Contemporary development of Einstein's ideas on space-time and Brownian motion

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Abstract

Development of the contemporary theory of physical phenomena in the microcosm is considered to be a result of development of Einstein's ideas on a possibility of the event space modification and on a possibility of stochastic (Brownian) motion of free particles. One considers the space-time modification, based on a new conception of geometry. In the framework of this conception any geometry is obtained as a result of the proper Euclidean geometry deformation. In the framework of this conception it is possible such a space-time geometry, where the free particle motion appears to be stochastic, although the geometry in itself remains to be deterministic. The stochasticity intensity depends on the particle mass. It is small for particle of a large mass, and it is essential for the particle of a small mass. The space-time geometry may be chosen in such a way, that the statistical description of random world lines of particles be equivalent to the quantum description (the Schrödinger equation). At such a choice of the space-time geometry the world function depends on the quantum constant, and the universal character of the quantum constant is a corollary of the fact, that all physical phenomena take place in the space-time, whose properties depend on the value of the quantum constant. The stochastic motion of free particles may be considered to be a kind of the relativistic Brownian motion, whose properties are conditioned by the properties of the space-time geometry. At such a description the quantum principles are not used. They can be obtained as a corollaries of the statistical description of nonrelativistic stochastic particles. The nonrelativistic quantum principles may not be used for description of relativistic phenomena. They are to be modified. This modification should be obtained from the statistical description of the relativistic stochastic particles.

1 Introduction

Papers [1, 2] by A. Einstein on modification of the event space model and the Brownian particle motion concerned the most actual physical problems of the beginning of the 20th century. Elimination of the absolute simultaneity, suggested by A. Einstein, generated a modification of the event space. Isaac Newton considered the event space as the direct product of time and of the three-dimensional space. A. Einstein suggested to replace the Newtonian event space by united event space (space-time) with the common geometry. In his paper [1] he formulated first the idea on possibility and necessity of the event space modification. This idea, known as a revision of the space-time conception, is connected closely with the general direction of the theoretical physics development – the increasing geometrization of physics and increasing role of the space-time structure in the explanation of physical phenomena. The first modification of the event space structure, produced by A. Einstein and the construction of the space-time geometry, carried out by G. Minkowski made a start for further modifications of the space-time. The second modification of the space-time was produced by A. Einstein in the beginning of the 20th century. This modification admitted the space-time curvature, which was generated by the matter placed in the space-time. The second modification, known as the general relativity, is connected with the supposition that the space-time geometry may be described by the Riemannian geometry.

In the beginning of the 20th century one discovered that the free particles of small mass move stochastically. The motion of free particles depends only on the space-time properties, and one needs the third modification of the space-time geometry. One needed such a space-time geometry, where the free particle motion be primordially stochastic and the particle mass be geometrized. Such geometry is impossible in the framework of the Riemannian geometry, which was used for the space-time geometry in the beginning of the 20th century.

The third modification of the space-time, has been produced only in the end of the 20th century. It was generated by appearance of the non-Riemannian geometry (T-geometry), possessing the earlier unknown property, that in the space-time with such a geometry the free particle motion is primordially stochastic (random). This stochasticity has no other reason, except for the space-time properties. Besides, the space-time with T-geometry contains an "elementary length", determined by the quantum constant, and the intensity of the stochasticity depends on the particle mass (on ratio of the elementary length to the particle geometrical mass). The use of T-geometry as a space-time geometry admits one to refuse the idea about enigmatic quantum nature of the matter and to explain the quantum phenomena as natural manifestation of the space-time properties.

The Einstein's idea on possibility of the random particle motion without a construction of a model of the phenomena, generating incident, was advanced in the paper [2]. The Brownian motion was considered to be dissipative and nonrelativistic. At the further development of the stochastic particle motion investigation one discovered that the individual quantum particle is stochastic (in a sense Brownian).

However, the "Brownian motion" of the quantum particles appeared to be *nondissipative and relativistic.* The random component of the quantum particle motion is always relativistic, even in the case, when the regular component of the particle motion is nonrelativistic. This circumstance is very important, because the statistical description of the random relativistic motion of a particle distinguishes conceptually from the nonrelativistic random motion.

At this point we face with the importance of the true understanding of the relativity theory and application of this understanding to the construction of the statistical description. It is a common practice to consider, that for taking into account the relativity theory at a description of a physical phenomenon it is sufficient that the dynamical equations describing this phenomenon can be written in the relativistically covariant form. Indeed, this condition is necessary for the true relativistic description, but it is not sufficient. For instance, describing the free particle motion, it is important not only to write dynamical equations correctly. It is necessary more to point out correctly what is the particle state. The classics of the relativity theory knew this circumstance [3]. In the nonrelativistic theory the state of several particles is described by their positions and momenta, i.e. by some point in the phase space. The values of positions and momenta are taken at the same time moment, which is common for all particles. It means that the physical object is a particle, i.e. a point in the three-dimensional space of positions.

In the relativistic theory one may not describe the state of several particles by a point in the phase space, i.e. by positions and momenta taken at the same time moment, as far as there is no absolute simultaneity. Positions and momenta of several particles taken at the same time correspond to different sets of events in different coordinate systems. In the case of deterministic particles the positions and momenta, taken at the same time in one inertial coordinate system, can be recalculated to the moving inertial coordinate system, if the particle are deterministic and their dynamic equations are known. However, one cannot do this in the case of stochastic particles, for which there are no dynamic equations. It is a reason, why the state of a relativistic particle is described by the world line. The world line (but not a point in the phase space) is the physical object, liable to the statistical description.

2 Statistical description of relativistic particles

Any statistical description is a description of *physical objects.* In the nonrelativistic case the physical objects are points of the three-dimensional space. In the relativistic case the physical objects are lengthy objects: world lines. Statistical description of nonrelativistic particles distinguishes from that of relativistic particles in the relation, that the state density ρ at the nonrelativistic description is defined by the relation

$$dN = \rho dV \tag{2.1}$$

whereas in the relativistic case the state density j^k is described by the relation

$$dN = j^k dS_k \tag{2.2}$$

where dN is the flux of world lines through the infinitesimal area dS_k. It follows from the relations (2.1) ¨ (2.2) that in the nonrelativistic case one can introduce the concept of the probability density of the state on the basis of the nonnegative quantity ρ, whereas in the relativistic case it is impossible, because one cannot construct the probability density on the basis of the 4-vector j^k.

Statistical description is a description of the statistical ensemble, i.e. the dynamic system consisting of many identical independent systems. These systems may be dynamical or stochastic. However, the statistical ensemble is a dynamic system in any case. It means, that there are dynamic equations, which describe the evolution of the statistical ensemble state. Investigation of the statistical ensemble as a dynamic system admits one to investigate the mean characteristics of the stochastic systems, constituting this ensemble. Besides, in the nonrelativistic case the statistical ensemble is a tool for calculation of different mean quantities and distributions, because in this case the ensemble state may be interpreted as the probability density of the fact, that the system state is placed at some given point of the phase space.

The statistical ensemble is used usually in the statistical physics, where the statistical description of the deterministic nonrelativistic systems is produced. The principal property of the statistical ensemble (*to be a dynamic system*) is perceived as some triviality, and the statistical ensemble is considered usually as a tool for calculation of mean values of different functions of the state. When one tries to apply this conception of the statistical ensemble to description of relativistic stochastic particles, it is quite natural that one fails, because the probabilistic conception of the statistical ensemble (statistical ensemble as a tool for calculation of mean values) cannot be applied here. The problem of construction of a dynamic system (statistical ensemble) from stochastic systems is not stated simply.

We display in the example of free nonrelativistic particles, how the statistical ensemble is constructed. The action $\mathcal{A}_{\mathcal{S}_{\mathrm{d}}}$ for the free deterministic particle $\mathcal{S}_{\mathrm{d}}$ has the form

$$\mathcal{A}_{\mathcal{S}_{\mathrm{d}}}[\mathbf{x}] = \int \frac{m}{2}\left(\frac{d\mathbf{x}}{dt}\right)^2 dt \tag{2.3}$$

where $\mathbf{x} = \mathbf{x}(t)$. For the statistical ensemble $\mathcal{A}_{\mathcal{E}[\mathcal{S}_{\mathrm{d}}]}$ of free deterministic particles we obtain the action

$$\mathcal{A}_{\mathcal{E}[\mathcal{S}_{\mathrm{d}}]}[\mathbf{x}] = \int \frac{m}{2}\left(\frac{d\mathbf{x}}{dt}\right)^2 dt d\boldsymbol{\xi} \tag{2.4}$$

where $\mathbf{x} = \mathbf{x}(t, \boldsymbol{\xi})$ is a 3-vector function of independent variables $t, \boldsymbol{\xi} = \{\xi_1, \xi_2, \xi_3\}$. The variables (Lagrangian coordinates) $\boldsymbol{\xi}$ label particles $\mathcal{S}_{\mathrm{d}}$ of the statistical ensemble $\mathcal{E}[\mathcal{S}_{\mathrm{d}}]$. The statistical ensemble $\mathcal{E}[\mathcal{S}_{\mathrm{d}}]$ is a dynamic system of hydrodynamic type.

The statistical ensemble $\mathcal{E}[\mathcal{S}_{\mathrm{st}}]$ of free *stochastic* particles $\mathcal{S}_{\mathrm{st}}$ is a dynamical system, described by the action

$$\mathcal{A}_{\mathcal{E}[\mathcal{S}_{\mathrm{st}}]}[\mathbf{x}, \mathbf{u}_{\mathrm{df}}] = \int \left\{ \frac{m}{2}\left(\frac{d\mathbf{x}}{dt}\right)^2 + \frac{m}{2}\mathbf{u}_{\mathrm{df}}^2 - \frac{\hbar}{2}\boldsymbol{\nabla}\mathbf{u}_{\mathrm{df}} \right\} dt d\boldsymbol{\xi} \tag{2.5}$$

where $\mathbf{u}_{\mathrm{df}} = \mathbf{u}_{\mathrm{df}}(t, \mathbf{x})$ is a diffusion velocity, describing the mean value of the stochastic component of velocity, whereas $\frac{d\mathbf{x}}{dt}(t, \boldsymbol{\xi})$ describes the regular component of the particle velocity, and $\mathbf{x} = \mathbf{x}(t, \boldsymbol{\xi})$ is the 3-vector function of independent variables $t, \boldsymbol{\xi} = \{\xi_1, \xi_2, \xi_3\}$. The variables $\boldsymbol{\xi}$ label particles $\mathcal{S}_{\mathrm{st}}$, substituting the statistical ensemble. The operator

$$\boldsymbol{\nabla} = \left\{ \frac{\partial}{\partial x^1}, \frac{\partial}{\partial x^2}, \frac{\partial}{\partial x^2} \right\}$$

is defined in the coordinate space $\mathbf{x}$.

The action for the single stochastic particle is obtained from the action (2.5) by omitting integration over $\boldsymbol{\xi}$. However, the obtained action

$$\mathcal{A}_{\mathcal{S}_{\mathrm{st}}}[\mathbf{x}, \mathbf{u}_{\mathrm{df}}] = \int \left\{ \frac{m}{2} \left(\frac{d\mathbf{x}}{dt} \right)^2 + \frac{m}{2} \mathbf{u}_{\mathrm{df}}^2 - \frac{\hbar}{2} \boldsymbol{\nabla} \mathbf{u}_{\mathrm{df}} \right\} dt \tag{2.6}$$

has only symbolic sense, as far as the operator $\boldsymbol{\nabla}$ is defined in some vicinity of the point $\mathbf{x}$, but not at the point $\mathbf{x}$ itself. It means, that the action (2.6) does not determine dynamic equations for the particle $\mathcal{S}_{\mathrm{st}}$, and the particle appears to be stochastic, although dynamic equations for the statistical ensemble of such particles exist. They are determined by the action (2.5). Thus, the particles described by the action (2.5) are stochastic, because there are no dynamic equations for a single particle. In the case, when the quantum constant $\hbar = 0$, the actions (2.6) and (2.3) coincide, because in this case it follows from (2.6), that $\mathbf{u}_{\mathrm{df}} = 0$.

Variation of action (2.5) with respect to variable $\mathbf{u}_{\mathrm{df}}$ leads to the equation

$$\mathbf{u}_{\mathrm{df}} = -\frac{\hbar}{2m} \boldsymbol{\nabla} \ln \rho, \tag{2.7}$$

where the particle density ρ is defined by the relation

$$\rho = \left[\frac{\partial (x^1, x^2, x^3)}{\partial (\xi_1, \xi_2, \xi_3)} \right]^{-1} = \frac{\partial (\xi_1, \xi_2, \xi_3)}{\partial (x^1, x^2, x^3)} \tag{2.8}$$

The relation (2.7) is the expression for the mean diffusion velocity in the Brownian motion theory.

Eliminating $\mathbf{u}_{\mathrm{df}}$ from the dynamic equation for $\mathbf{x}$, we obtain dynamic equations of the hydrodynamic type.

$$m \frac{d^2 \mathbf{x}}{dt^2} = -\boldsymbol{\nabla} U (\rho, \boldsymbol{\nabla} \rho), \qquad U (\rho, \boldsymbol{\nabla} \rho) = \frac{\hbar^2}{8m} \left(\frac{(\boldsymbol{\nabla} \rho)^2}{\rho^2} - 2 \frac{\boldsymbol{\nabla}^2 \rho}{\rho} \right) \tag{2.9}$$

By means of the proper change of variables these equations can be reduced to the Schrödinger equation [4].

However, there is a serious mathematical problem here. The fact is that the hydrodynamic equations are to be integrated, in order they can be described in terms of the wave function. The Schrödinger equation consists of two real equations. To obtain from them four hydrodynamic equations, one needs to take gradient from one of real components of the Schrödinger equation and to introduce proper designations. The inverse transition from hydrodynamic equations to their representation in terms of the wave function needs an integration. Three arbitrary functions appear as a result of this integration, and two-component wave function is constructed from these arbitrary functions [4]. The fact, that the Schrödinger equation can be written in the hydrodynamic form, is well known [5, 6]. However, the inverse transition from the hydrodynamic equations to the wave function was not known until the end of the 20th century [4], and the necessity of integration of hydrodynamic equations was a reason of this fact.

Derivation of the Schrödinger equation as a partial case of dynamic equations, describing the statistical ensemble of random particles (2.5), shows that the wave function is simply a method of description of hydrodynamic equations, but not a specific quantum object, whose properties are determined by the quantum principles. At such an interpretation of the wave function the quantum principles appear to be superfluous, because they are necessary only for explanation, what is the wave function and how it is connected with the particle properties. All remaining information is contained in the dynamic equations. It appears that the quantum particle is kind of stochastic particle, and all its exhibitions can be interpreted easily in terms of the statistical ensemble of stochastic particles (2.5).

The idea of that, the quantum particle is simply a stochastic particle, is quite natural. It was known many years ago [7]. However, the mathematical form of this idea could not be realized for a long time because of the two problems considered above (incorrect conception on the statistical ensemble of relativistic particles and necessity of integration of the hydrodynamic equations).

3 Necessity of the next modification of the space-time model

Thus, the quantum mechanics can be founded as a mechanics of stochastic particles. However, it is not known, why the motion of free particles is stochastic and from where the quantum constant appears. There are two variants of answer to these questions.

1. The stochasticity of the free particle motion is explained by the space-time properties, and the quantum constant is a parameter, describing the space-time properties.

2. The stochasticity of the free particle motion is explained by the special quantum nature of particles. The motion of such a particle distinguishes from the motion of usual classical particle. There is a series of rules (quantum principles), determining the quantum particle motion. The universal character of the quantum constant is explained by the universality of the quantum nature of all particles and other physical objects. As to event space, it remains to be the same as at Isaac Newton.

It is quite clear that the first version of explanation is simpler and more logical, as far as it supposes *only a change of the space-time geometry.* The rest, including the principles of classical physics, remains to be unchanged. The main problem of the first version was an absence of the space-time geometry with such properties. In general, one could not imagine that such a space-time geometry can exist. As a result in the beginning of the 20th century one chose the second version. After a large work the necessary set of additional hypotheses (quantum principles) had been invented. One succeeded to explain all nonrelativistic quantum phenomena. However, an attempt of the quantum theory expansion to the relativistic phenomena lead to the problem, which is formulated as *join of nonrelativistic quantum principles with the principles of the relativity theory.*

The choice of the proper space-time geometry appeared to be possible only after a change of the geometry conception, which determines what (generalized) geometries are possible, in general. The new conception of geometry appeared to be very simple. Any generalized geometry is a modification of the proper Euclidean geometry. Constructing a generalized geometry, one repeated conventionally the reasonings of Euclid. At these reasonings one uses another axioms and deform the space in addition. In the new conception one suggests to obtain generalized geometries by means of a simple deformation of the space.

Any geometry is a totality of all geometrical objects and relations between them. The algorithms of the geometrical objects construction and those of relation between them has been developed in the proper Euclidean geometry. Besides, the principles of these algorithms construction have been developed and compatibility of all axioms, lying in the foundation of these principles has been proved [8]. All this admits one to consider the proper Euclidean geometry as already constructed geometry. Conventionally one uses a modification of the Euclidean algorithms for a construction of the generalized geometry. In the new conception of the geometry the modification of the Euclidean algorithms is simplified essentially. In the new geometry conception only operand of the Euclidean algorithm is different in different generalized geometries, but the algorithm in itself remains to be the same for all generalized geometries.

In order such a representation of Euclidean algorithms to be possible, it is necessary to use as the operand such a quantity, which determine the generalized geometry completely. In particular, such an operand is to determine the proper Euclidean geometry. Such a quantity is the world function $\sigma = \frac{1}{2}\rho^2$, where the quantity ρ is the distance between two points of the space [9]. The circumstance, that the distance (or the world function) is an important geometrical quantity was known long ago. But the fact that the world function is the *quantity, which determines the geometry completely*, became to be known only in the end of the 20th century [10, 11]. It was proved, that the proper Euclidean geometry is determined completely by its world function σ_{E}, if it satisfies the set of conditions, written in terms of σ_{E}. It means, that the algorithm of any proposition $\mathcal{S}$ of the proper Euclidean geometry $\mathcal{G}_{\mathrm{E}}$ can be represented in the form $S(\sigma_{\mathrm{E}})$, where S is the Euclidean algorithm of construction of the proposition $\mathcal{S}$. Then the analogous proposition $\mathcal{S}$ of the generalized geometry $\mathcal{G}$ is described by the same algorithm $S(\sigma)$, but with other operand σ, which is the world function of the geometry $\mathcal{G}$.

As far as the construction algorithms of all propositions of the proper Euclidean geometry are supposed to be known, the construction algorithm of all propositions of a generalized geometry appears to be very simple. Using this algorithm, one can construct any σ-immanent geometry, i.e. the geometry described completely by its world function σ. The class of such geometries is very wide. It is much more powerful, than the class of the Riemannian geometries, which are used usually for description of the space-time properties. We shall refer to the σ-immanent geometries as the physical geometries, because such geometries are very convenient for description of the space-time, whose main characteristic is interval between two events (points in the space-time). Any change of the space-time interval is accompanied by a change of the world function, and it means some deformation of the space-time.

The σ-immanent geometry is called also the tubular geometry (shortly T-geometry), because in such a geometry a hallow tube plays the role of the straight line. A tube as a generalization of the one-dimensional straight is the general case of T-geometry. The proper Euclidean geometry, where the tube degenerates into one-dimensional straight line, is a very special (degenerate) case of T-geometry. If one constructs the generalized geometry on the basis of the deformation, which does not violate one-dimensionality of the Euclidean straight (the Riemannian geometry is constructed like this), one may construct only degenerate geometry with one-dimensional lines instead of tubes. The stochastic motion of free particles is characteristic for the nondegenerate space-time T-geometry. It is connected with the fact, that the 4-momentum of a free particle is transferred along the world line in parallel, and simultaneously it is tangent to the world line, i.e. the momentum 4-vector determines the world line direction. If there is only one direction parallel to the direction of the momentum vector at the point P, the direction of the momentum vector at the neighbor point P' is determined single-valuedly, and the world line of the particle appears to be deterministic. If there are many directions parallel to the momentum vector at the point P, the direction of the momentum vector at the neighbor point P' appears to be multivarious, and the world line appears to be random, because the direction of the tangent vector appears to be random. The straight is defined in the proper Euclidean geometry (as in any T-geometry) as a set of such points R, that the vector $\mathbf{P}_0\mathbf{R}$ is parallel to the vector $\mathbf{P}_0\mathbf{P}_1$, which determines the direction of the straight, passing through the points P_0, P_1, given this straight.

Transformation of the one-dimensional Euclidean straight into a tube is connected with the circumstance, that in the nondegenerate T-geometry there are directions (vectors) which are parallel to the given vector, but nonparallel between themselves. In other words, the parallelism property is intransitive, in general. In the framework of the Riemannian geometry there is only one homogeneous isotropic space-time geometry. It is the Minkowski geometry. The set of all homogeneous isotropic space-time geometries is described by the set of functions of one argument.

Such T-geometries are described by the world function of the form

$$\sigma = \sigma_{\mathrm{M}} + D\left(\sigma_{\mathrm{M}}\right) \tag{3.1}$$

where σ_{M} is the world function of the Minkowski geometry, and $D\left(\sigma_{\mathrm{M}}\right)$ is the distortion function, which vanishes for the Minkowski geometry. The free particle motion in such a space-time geometry is stochastic, in general. It is deterministic only in the case, when $D\left(\sigma_{\mathrm{M}}\right) = 0$ and the space-time T-geometry turns into the Minkowski geometry.

4 Contemporary state of the theory of physical phenomena in microcosm

The scheme of a fundamental physical theory is shown in the figure. This theory is a logical structure. The fundamental principles of the theory are shown below. The experimental data, which are to be explained by the theory are placed on high. Between them there are a set of logical corollaries of the fundamental principles. It is possible such a situation, when for some conditions one can obtain a list of logical corollaries, placed near the experimental data. It is possible such a situation, when some circle of experimental data and physical phenomena may be explained and calculated on the basis of this list of corollaries without a reference to the fundamental principles. In this case the list of corollaries of the fundamental principles may be considered as an independent physical theory. Such a theory will be referred to as the truncated theory, because it explains not all phenomena, but only a restricted circle of these phenomena (for instance, only nonrelativistic phenomena). Examples of truncated physical theories are known in the history of physics. For instance, the thermodynamics is such a truncated theory, which is valid only for the quasistatic thermal phenomena. The thermodynamics is an axiomatic theory. It cannot be applied to nonstatic thermal phenomena. In this case one should use the kinetic theory, which is a more fundamental theory, as far as it is applied both to quasistatic and nonstatic thermal phenomena. Besides, the thermodynamics can be derived from the kinetic theory as a partial case.

The truncated theory has a set of properties, which provide its wide application.

Firstly, the truncated theory is simpler, than the fundamental one, because a part of logical reasonings and mathematical calculations of the fundamental theory are used in the truncated theory in the prepared form. Besides, the truncated theory is located near experimental data, and one does not need long logical reasonings for its application.

Secondly, the truncated theory is a list of prescriptions, and it is not a logical structure in such extent, as the fundamental theory is a logical structure. The truncated theory is axiomatic, it contains more axioms, than the fundamental theory, as far as logical corollaries of the fundamental theory appear in the truncated theory as fundamental principles (axioms).

Thirdly, being simpler, the truncated theory appears before the fundamental theory, whose corollary it is. It is a reason of conflicts between the advocates of the fundamental theory and advocates of the truncated theory, because the last consider the truncated theory to be the fundamental one. Such a situation took place, for instance, at becoming of the statistical physics, when advocates of the axiomatic thermodynamics oppugn against Gibbs and Boltzmann. Such a situation took place at becoming of the doctrine of Copernicus-Galileo-Newton, when advocates of the Ptolemaic doctrine oppugn against the doctrine of Copernicus-Galileo-Newton. They referred that there was no necessity to introduce the Copernican doctrine, as far as the Ptolemaic doctrine is simple and customary. Only discovery of the Newtonian gravitation law and consideration of celestial phenomena, which cannot be described in the framework of the Ptolemaic doctrine, terminated the contest of the two doctrines.

The main defect of the truncated theory is an impossibility of its expansion over wider circle of physical phenomena. For instance, let the truncated theory explains nonrelativistic physical phenomena. It means, that the basic propositions of the truncated theory are obtained as corollaries of the fundamental principles and nonrelativistic character of the considered phenomena. To expand the truncated theory on relativistic phenomena, one needs to separate, what in the principles of the truncated theory is a corollary of fundamental principles and what is a corollary of nonrelativistic character of the considered phenomena. A successful separation of the two factors means essentially a perception of the theory truncation and construction of the fundamental theory. If the fundamental theory has been constructed, the expansion of the theory on the relativistic phenomena is obtained by an application of the fundamental principles to the relativistic phenomena. The obtained theory will describe the relativistic phenomena correctly. It may distinguish essentially from the truncated theory, which is applicable for description of only nonrelativistic phenomena.

The conventional nonrelativistic quantum theory is a truncated theory, which is applicable for description of nonrelativistic phenomena only. This statement is called in question usually by researchers working in the field of the quantum theory. The problem of the relativistic quantum theory is formulated usually as a problem of unification of the nonrelativistic quantum principles with the principles of the relativity theory. Conventionally the nonrelativistic quantum theory is considered to be a fundamental theory. The relativistic quantum theory is tried to be constructed without puzzling out, what in the nonrelativistic quantum theory is conditioned by principles and what is conditioned by its nonrelativistic character. It is suggested that the linearity is the principle property of the quantum theory, and it is tried to be saved. However, the analysis shows that the linearity of the quantum theory is some artificial circumstance [12], which simplifies essentially the description of quantum phenomena, but it does not express the essence of these phenomena. The conventional approach to construction of the relativistic quantum theory is shown by the dashed line in the scheme. Following this line, the construction of the true relativistic quantum theory is as difficult, as discovery of the Newtonian gravitation law on the basis of the Ptolemaic conception. Besides, even we succeed to construct such a theory, it will be very difficult to choose the valid version of the theory, because it has no logical foundation. In other words, the conventional approach of construction of the relativistic quantum theory (invention of new hypotheses and fitting) seems to lead to blind alley, although one cannot eliminate the case that it appears to be successful.

Alternative way of construction of the relativistic theory of physical phenomena in the microcosm is shown by the solid line in scheme. It supposes derivation of fundamental principles and their subsequent application to the relativistic physical phenomena. Elimination of the nonrelativistic quantum principles is characteristic for this approach. This elimination is accompanied by the elimination of the problem of the unification of the nonrelativistic quantum principles with the relativity principles. Simultaneously one develops dynamical methods of the quantum system investigation, when the quantum dynamic system is investigated simply as a dynamic system. These methods are free of application of quantum principles. They are used for investigation of both relativistic and nonrelativistic quantum systems. A use of logical construction is characteristic for this approach. Invention of new hypotheses and fitting are not used.

Application of dynamical methods to investigation of the Klein-Gordon particle admits one to discover a special quantum field responsible for the particle production [13]. It is especially important, because in the classical physics such fields are not known. Application of dynamical methods to investigation of the Dirac particle admits one to establish, that the Dirac particle has an internal structure [14], which is described nonrelativistically [15]. Application of dynamic methods admits one to establish the interpretation of quantum phenomena, founded on the concept of the classical stochastic particle. As a result the multiplicity of interpretation of the wave function and other quantum phenomena has been eliminated. In particular, it was shown, that the Copenhagen interpretation, where the wave function describes an individual particle, is incompatible with the quantum mechanics formalism [16, 12]. These results cannot be obtained by the conventional methods, whose capacities are restricted by a use of the quantum principles. Thus, at construction of relativistic theory of physical phenomena in microcosm some optimism appears. It is generated by the derivation of fundamental principles and by application of the dynamic methods of investigation.

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