of «quarks» (to be more precise, 8 «quarks» and 8 «antiquarks»), of which it turned out to be possible to "construct" all kinds of «leptons», «mesons» and «baryons» known in the Standard Model. This Chapter takes into account the omnipresent vacuum fluctuations and attempts to study regularities in the chaotic behavior of the cores and "particelles" of the abovementioned local vacuum formations.

Vacuum fluctuations are non-removable in principle. This means that the axiomatic probability of quantum physics is as primary as is the determinism of differential geometry, which derives from the presumption of continuity of the vacuum.

The equal coexistence of probabilistic and deterministic principles is forcing Alsigna to develop "Stochastic metraphysics", which leads to an average description of discrete (quantum) metric structures. The reason is that discrete sets of average states of chaotically wandering "particelles" (Figure 4.2.1) are inevitably manifested in the average metric-dynamic (convex-concave) configurations of vacuum areas both inside and outside of the cores (Figures 4.5.2 and 4.5.6).

Let's outline the basic notions of the Alsigna's "Stochastic (quantum) metraphysics", which are presented in this work:

1). The notion of mass with the dimension "kilogram" cannot be introduced into the completely geometrized physics, in principle. Therefore, the notion of mass has to be excluded from all metraphysical perceptions. Instead of point particles with mass, charge, spin, etc., the Alsigna's metraphysics to consider spherical cores of local vacuum formations (Figure 4.7.1). Introduced in a similar way are such geometrized notions as the core "inertance" *(analogue of a point particle's inert mass),* "intensity of a source of radial vacuum flows" around the core *(analogue of a point particle's charge)*, "displacement of vacuum layers" around the core *(analogue of a*

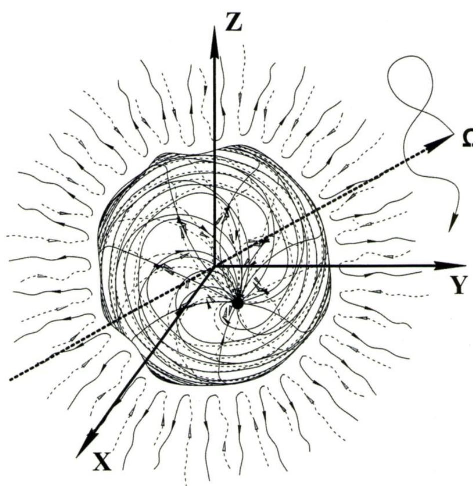


Fig. 4.7.1. The core of local vacuum formation is an analogue of a point material particle in post-Newtonian physics

point particle's gravitational mass, see Chapter 9), the core's "*energium*" *(a massless analogue of a point particle's energy)*, "tension" of a vacuum continuum *(a massless analogue of elastic tensions in a solid medium*), "effect" *(a massless analogue of force)*, etc.

Masslessness of Alsigna's metraphysics causes the greatest objections from scientists, educated in the post-Newtonian scientific methodology. However, those researchers who have already faced the problem of geometrizing the notion of "mass" join the ranks of Alsigna supporters

2). Vacuum length is conventionally considered as a continuous elastic-plastic pseudo-medium. The real substantiality of this pseudo-environment is not manifested in any way (i.e., it is not observed experimentally). However, the relation to vacuum as a continuous elastic-plastic medium allows: firstly, to objectify this "subject" of research; secondly, to apply the methods of differential geometry and mechanics of continuous media to the study of vacuum extent.

3). Within the Algebra of Signatures, the vacuum extent is not one continuous pseudo-space, but the result of additive superposition of a set of continuous pseudo-spaces, that is, 4-dimensional lengths each with one of the 16 possible signatures, or topologies (see Chapter 1 and 2). The superposition of these 4-lengths is such that, on average, the non-curved vacuum has only zero characteristics. That is, when additive superposition of these 16 types of non-curved solid pseudo-spaces, they fully compensate for the manifestations of each other to the complete "absence" (i. e. zeroing of all diligent metric-dynamic characteristics). In the same manner, the fluctuations of the vacuum state are such that are, on the average, identical to their compete absence. Each of these 16 continuous pseudo-spaces can be described as a superposition of another 7 sub-spaces with different signatures (topologies), and such identification of sub-spaces can be indefinitely continued [7]. Therefore, Alsigna's vacuum state is an infinitely overlapping, continuous, all-fluctuating pseudo-space, which is, on the average, "nonexistent." For that reason, Alsigna's vacuum state is also called the "Void" [19, 22].

4). If anything appears out of the Void (i.e. the vacuum state) it should necessarily appear in two mutually opposite forms: "particle" (local convexity) – "antiparticle" (local concavity); wave – antiwave; motion – antimotion; deformation – antideformation; dimension – antidimension, etc. These pairs of "features" and "antifeatures" are absolutely symmetrical in relation to the Void, but they can be phase-twisted and/or rotated against one another at different angles. These rotations and phase-shifts of vacuum features and antifeatures predetermine the existence of worlds and effects acting within them. The development of these worlds is a gradual process of increasingly sophisticated entanglement of the features and antifeatures inhabiting them. But no matter how these worlds can be intermixed and interrelated, the global averaging of each one of them is identical to the original Void.

5). If we view a vacuum state as an objective feature (a continuous pseudo-space) that is located outside of the observer, it turns out that the notion of "time" is not attributable to such a state (an attribute of the external reality). In that case, "time" is only an "arithmetization" of the feeling of duration, which is only an attribute of an external observer. In other words, there is no space and no time external to the observer's reality (these are only mathematical abstractions generated by the observer's consciousness); only a continuous pseudo-space and its movements exist. Therefore, Alsigna had to change the approach to interpreting the components of the metric tensor. In this situation, nonzero components of metric tensor $g_{\alpha\beta}$ determine the curving of the 3D local area of vacuum state (or any of its 3D sub-spaces), while zero components of metric tensor g_{00}, $g_{\alpha 0}$, $g_{0\beta}$ are related to the accelerated linear or rotational motions of the same curved local vacuum area. Therefore, in the Alsigna formalism, a vacuum state (as well as all its sub-spaces and sub-sub-spaces) is identified as a continuous 3D elastic-plastic pseudo-space, where any curving of its local area inevitably gives rises to accelerated linear (laminar) or rotational (turbulent) motion in the same area. Therefore, Alsigna "sees" that intravacuum (pseudo-substantial) flows, which are called "intravacuum currents" form in any curved area of vacuum (or in any region of one of its sub-spaces). Any curvatures of any local area of a 3D vacuum state give rise to intravacuum currents, and, conversely, the formation of an intravacuum current inevitably leads to a local curving of the respective 3D sub-space of the vacuum state. Moreover, interrelations between the zero and nonzero components of metric tensor g_{ij} are determined by the Einstein field equations. The four-dimensionality of the Einstein mathematical apparatus (to be more precise, Riemannian differential geometry) is connected not with the curvature of space-time (*which, according to Alsigna, does not exist in external reality as it is only an attribute of the observer's logical thinking),* but with the simultaneous inclusion of the curvature of the local 3D area of pseudo-substantial space and its own velocity and acceleration. Let's also note that in Alsigna, intravacuum currents are described with the help of quaternions, and the currents (flows) of various intravacuum sub-spaces are added together by the rules of Clifford Algebra.

6). The vacuum state is in the permanent process of extremely sophisticated and multifaceted fluctuations, which are present everywhere. These fluctuations are connected with enormously complex overlappings inside vacuum spaces, sub-space and sub-sub spaces of various topologies as well as with chaotic vibrations of each of these spaces and sub-spaces. The multifaceted vacuum fluctuations may be caused by the Colossal Determined (or Predetermined) Processes related to the Global Formation of the Universe. However, these Processes are so "entangled" on the local level of the vacuum state that Alsigna is forced to treat these processes as random ones and apply the methods of probability theory and mathematical statistics to their study. The attitude toward the vacuum state as an extremely complicated fluctuating and overlapping continuous pseudo-space is forcing Alsigna into developing a statistical (quantum) metraphysics. Stable features and antifeatures "woven" of that multifaceted pseudo-space and their stable metric-dynamic configurations are identified through the extremality of its action and entropy.

7). The condition for the existence of the average stable vacuum formations is determined by the “Action Extremum Principle”, which is closely related to the “Entropy Extremum Principle” the “Principle of the Conservation of the Integrals of the Averaged Motion of Local Vacuum State Regions” and the “Principle of the General Invariance of the Stochastic metraphysics in Respect to Random Transformations in Four Coordinates”. From the above principles it follows that the average (frozen) geometric “frame” of the stable local vacuum formations must satisfy the Einstein Field Equations (which are second order differential equations, see Chapter 2), while the averaged behavior of the cores of these vacuum formations must satisfy the Dirac Relativistic Equation, which, in the condition of low (compared to the speed of light) velocities (i.e. wave propagation velocity through the vacuum state) simplifies down to the Schrödinger equation (see Chapter 3).

Altogether, the deterministic Einstein vacuum equations and the probabilistic Dirac or Schrödinger equations, derived from the above common Action Extremum Principle, Entropy Extremum Principle, Principle of the Conservation of Integrals of the Average Motion of the Vacuum State Local Areas and Principle of the General Invariance of Statistical metraphysics with respect to Random Transformations in Four Coordinates, form the basis of massless statistical (quantum) metraphysics and thus ensure the completeness of the Alsigna's logical apparatus.

The presumptions of the statistical (quantum) metraphysics, Alsigna, as outlined above, call for a radical revision of the standard physics paradigm, which can be justifiable only in case of resolving certain problems of modern physics and predicting new effects.

The solution of one such problem is proposed in this work. Within the framework of Stochastic (quantum) metraphysics, «muons» and tau-«leptons» may be interpreted as the first and the second excited states of «electrons» and «positrons» respectively; *c*- and *t*-«quarks» are, respectively, the first and the second excited states of a *u*-«quark», while *s*- and *b*-«quarks» are the first and the second excited states of a *d*-«quark».

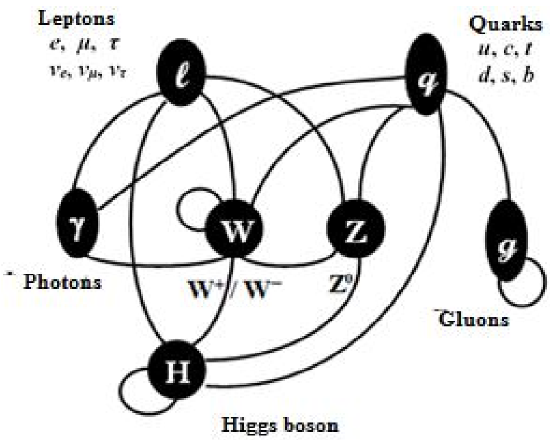


Fig. 4.7.2. Elements of the Standard Model

Therefore, Alsigna is able to explain metric-dynamic models of all «quarks», «mesons», «baryons» and «bosons», which are included into the Standard Model (see Chapter 2 and Figure 4.7.2), including the metric-statistical models of «muons», tau-«leptons» as well as *s, b, c, t* -«quarks».

Not considered in this Chapter were only all varieties of "neutrino" ν_e, ν_μ, ν_τ, metric - dynamical models which are presented in the Chapter 7.