EXTENDED QUANTUM THEORY

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It is shown in [2] that, besides the Heisenberg – Schrodinger quantum mechanics at moderate energies (MEQM), there exist else two quantum theories: high-energy quantum mechanics (HEQM) and low-energy one (LEQM) completed the first by natural way. In the latter, the well-known symmetry between the configuration and momentum spaces, inherent in MEQM, is broken. In this paper, the connection between these three theories is established (briefly, the complete theory is called EQ-theory). HEQM is well adapted to the description of particle constituents – granules. The connection of these objects playing the role of hidden entities with particles and their dynamical structure and physical properties is made clear. This dynamical structure breaks such laws of laboratory (Lagrangian) physics as the conservation of energy, fermionic charge, and probability. It causes also the *P, C, T* and fermion-antifermion asymmetry of our Universe.

1. The question about the completeness (closedness) of the usual quantum (wave) mechanics created by Heisenberg, de Broglie and Schrodinger was arisen soon after the building of the mathematical apparatus of this theory (Dirac, von Neumann) and elucidation that 1) predictions of MEQM are of statistical (probabilistic) character, 2) the theory is acausal (it breaks the causality principle). With the intention to eliminate these 'lacks“, one tried to find the answer to the first question (in analogy with statistical physics) on the way of introducing the so-called hidden parameters (de Broglie, Einstein, and others). The von Neumann theorem about impossibility of such parameters in the framework of MEQM (his proof is based solely on the means of the same theory[1]), it seemes, closed this way. Von Neumann himself gave such an evaluation of this theorem: '... the introduction of the hidden parameters is wittingly impossible in any case without fundamental changes of the existing theory“ ([1], Capture 3,n.2). At the same time, he considered that '... quantum mechanics in the present form stays still non-complete“ ([1], Capture 4, n.2).

Proceeding from [2], we can give now the following solution of the problem: the Heisenberg – Schrodinger quantum mechanics is in fact non-complete, and hidden parameters exist (certainly, not in the frame of the usual theory but in a more large one). It may be completed by another two quantum theories one of which contains the hidden parameters in the form of fields connected with the space discontinuum. The latter describe the particle substructure – particle constituents (granules). These point-like objects are not described by any differential equations. However, they have a definite non-standard dynamical structure, which may be called hidden too and which plays the role of the Kummer ideal numbers. The structure is some two-level (named bi-Hamiltonian) dynamical system described by the pair of non-Lagrangian fields $f(x)$ and $\dot{f}(\dot{x})$. Due to the quantum transition $f \to \dot{f}$, which leads to arising a fundamental Lagrangian particle, the fields $f(x)$ and $\dot{f}(\dot{x})$ enter the particle field $\psi(X, Y) \sim \langle \dot{f}(X - Y), f(X + Y)\rangle$ (the latter is a transition matrix element), which allows one to compare f and $\dot{f}$ with ideal numbers. Due to the bi-Hamiltonian character of the system, particle fields are bilocal magnitudes. In the asymptotic $|X| >> |Y|$, they transit to usual local fields $\psi(X)$. Inner coordinates Y which describe the space-time structure of a particle may be called hidden (from experiment) too. These parameters are nearer to the de Broglie’s ones than to others. But the deepest hidden parameters are the variables of a bi-Hamiltonian dymanical system that produce the fundamental particles.

Hereby, the complete theory has a more acausal character than the previous one due to the inner coordinates Y, leading to the breaking of microcausality in the region $|X| << |Y|$ (compare with [3]). Moreover, we will see that other principles of Lagrangian physics are also broken about that we already said in the abstract.

It turns out that the question about non-completeness of usual quantum mechanics was right in spite of false intentions. This history is a very good example of efficiency of the law of material implication (truth follows from falsehood).

2. The well-known quantum mechanics refused such a geometric manner of classical mechanics as to describe the particle motion by means of a trajectory and replaced it by a wave. On the mathematical language, the transition from classical theory to

[1] It is very important to emphasize that to establish, in fact, the non-closedness of the theory is possible only by means of tools of a more large (deep) theory. For example, any number ring is closed under proper ring operations. However, some of them have extensions, which indicates their non-closedness with respect to more general algebraic operations than proper ring ones.

quantum one is connected with the transition from the cotangent fibration $(M_X, T^* M_X)$ of the configuration space M_X to a tangent one $(M_X, T M_X)$, see [2] (all happens in the framework of the Newtonian model of space as a differential manifold with natural measure). As a result, the Fourier transformation F is playing an essential role, by mapping the configuration space M_X into the momentum space M_p and the fibration $(M_X, T M_X)$ into a fibration $(M_p, T M_p)$. Hereby, $F(T M_X) = M_p$ and $F(M_X) = T M_p$. This symmetry between M_X and M_p is also expressed so [4]: in the X-representation, a momentum $p = -i\frac{\partial}{\partial x}$ and, in the p-representation, a coordinate $X = i\frac{\partial}{\partial p}$ (the Planck constant h is equal to 1). For wave functions, the Fourier transformation is written in the form:

$$\psi(X) = \int_{-\infty}^{\infty} e^{iXp}\,\psi(p)\,dp,$$

$$\psi(p) = \frac{1}{2\pi}\int_{-\infty}^{\infty} e^{-ipX}\,\psi(X)\,dX. \qquad (1)$$

Hereat, the Plansherel equality is fulfilled:

$$(\psi, \varphi) = \int_{-\infty}^{\infty} \overline{\psi}(X)\,\varphi(X)\,dX = 2\pi\int_{-\infty}^{\infty} \overline{\psi}(p)\,\varphi(p)\,dp. \quad (2)$$

In these formulas, *dX* and *dp* are usual Lebesgue measures on M_X and M_p, correspondingly, and the integral means a Lebesgue integral. The Hilbert spaces $H(M_X)$ $(H(M_p))$ of functions on M_X (M_p) with the scalar product (2) play an important role in the theory. From the permutation relation $[X, p] = i$ and the condition for wave functions to belong to the space $H(M_X)$ $(H(M_p))$, the Heisenberg uncertainty relation follows: $\Delta X\,\Delta p \geq 1/2$, where ΔX, Δp are dispersions of X and p in the wave function $\psi(X)$. Therefore, if a particle is localized in M_X, i.e., $\Delta X = 0$, so $\Delta p = \infty$ (one should not mix the particle localization with its pointness; we speak about the wave properties but not a geometric size). Fairly one considers that such a limit is not achieved for an elementary particle (particle is not a point-like object) because the state $\delta(X) \notin H(M_X)$ and therefore $\delta(X)$ as a wave function does not exist[2] (see [1], Capture 2, n. 8).

[2]It is important to note that the understanding of non-proper functions as functionals is not adequate to the intentions of quantized field theory in which these objects are multiplicated like usual functions (for example, the usual product of causal functions $S^c(X)\,D^c(X)$ is used) but not like functionals $S^c(X) \otimes D^c(X')$ with direct product. With respect to the usual product, these objects are not a ring.

However, experiment shows that a fundamental particle (for example, a proton) has point-like constituents – partons or granules, and one considers that they may be localized within the particle, i.e., for them, $\Delta X = 0$ and then $\Delta p \geq \infty$. Due to the infinite momentum p, these objects have the possibility to go out from the particle according to the usual quantum theory of measurement and to be observed in space. However, granules were not still observed. In connection with this, the hypothesis about confinement of constituents was advanced. But it is clear that the confinement hypothesis is not compatible with demands of the usual quantum theory. Therefore, *we infer that the relation between the space-time (X) description and causal (p) one for particle's constituents is quite another than that for particles themselves.* In particular, the localized state of a granule is not described by the Dirac δ-function $\delta(X - X_0)$. However in mathematics, there is another point-like object, the Kronecker delta-symbol δ_{X, X_0}. Such functions are present in the N.Bohr theory of almost periodic functions considered on the momentum space (see [5]). In [2], a new quantum theory based on the Hilbert space of such functions is suggested. The latter is used for the description of granules. In this theory, a new N.Bohr's topology is considered on the momentum space M_p (see below). Induced by it, the topology on the configuration space M_X is the strongest, i.e., a discrete one. In such a topology, the configuration space is a quite nonconnected set of its points, i.e., a discontinuum labeled as M'_X. The scalar product for functions given on M_p, connected with the Bohr measure on M_p, is written as [2]

$$(\psi, \varphi)' = \lim_{P\to\infty}\frac{1}{2P}\int_{-P}^{P} \overline{\psi}(p)\,\varphi(p)\,dp =$$

$$= \text{m.v.}\int \overline{\psi}(p)\,\varphi(p)\,dp. \qquad (3)$$

The Hilbert space $H'(M_p)$ of almost periodical functions on M_p is connected with (3) (this class of functions was investigated in detail by N.Bohr [5] (see also [1], Capture 2, n. 3)). The space $H'(M_p)$ is non-separable (in it, dense sets are uncountable).

On the one hand, the new theory should be considered as any limit case of the Schrodinger wave mechanics (when $\Delta p = \infty$ even if $\Delta X \neq 0$; it is very important to notice that the matrix version of the theory with non-separable space is impossible). On the other hand, we will see that it is an independent theory with a new kind of Fourier transformation [5]:

$$\text{m.v.}\int e^{iXp}\,\psi(p)\,dp, \qquad (4)$$

where $\psi(p)$ is an almost periodic function which gives a function $\psi'(X) \in H'(M'_X)$ concentrated in a countable set of points $\{X_i\}_{\psi'} \subset M'_X$, i.e.,

$$\psi'(X) = \sum_i \delta_{X,X_i}\, \psi'(X_i). \qquad (5)$$

Hereby, the Parseval equality is fulfilled [5]:

$$\text{m.v.} \int |\psi(p)|^2 dp = \sum_i |\psi'(X_i)|^2, \qquad (6)$$

where

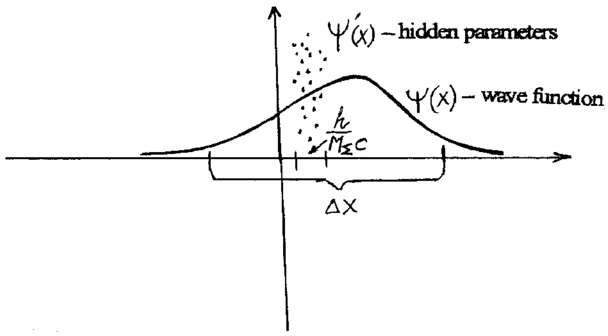
$$\psi(p) = \sum_i e^{-ipX_i}\, \psi'(X_i), \qquad (7)$$

or, in more general form,

$$\text{m.v.} \int \bar{\psi}(p)\, \varphi(p)\, dp = \sum_i \bar{\psi}'(X_i)\, \varphi'(X_i), \qquad (8)$$

where $X_i \in \{X_k\}_{\psi'} \cap \{X_j\}_{\varphi'}$. It is obvious that the symmetry between the configuration and momentum spaces, inherent in the usual theory, is completely broken: M_p stays a connected manifold, while M'_X is a non-connected set of points (discontinuum)[3]. Further, we investigate the connection between both theories.

3. First of all, we have to clarify the interrelation between two Hilbert spaces $H(M_X)$ and $H'(M'_X)$ (as well as between $H(M_p)$ and $H'(M_p)$). It is clear that from the point of view of measure (2), functions $\psi'(X)$ given in countable subsets $\{X_i\}$, having the zero Lebesgue measure, are equivalent to zero (the Egorov theorem, see [6]). Therefore, $\psi(X) + \psi'(X) \approx \psi(X)$, where $\psi \in H(M_X)$. It is obvious that if $\psi'(X)$, $\varphi'(X) \in H'(M'_X)$, so the sum $\psi'(X) + \varphi'(X)$ and product $\psi'(X)\,\varphi'(X)$ belong to $H'(M'_X)$ (i.e., $H'(M'_X)$ is a ring). Moreover, the product $\psi(X)\,\psi'(X)$ as a function given on a subset $\{X_i\}_{\psi'}$ belongs to $H'(M'_X)$ too, i.e., $H'(M'_X)$ is an ideal in the whole space which we label as $\mathcal{H} = H(M_X) +)\, H'(M'_X)$ (semi-direct sum looks at the side of the ideal). Certainly, we need that the space $H(M_X)$ has to allow the multiplication operation (but it does not allow it, see [6]). In connection with this, we consider the pre-Hilbert space $C_2(M_X) = C(M_X) \cap H(M_X)$ where $C(M_X)$ is a ring of continuous functions on M_X, see [6]. In this construction, the space $H(M_X)$ is a factor space of $\mathcal{H}$ by the ideal $H'(M'_X)$ (the latter is a kernal of the norm $\|\cdot\| = \sqrt{(.,.)}$): $H(M_X) = \mathcal{H}/H'(M'_X)$ ($H'(M'_X)$ is as if a 'filling" of zero $0 \in H(M_X)$) [4]. So, elements of $\mathcal{H}$ (more exact wave functions) are written in the form $\psi(X) + \psi'(X)$ [5], see Figure.



On the other hand, the usual Fourier transform (1) of a function $\psi(X) \in H(M_X)$, i.e., the function $\psi(p) \in H(M_p)$ is not an almost periodic function and, from the point of view of the scalar product (8), we have $(\psi, \psi)' = 0$ and $(\psi, f)' = 0$, where $f \in H'(M_p)$ is an almost periodic function, in particular, $\text{m.v.} \int \psi(p)\, e^{-ipX} dp = 0$[6]. So, the Hilbert space $H(M_p)$ is a kernal of the norm $\|\cdot\|' = \sqrt{(.,.)'}$, and we may say that $H(M_p)$ is orthogonal to $H'(M_p)$ with respect to the scalar product $(.,.)'$ (functions $\psi \in H(M_p)$ are given on sets of zero Bohr measure: on the real axis $\mathbf{R}_1$, any finite interval has zero Bohr measure!).

Thus, the Hilbert spaces of the both theories MEQM and HEQM − separable H and non-separable H' − are orthogonal one to other.

If we denote the MEQM-theory as (C_X, C_p), HEQM as (D_X, C_p) and LEQM as (C_X, D_p), so the complete theory will be written as

$$\text{EQ-theory} = (C_X, D_p) + (C_X, C_p) + (D_X, C_p) \qquad (9)$$

(the facts that (D_X, C_p) is dual to (C_X, D_p) and the case (D_X, D_p) is impossible follow from the Pontryagin

[3] As a result, the formula $X = i\dfrac{\partial}{\partial p}$ has a meaning while another formula $p = -i\dfrac{\partial}{\partial X}$ makes no sense (M'_x being a discontinuum loses the differential structure $\partial/\partial X$ and usual measure dX).

[4] Obviously, the scalar product (8) may not be transferred from $H'(M'_X)$ to $H(M_X)$, but (2) may be transferred from $H(M_X)$ to $H'(M'_X)$. Another construction − the direct sum $H(M_X) \oplus H'(M'_X)$ with the scalar product $(\psi_1, \psi_2) + (\psi'_1, \psi'_2)$, where $\psi_i \in H(M_X)$, $\psi'_i \in H'(M'_X)$ − contradicts to experiment.

[5] We see the exact wave function looks like the *de Broglie's double solution [7]*. De Broglie considered that its singular part ψ' will be a solution of any non-linear equation (but, it seems, to mathematically realize this idea is impossible). It is interesting that Heisenberg also applied the idea of nonlinearity [8].

[6] Scalar product (8) may be transferred from $H'(M_p)$ to $H(M_p)$, but (2) may not be transferred from $H(M_p)$ to $H'(M_p)$.

dual principle [9]). From here, our first statement follows: *the Heisenberg ‒ Schrodinger quantum mechanics MEQM is not a complete theory*.

4. The space $H'(M'_X)$ of point-like functions is called a space of hidden (supplementary) parameters. It describes particle constituents ‒ granules. The reduction of the description by a function $\psi(X)$ to the description by a function $\psi'(X)$, i.e., the transition $H \to H'$, is called the phase transition 'particle $\to$ granules" (it is accompanied by another phase transition 'continuum $M_X \to$ discontinuum M'_X"). The spaces H and H' are connected with different energy regions. $H(M_X)$ and $H(M_p)$ are well adapted to the description of behaviour of a particle in the region of moderate momenta and distances: functions $\psi(p)$ and $\psi(X)$ must quite rapidly decrease with growth of $|p|$ and $|X|$, correspondingly; the regions of large p and small X are in fact cut. The moderate region is connected with the Lebesgue measure on M_X and M_p.

The spaces $H'(M'_X)$ and $H'(M_p)$ are well adapted to the description of a particle behaviour at very small distances X and very large momentum p. This region is connected with the Bohr measure on M_p, with respect of which the small momentum region (low energies) is thrown away. At the transition from moderate energies to high ones, physics is as if 'pumping" from H into H'.

In the high-energy region, a particle should be considered as *a coherent ensemble of granules* $\psi'(X) = \sum_i \delta_{X,X_i}\psi'(X_i)$ (a granule is the rate $\psi'(X_i)$ of the function $\psi'(X)$ at point X_i). As always, the transition from one pure state $\psi(X)$ to another one $\psi'(X)$ does not accompanied by a change in entropy S. Therefore, the phase transition 'particles $\to$ granules" at a certain time is reversible (see further).

As always, a coherent ensemble $\psi'(X)$ may not be spontaneously distorted: for this, a significant intervention is needed[7]. We may consider the coherency to be a kind of confinement. In our opinion, three things (coherency, confinement, and hideness) are equivalent[8]. We will see further that the pure (coherent) ensemble of granules may be turned into a mixed ensemble only at a very high energy.

5. Nevertheless, one can consider that the phase transition 'particle $\to$ granules" begins already at moderate energies. Here, it is reversible, and the granule structure of a particle is not dispayed: from the point of view of the Lebesgue measure, functions belonging to the space $H'(M'_X)$ are equivalent zero.

We can estimate the number of granules from which a particle consists of if to take into account the dynamical structure of a granule, considered in [2]. Proceeding from it, one can say that the mean energy of a granule (more exactly, quanta f, see [2]) is defined by a temperature T_f of the ensemble of quanta f and is equal $\varepsilon_f = T_f$. If the particle energy is ε so, proceeding from the energy conservation law postulated in the reversible phase transition 'particle $\to$ granules", the number of granules, from which a particle consists of, is equal to $N(\varepsilon) = \varepsilon/\varepsilon_f$.

At rest, we have $\varepsilon = M_\Sigma c^2 = \sqrt{T_f T_{\dot f}}\,\mu_\Sigma = khc\,\mu\,\mu_\Sigma$, where $T_{\dot f}$ is the temperature of other component of the bi-Hamiltonian system $\dot f$, see [2]. The function μ_Σ depending on quantum numbers Σ and characterizing the kind of a particle is found in [2]. Here, μ is a dimensionless parameter of the theory: $\mu = \sqrt{T_f T_{\dot f}}/(khc) = 0{,}26$ (c, h, k are three fundamental constants: c is the light velocity, h ‒ the Planck constant, k ‒ a new universal constant equal to $5 \cdot 10^{13}\ \mathrm{cm}^{-1}$). Numerical values of T_f and $T_{\dot f}$ are found in [2]. Thus, for the rest particle, we have $N(M_\Sigma) = M_\Sigma c^2/T_f = \sqrt{\eta}\,\mu_\Sigma$, where $\eta = T_{\dot f}/T_f \sim 10^{12}$ is another dimensionless parameter of the theory. For baryons, we have $\mu_\Sigma \sim 1$ (see [2]) and therefore $N(M_\Sigma) \sim 10^6$. The mean size of free quanta f (wave cloud) is $\lambda_f = \frac{hc}{T_f} \sim 10^{-8}$ cm. However, being within a particle (at rest, the volume of a particle is $\left(\frac{h}{\mu_\Sigma c}\right)^3$), it has the size $\lambda_f(M_\Sigma) = \frac{h}{M_\Sigma c N^{1/3}(M_\Sigma)} = \frac{hc}{T_f}\frac{1}{(\mu_\Sigma^2\eta)^{2/3}} \sim 10^{-8}\lambda_f \sim 10^{-16}$ cm, i.e., under this condition, quanta f are quite deep pressed into the fiber or point of the discontinuum[9]

[7] For example, although a classical coherent electromagnetic wave consists of photons, it does not spontaneously decay into separable photons. For this, a significant effort is needed. Therefore in this case, the photoeffect, for example, goes by another way than in the case of a separable photon. Hereby, if (in the measurement process, for example) a coherent ensemble decays into its constituents, a mixed ensemble is arisen. Hereat, entropy grows [1]. Roughly speaking, a particle has to do with granules like an electromagnetic wave has to do with photons.

[8] We recall that, in the quark model, a particle wave function is the product of quark ones. Therefore, a non-solvable problem is arisen.

[9] It is clear that, at the phase transition $M_X \to M'_X$, the vector fibration (M_X, S), where S is a vector (in particular, spinor) fiber, decays into separable fibers S_{X_i} ($X_i \in M'_X$). The second-quantized version of the Dirac field in the case of discontinuum M'_X leads to a Dirac ‒ Grassmann fiber $S_8^{(*)}(G)$. The latter has a bi-Hamiltonian dynamical structure described by the Heisenberg algebra $h_8^{(*)}$, see [2]. If we do not touch the topological questions, the transition MEQM $\to$ HEQM may be described so: the space $H(M_p)$ is radically extended to the space $H'(M_p)$ (a new measure on M_p and a new scalar product (8) are considered). Hereby, the space $H(M_X)$ is narrowed to the class of functions ψ', the supports of which are countable sets $\{X_i\}_{\psi'}$ in the space M_X (M'_X is not appeared).

but not so much in order to begin the irreversible quantum transition $f \to \dot f$ (the latter begins when the size $\lambda_f(\varepsilon)$ of the cloud f is equal to $\sim \frac{1}{\eta}\lambda_f = \frac{hc}{T_{\dot f}}\lambda_{\dot f} \sim 10^{-20}$ cm) [10].

In the high-energy region, the situation changes radically. First, the number of granules grows with increase in the energy ε (and, for example, at the energy $\varepsilon = T_{\dot f} / \mu_\Sigma \sim 10^6$ GeV, it is equal to $\eta / \mu_\Sigma \sim 10^{12}$). Second, at the energy $\varepsilon = T_{\dot f} / \mu_\Sigma = \varepsilon_c$ (this threshold is called critical) due to the Lorentz space contraction, the cloud f is so much pressed inside the fiber (point) that its size is $\lambda_f(\varepsilon) = \frac{hc}{(\varepsilon\, \mu_\Sigma \sqrt{T_{\dot f}})^{2/3}}$ that is compatible with the size of the cloud $\dot f$ equal to $\lambda_{\dot f} = hc / T_{\dot f}$. Under these circumstances, the evolution of the pure (coherent) ensemble f is broken, and the irreversible quantum transition $f \to \dot f$ begins (the transition matrix element of this process is described by a non-Hermitian form because the quantum theory of a bi-Hamiltonian system is non-unitary, see [2]). The transition terminates by creating the mixed ensemble — a downpour of $N \sim \eta / \mu_\Sigma$ particles[11]. Hereby, the entropy increases, of course.

In the quantum transition $f \to \dot f$, the energy $T_f - (-T_{\dot f}) = T_f + T_{\dot f} \approx T_{\dot f}$ is released (quanta $\dot f$ have negative energies, see [2], hereat $T_f << T_{\dot f}$). If, in every fiber where there is our dynamical system, the transition $f \to \dot f$ takes place, the total energy of a downpour equals to $2\eta \frac{T_{\dot f}}{\mu_\Sigma}$ (here, $N = 2\eta / \mu_\Sigma$ is the number of transitions equal to the number of particles in the downpour). The difference $2 \frac{\eta}{\mu_\Sigma} T_{\dot f} - 2\varepsilon_c =$ $= 2 \frac{T_{\dot f}}{\mu_\Sigma}(\eta - 1)$ is a maximal gain in energy and the ratio $2 \frac{T_{\dot f}}{\mu_\Sigma}(\eta - 1) / 2 \frac{T_{\dot f}}{\mu_\Sigma} = \eta - 1 \sim 10^{12}$ is a maximal efficiency of our machine — the bi-Hamiltonian dynamical system produces particle downpours.

The transition $f \to \dot f$ takes place in fact not in each fiber where there is the system (the rest of quanta f forms a so-called dark matter). Taking into account this circumstance, the efficiency is $\alpha\eta$, where $0 \le \alpha \le 1$.

Thus, the non-completeness (non-closedness) of the Heisenberg — Schrodinger quantum mechanics turns on *a new energy source* — a bi-Hamiltonian dynamical system [12]. In connection with this, it is very important to note that if a dynamical system in whole is a Lagrangian (or Hamiltonian) one according to the well-known Noether theorem, such a system is characterized by energy-momentum integral. A decisive role in the proof of the theorem is played by the condition of connectness and homogeneity of the space-time (Lagrangian plane) [13]. But namely this condition is broken in the critical situation when the space-time from a continuum turns into a discontinuum, and a new kind of dynamics appeares [2]. Namely the bi-Hamiltonian character of the system (two sets of 4-momentum p_μ and $\dot p_\mu$ are connected one with other by the complementary condition $[p_\mu, \dot p_\nu] \neq 0$, see [2]) is a reason for the irreversible pump of energy into the Lagrangian particle field system at the moment of irreversible quantum transition $f \to \dot f$ (hence, the perpetuum mobile is possible !).

The conclusion about non-closedness (non-conservativeness) of the elementary particle world follows from a serious reliable mathematics. Now it looks like a sedition, but we have to reconcile ourselves to this fact like in the case of causality breach. Logical analysis of the problem shows that neither the causality principle nor the conservation energy law are universal laws of Nature. They are consequences of that mathematics which is used for the description of Lagrangian dynamical systems, and therefore they have a limited application region. It is possible, in a new mathematics used for the description of a new level of physical reality (subquantum level or submicroworld), these principles will be replaced by others (after all, only mathematics may answer what laws make sense in the given physical theory).

6. In conclusion, we would like to stop at the role of the quantum transition $f \to \dot f$ in the problem of non-conservation of the fermionic (baryonic) charge. As a result of the transition, the pure ensemble of granules

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[10] In this connection, one can say that, at moderate energies due to a large size of granules within a particle ($\lambda_f(M_\Sigma) \sim 10^{-16}$ cm $>> 10^{-20}$ cm), emptinesses ('wounds") between granules (points of discontinuum) are as if 'healed" (Leibniz called these 'hiatuses"). As a result, the image of space-time continuum is arisen with the Lebesgue measure dX and continuous functions $\psi(X)$ (hereby, we can speak about reversibility of the phase transition $M_X \leftrightarrow M'_X$).

[11] Certainly, it is insufficient to go to the coordinate system in which a particle has an energy ε_c (in the case of one particle, the energy is not Lorentz-invariant). It is necessary to collide at least two particles with the total energy $\ge 2\varepsilon_c$ in the CMS (in this case, $2\varepsilon_c$ is Lorentz-invariant). In this case, the space-time is indeed two-dimensional (see [2]) and, as a result, the downpour has a jet structure.

[12] Non-closedness of usual quantum mechanics is a consequence of a simple purely mathematical fact concerning the non-closedness of the ring of finite-dimensional representations of the group SU(2), by which spin properties of particles are described, see [10].

[13] It is important to note that the proof of the Noether theorem bases solely on the means of the Lagrangian mechanics and has a meaning only for Lagrangian dynamical systems (compare with the von Neumann theorem about impossibility of hidden parameters in the frame of usual quantum mechanics, see footnote 1.

(sum) $\psi'(X) = \sum_{i=1}^{N} \delta_{X,X_i} \psi'(X_i)$ is transformed into a mixed ensemble of particles (product) $\prod_{i=1}^{N} \psi(X^{(i)}, Y^{(i)})$, where $\psi(X^{(i)}, Y^{(i)})$ is a field of particles, grown together with a space-time map $X_\mu^{(i)}$ from the point X_i of the discontinuum. Thus, in the case of fermions, N fermions (baryons and leptons) are originated from one fermion. In this case, the transition from the linear space (of granules) to the algebra (of particle fields) takes place, i.e., the transition from one algebraic structure to another one occurs. It is important to note that only in the case of discontinuum, the pure ensemble $\psi'(X) = \sum_i \delta_{X,X_i} \psi'(X_i)$ is, at the same time, a mixed one[14]. In fact, $\delta_{X,X'}$ has all properties of projection operator: $\delta^+_{X,X'} = \delta_{X',X} = \delta_{X,X'}$, $\delta^2_{X,X'} = \delta_{X,X'}$ (but there is an uncountable set of such operators). Therefore, for any operator A, we have $\bar{\psi}(X)\, A\, \psi(X) = \sum_i \delta_{X,X_i} \bar{A}(X_i)$, where $\bar{A}(X_i) = \bar{\psi}'(X_i)\, A\, \psi'(X_i)$, i.e., *only 'diagonal" elements give the contribution, but non-diagonal ones which include phase interference are not appeared.*

It is important to keep in mind that to write a mixed ensemble in the form of the sum of its constituents is not obligatory. It may be written, for example, as the set of numbers $(\psi'(X_1),..., \psi'(X_n))$ (in the Dirac case, $\psi'(X_i)$ are Grassmannian numbers, see [2]). Therefore, we may consider that the phase transition $M_X \to M'_X$ is accompanied by the transition from the linear space $H(M_X)$ to another more general algebraic structure (as entropy grows), and we use this possibility. Due to the irreversibility of the quantum transition $f \to \dot{f}$, such a process is irreversible too.

[14] In usual quantum mechanics, such is impossible, and the von Neumann theorem is based on this circumstance (see [1], Capture 4, n.2). A transition from one algebraic structure to another one is connected with the transition from the pure ensemble to a mixed one and in quantum mechanics as well. So, under the measurement of a magnitude A in the pure ensemble described by the vector $\psi = \sum_n c_n \psi_n$ (ψ_n's are eigenvectors of the operator A), a mixed ensemble is arisen. It is described by a statistical matrix $U = \sum_n |c_n|^2 P_n$, where P_n is the projector on the state ψ_n. The matrix U may be written in the form of a product $U = \prod_n e^{-\alpha_n P_n}$ if we put $|c_n|^2 = e^{-\alpha_n}$ and use the conditions $P_n^2 = P_n$, $P_n P_m = 0$ $(n \neq m)$, $\sum_n P_n = 1$. The technics of projection operators used by von Neumann for description of a mixed ensemble is possible only in the case of *separable* Hilbert space. In the case of *non-separable* one, such a technics is impossible (therefore, the von Neumann proof does not hold).

The transition is prepared beforehand by the second-quantized procedure of granules when the linear space of functions $\psi'(X)$ is endowed by a multiplication law and (in the most important Dirac case) obeys the quantum conditions

$$\{\psi'(X_i), \bar{\psi}'(X_j)\} = 0 \qquad (10)$$

(here, $\{.,.\}$ is the anticommutator, see [2]). Conditions (10) define the Grassmannian algebra $\oplus_i S_8^{(*)}(G, i)$. The complete picture is the following. From the beginning, we have a mapping $\sum_{i=1}^{N} \delta_{X,X_i} \psi'(X_i) \to (\psi'(X_1),...,\psi'(X_N))$. In this process, the probabilistic (non-classical)nature of waves $\psi'(X)$ (emphasized by the Copenhagen interpretation of quantum mechanics) is seen. Then the enclosure is considered as

$$(\psi'^{(X_1)},...,\psi'^{(X_N)}| \to (\Phi^{(1)},...,\Phi^{(N)}) \to$$
$$\to \Phi^{(1)} \times \cdots \times \Phi^{(N)} \to \Phi^{(1)} \wedge \cdots \wedge \Phi^{(N)},$$

where $\psi'(X_i) \to \Phi^{(i)}$ is the mapping of the i-th copy of the algebra $S_8^{(*)}(G)$ into the Heisenberg algebra $h_8^{(*)}$ ($\Phi^{(i)}$ are the generators of the i-th copy of this algebra). $\wedge$ is the external multiplication (inherited from the Grassmannian algebra). Further we consider the non-Fock representation of the algebra $h_8^{(*)}$ in the dual pair of topological vector spaces $(\vec{F}, \vec{F})$ (this part of the theory is non-unitary). Then the transition matrix elements

$$\langle \dot{f}(\dot{x}^{(1)}), \Phi^{(1)} f^{\Sigma^{(1)}}(x^{(1)}\rangle \wedge \cdots \wedge \langle \dot{f}(\dot{x}^{(N)}), \Phi^{(N)} \times$$
$$\times f^{\Sigma^{(N)}}(x^{(N)})\rangle$$

and particle fields connected with them

$$\psi^{\Sigma^{(1)}}(X^{(1)}, Y^{(1)} \wedge \cdots \wedge \psi^{\Sigma^{(N)}}(X^{(N)}, Y^{(N)})$$

are considered (see [2]). It is important to emphasize that the fields $\psi^\Sigma(X, Y)$ appear with their *a priori* standardization defined by the bi-Hamiltonian system and, in particular, by the transition $f \to \dot{f}$ (the previous space normalization $(\psi, \psi) = \int |\psi(X)|^2 dX = 1$ is broken). After the switching on interactions between the fields $\psi^\Sigma(X, Y)$, the coupling constants (as to strong interaction) are determined by an *a priori* renormalization, and the fields themselves have the usual space standardization.

So far as the quantum transition $f \to \dot{f}$ is described by a non-unitary quantum scheme in which the notion of probability is absent, the total probability is not preserved in the process $\psi \to \prod_{i=1}^{N} \psi_i$ (where $N = \eta$): N fermions may be arisen from one [15]. However, there is some subtlety: perhaps not all quanta f will transit into $\dot{f}$. Then the manifolding coefficient N will be equal to $\alpha\eta < \eta$ (see earlier).

In [12], it was shown that the fermion-antifermion asymmetry of the representation space $\vec{F}$ as well as *P, C, T* are connected with the structure of the space $\vec{F}$. All this means that, in the foundation of our Worldbuilding, such laws of laboratory physics as energy conservation, fermionic charge conservation, probability conservation, causality, and *P, C, T* symmetry are invalid [16]. All these laws are inherent only to Lagrangian or Hamiltonian physics.

7. An answer to the main question of quantum mechanics, 'why has a particle wave function the probabilistic sens?" may be as follows: the particle's indivisibility is not absolute. In a potential, a particle is the coherent ensemble of $N(\varepsilon)$ similar particles. The latter are hidden parameters. Under usual circumstances (moderate energy ε), this potential may be accounted by statistical manner only and cannot be banished.

8. Now we may certainly say that the simple join of the special relativity demands with the principles of the Heisenberg — Schrodinger quantum mechanics (MEQM) established by Feynman, Schwinger, and Tomonaga is insufficient for building a consequent interaction particle theory free from ultraviolet divergences. For this purpose, HEQM and its natural continuation — non-unitary quantum mechanics [2] — are needed. From the latter, a new field particle theory free from the abovementioned troubles follows, see [2].

[15] Note that none of the known interactions posesses such a property. Nevertheless, the hypotesis about non-conservation of the baryonic charge was already suggested earlier [11].

[16] In spite of paradoxality of this statement, the suggested theory is in accordance with experimental data. In [13], the spectral mass formula for fundamental hadrons is obtained. (By comparison of this formula with experimental data [14], the numerical value of the third universal constant k was obtained). In [15], the masses of e, μ, and τ leptons are found. Concerning W, Z intermediate mesons, one can say that they are absent in the theory. About a new theory of weak interaction, see [16]. The bilocal field theory of smearing particles is attemped for calculation of quantum electrodynamical effects (radiative corrections) in [17]. In [2], the cosmological aspects of bi-Hamiltonian dynamical systems are considered and the Big-Bang mechanism came to light.

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