Multivariance as immanent property of the space-time geometry.

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Abstract

It shown that the space-time geometry is multivariant, and one cannot describe it completely, using formalism of the linear space. Tachyons and tachyon gas cannot be described in terms of the linear space formalism. To describe correctly the space-time geometry, one needs to use the metric approach and description in terms of the world function. In the framework of metric approach to geometry one can explain freely the dark matter nature.

Key words: multivariant geometry; metric approach; restriction on coordinates; tachyon gas; dark matter; Galiley phenomenon

1 Introduction

Multivariance of the space-time geometry is a such its property, when at the point C there are many vectors $\mathbf{CD}$, $\mathbf{CD}_1, \mathbf{CD}_2, ...$which are equivalent to a vector $\mathbf{AB}$ at the point A, but vectors $\mathbf{CD}$, $\mathbf{CD}_1, \mathbf{CD}_2, ...$are not equivalent between themselves. Multivariance of the space-time geometry appears only in the case, when the geometry is described in terms of the world function σ. In this case the geometry may be described in the coordinateless form, and restrictions imposed by a use of coordinate system are removed. Such a description is impossible in the case, when the space-time geometry is described in terms of the linear space (linear algebra) in some coordinate system. The space-time geometry $\mathcal{G}$ is a result of a generalization of the proper Euclidean geometry $\mathcal{G}_{\mathrm{E}}$. A generalization of the proper Euclidean geometry $\mathcal{G}_{\mathrm{E}}$ depends on the representation of the $\mathcal{G}_{\mathrm{E}}$.

In the metric approach [1] the space-time geometry is described by a structure σ, given on the set Ω of points (events) P. The structure σ is defined by the world function σ, which is a single-valued real function

$$\sigma: \quad \Omega\times\Omega\rightarrow\mathbb{R}, \quad \sigma(P,Q)=\sigma(Q,P), \quad \sigma(P,P)=0, \quad \forall P,Q\in\Omega \tag{1.1}$$

The world function has been introduced by Synge and Ruse for description of the Riemannian geometry [2, 3]. For description of the space-time geometry the world function has been used by Synge [4]. Representation of the proper Euclidean geometry $\mathcal{G}_{\mathrm{E}}$ in terms of the world function σ is called the σ-representation. Conventional representation of the proper Euclidean geometry $\mathcal{G}_{\mathrm{E}}$ in terms of the linear space and in some coordinate system is called the V-representation of $\mathcal{G}_{\mathrm{E}}$.

In the proper Euclidean geometry $\mathcal{G}_{\mathrm{E}}$ the world function σ has a special form σ_{E},

$$\sigma_{\mathrm{E}}(P,P')=\sigma_{\mathrm{E}}(x,x')=\frac{1}{2}\sum_{k=1}^{k=n}\left(x^k-x'^k\right)^2 \tag{1.2}$$

where $P=\{x^1,x^2,...x^n\}$, $P'=\{x'^1,x'^2,...x'^n\}$ are points of the n-dimensional Euclidean space E^n, $P,P'\in E^n$ and $x=\{x^1,x^2,...x^n\}$, $x'=\{x'^1,x'^2,...x'^n\}$ are coordinates in some Cartesian coordinate system K_n.

The way of generalization of $\mathcal{G}_{\mathrm{E}}$ depends essentially on the method of the $\mathcal{G}_{\mathrm{E}}$ representation. There are two methods of $\mathcal{G}_{\mathrm{E}}$ representation: (1) V-representation and (2) σ-representation [5].

At V-representation one uses axiomatic approach to $\mathcal{G}_{\mathrm{E}}$, when the Euclidean geometry is constructed on the basis of linear space $\mathcal{L}_n$. The linear space $\mathcal{L}_n$ is a set Ω_n of elements $u\in\Omega_n$. These elements u will be referred to as linear vectors (linvectors). Multiplication of a linvector $u\in\Omega_n$ by a real number a gives linvector $au\in\Omega_n$. Sum of two linvectors $u\in\Omega_n$ and $v\in\Omega_n$ gives a new linvector $(u+v)\in\Omega_n$. These operations has the linear properties, which can be found in any textbook on linear algebra. The term "linvector" (instead of conventional term "vector") is used, because any linvector $u\in\Omega_n$ exists in one copy.

On the contrary, vector $\mathbf{AB}$ in $\mathcal{G}_{\mathrm{E}}$ is defined as the ordered set $\mathbf{AB}=\{A,B\}\in\Omega\times\Omega$ of two points $A,B\in\Omega$, where Ω is the set of points of the space-time. Among vectors $\mathbf{PQ}\in\boldsymbol{\Omega}\times\boldsymbol{\Omega}$ of the Euclidean space E^n there are equivalent (equal) vectors, and there are many equivalent vectors $\mathbf{PQ}\in\boldsymbol{\Omega}\times\boldsymbol{\Omega}$. It is incorrect to use the same term for objects with different properties.

The set $\Omega_{\mathbf{AB}}$ of vectors $\mathbf{CD}$ which are equivalent to vector $\mathbf{AB}$ is defined as a set of vectors $\mathbf{CD}$ which are in parallel with $\mathbf{AB}$ and length $|\mathbf{CD}|$ and $|\mathbf{AB}|$ are equal.

$$\Omega_{\mathbf{AB}}=\{\mathbf{CD}|\left(\mathbf{CD}\mathrm{eqv}\mathbf{AB}\right)\} \tag{1.3}$$

$$\left(\mathbf{CD}\mathrm{eqv}\mathbf{AB}\right): \quad \left(\mathbf{CD}\upuparrows\mathbf{AB}\right)\wedge|\mathbf{CD}|=|\mathbf{AB}| \tag{1.4}$$

$$\left(\mathbf{CD}\upuparrows\mathbf{AB}\right): \quad \left(\mathbf{CD}.\mathbf{AB}\right)=|\mathbf{CD}|\cdot|\mathbf{AB}| \tag{1.5}$$

Here $(\mathbf{CD}.\mathbf{AB}) \in \mathbb{R}$ is the scalar product of two vectors $\mathbf{CD}$ and $\mathbf{AB}$ which is defined by the relation

$$(\mathbf{CD}.\mathbf{AB}) = \sigma_{\mathrm{E}}(C,B) + \sigma_{\mathrm{E}}(D,A) - \sigma_{\mathrm{E}}(C,A) - \sigma_{\mathrm{E}}(D,B) \tag{1.6}$$

$$|\mathbf{CD}|^2 = 2\sigma_{\mathrm{E}}(C,D) \tag{1.7}$$

Equivalence of two vectors $\mathbf{CD} \in \mathbf{\Omega} \times \mathbf{\Omega}$ and $\mathbf{AB} \in \mathbf{\Omega} \times \mathbf{\Omega}$ is defined in terms of the Euclidean world function σ_{E}. In the Cartesian coordinate system K_n, where the world function σ_{E} has the form (1.2) and points A, B, C, D have respectively coordinates x_A, x_B, x_C, x_D the scalar product (1.6) and $|\mathbf{CD}|$ take respectively the form

$$(\mathbf{CD}.\mathbf{AB}) = \sum_{k=1}^{k=n} \left(x_D^k - x_C^k\right)\left(x_B^k - x_A^k\right) \tag{1.8}$$

$$|\mathbf{CD}|^2 = \sum_{k=1}^{k=n} \left(x_D^k - x_C^k\right)^2 \tag{1.9}$$

These expressions coincide respectively with the scalar product of two linvectors $(u_{\mathbf{CD}}.u_{AB})$ and with $|u_{\mathbf{CD}}|^2$, provided $u_{\mathbf{CD}}$ and u_{AB} have coordinates respectively $\left(x_D^k - x_C^k\right)$ and $\left(x_B^k - x_A^k\right)$.

In $\mathcal{G}_{\mathrm{E}}$ the equivalence relation (1.4) is reflexive, symmetric and transitive. Then the set $\Omega_{\mathbf{AB}}$ is the equivalence class of the vector $\mathbf{AB}$. One may identify the linvector $u_{\mathbf{AB}} \in L_n$ with the equivalence class $\Omega_{\mathbf{AB}}$ of the vector $\mathbf{AB} \in \mathbf{\Omega} \times \mathbf{\Omega}$. Axiomatics of the linear space L_n and operations in L_n can be used for construction of geometric relations in $\mathcal{G}_{\mathrm{E}}$. After generalization of $\mathcal{G}_{\mathrm{E}}$, when σ_{E} is replaced by another world function σ, the equivalence relation (1.4) ceases to be transitive, in general. As a result the set $\Omega_{\mathbf{AB}}$ ceases to be an equivalence class of the vector $\mathbf{AB}$. One may not identify the linvector $u_{\mathbf{AB}} \in L_n$ with the set $\Omega_{\mathbf{AB}}$, because not all vectors $\mathbf{CD} \in \Omega_{\mathbf{AB}}$ are equivalent between themselves. The geometry $\mathcal{G}$, obtained as a result of the replacement $\sigma_{\mathrm{E}} \to \sigma$, appears to be multivariant.

At the generalization of the proper Euclidean geometry one obtains a physical geometry $\mathcal{G}$, replacing the world function σ_{E} by the world function σ of the geometry $\mathcal{G}$ in all geometric relations of $\mathcal{G}_{\mathrm{E}}$, which can be expressed in terms of only the Euclidean world function σ_{E}. These relations will referred to as general geometric relations. Expressions (1.6), (1.7) are examples of general geometric relations.

Another example of such a relation is definition of linear dependence of n vectors $\mathbf{P}_0\mathbf{P}_1, \mathbf{P}_0\mathbf{P}_2,...\mathbf{P}_0\mathbf{P}_n$. Vectors $\mathbf{P}_0\mathbf{P}_1, \mathbf{P}_0\mathbf{P}_2,...\mathbf{P}_0\mathbf{P}_n$ are linear dependent, if the condition

$$F_n(\mathcal{P}^n) = 0 \tag{1.10}$$

is fulfilled. Here $\mathcal{P}^n = \{P_0, P_1, ...P_n\}$ and $F_n(\mathcal{P}^n)$ is the Gram determinant

$$F_n(\mathcal{P}^n) \equiv \det ||(\mathbf{P}_0\mathbf{P}_i.\mathbf{P}_0\mathbf{P}_k)||, \quad i,k = 1,2,...n \tag{1.11}$$

Scalar product in (1.11) is expressed via the world function by means of (1.6).

2 Multivariant geometry

Let us consider a generalization $\mathcal{G}$ of the proper Euclidean geometry $\mathcal{G}_{\mathrm{E}}$. One replaces the world function σ_{E} by the world function σ in all general geometric relations. But there are special relations of the geometry $\mathcal{G}_{\mathrm{E}}$, which depends on special properties of the world function σ_{E}. These special properties determine dimension of the geometry $\mathcal{G}_{\mathrm{E}}$ and properties of the Cartesian coordinate system in $\mathcal{G}_{\mathrm{E}}$.

If σ_{E} is the world function of n-dimensional Euclidean space E^n, it satisfies the following relations.

I. Definition of the dimension and introduction of the rectilinear coordinate system:

$$\exists\mathcal{P}^n \equiv \{P_0, P_1, ...P_n\} \subset \Omega, \qquad F_n(\mathcal{P}^n) \neq 0, \qquad F_k\left(\Omega^{k+1}\right) = 0, \qquad k > n \tag{2.12}$$

where $F_n(\mathcal{P}^n)$ is the Gram's determinant (1.11). Vectors $\mathbf{P}_0\mathbf{P}_i$, $\ i = 1, 2, ...n$ are basic vectors of the rectilinear coordinate system K_n with the origin at the point P_0. The covariant metric tensor $g_{ik}(\mathcal{P}^n)$, $\ i, k = 1, 2, ...n$ and the contravariant one $g^{ik}(\mathcal{P}^n)$, $\ i, k = 1, 2, ...n$ in a rectilinear coordinate system K_n are defined by the relations

$$\sum_{k=1}^{k=n} g^{ik}(\mathcal{P}^n)\, g_{lk}(\mathcal{P}^n) = \delta_l^i, \qquad g_{il}(\mathcal{P}^n) = (\mathbf{P}_0\mathbf{P}_i.\mathbf{P}_0\mathbf{P}_l), \qquad i, l = 1, 2, ...n \tag{2.13}$$

$$F_n(\mathcal{P}^n) = \det ||g_{ik}(\mathcal{P}^n)|| \neq 0, \qquad i, k = 1, 2, ...n \tag{2.14}$$

II. Linear structure of the Euclidean space:

$$\sigma_{\mathrm{E}}(P, Q) = \frac{1}{2}\sum_{i,k=1}^{i,k=n} g^{ik}(\mathcal{P}^n)\,(x_i(P) - x_i(Q))\,(x_k(P) - x_k(Q)), \qquad \forall P, Q \in \Omega \tag{2.15}$$

where coordinates $x_i(P)$, $i = 1, 2, ...n$ of the point P are covariant coordinates of the vector $\mathbf{P}_0\mathbf{P}$, defined by the relation

$$x_i(P) = (\mathbf{P}_0\mathbf{P}_i.\mathbf{P}_0\mathbf{P}), \qquad i = 1, 2, ...n \tag{2.16}$$

III: The metric tensor matrix $g_{lk}(\mathcal{P}^n)$ has only positive eigenvalues

$$g_k > 0, \qquad k = 1, 2, ..., n \tag{2.17}$$

IV. The continuity condition: the system of equations

$$(\mathbf{P}_0\mathbf{P}_i.\mathbf{P}_0\mathbf{P}) = y_i \in \mathbb{R}, \qquad i = 1, 2, ...n \tag{2.18}$$

considered to be equations for determination of the point P as a function of coordinates $y = \{y_i\}$, $\ i = 1, 2, ...n$ has always one and only one solution.

Not all conditions I – IV are independent, they determine different properties of $\mathcal{G}_{\mathrm{E}}$. For instance, the condition I determines the dimension n of the Euclidean space E^n. This dimension n is the maximal number of linear independent vectors in $\mathcal{G}_{\rm E}$. This number is determined by the general geometric expression (1.11) which depends on the form of the world function. If conditions (2.12) are not fulfilled, one cannot introduce a coordinate system in the conventional form, because the metric dimension n_m of the geometry $\mathcal{G}$ remains to be not determined.

The sum of two vectors is defined as follows. If one adds vectors **AB** and **BC,** when the end of one vector is the origin of the other, then one obtains

$$\mathbf{AB}+\mathbf{BC}=\mathbf{AC} \tag{2.19}$$

If one adds arbitrary vectors **AB** and **CD**, one obtains

$$\mathbf{AB}+\mathbf{CD}=\mathbf{AB}+\mathbf{BR}=\mathbf{AR} \tag{2.20}$$

where the point R is defined from the relation

$$(\mathbf{CD}\mathrm{eqv}\mathbf{BR}) \tag{2.21}$$

According to (1.4) - (1.6) the relation (2.21) represents two equations of the type (1.4). If these equations have always one and only one solution for the point R (as in $\mathcal{G}_{\rm E}$), the operation of addition is defined univalently. However, if the solution is multivariant, one cannot define the addition as a single-valued operation in the form, that is used in linear space for addition of linvectors. Multiplication of a vector **AB** by a real number a is defined as follows

$$a\mathbf{AB}=\mathbf{AR} \tag{2.22}$$

where the point R is determined from the relations

$$(\mathbf{AB}.\mathbf{AR})=a\left|\mathbf{AB}\right|^2,\quad \left|\mathbf{AR}\right|=a\left|\mathbf{AB}\right| \tag{2.23}$$

If solution of equations (2.23) is multivariant, the multiplication operation is multivariant also.

Summarizing, one can say, that the proper Euclidean geometry $\mathcal{G}_{\rm E}$ can be reduced to linear algebra. However, generalizations of $\mathcal{G}_{\rm E}$ cannot be reduced, in general, to linear algebra. They are multivariant, in general, and this multivariance is a corollary of the vector directivity which is absent in algebra.

Most restrictions on world function $\sigma_{\rm E}$ of $\mathcal{G}_{\rm E}$ arise from restrictions (2.12), which consist of many equations. These restriction have a global character. One may reduce these restriction to a local form

$$\exists\mathcal{P}^n\equiv\{P_0,P_1,...P_n\}\subset\Omega_\varepsilon,\qquad F_n\left(\mathcal{P}^n\right)\neq 0,\qquad F_k\left(\Omega_\varepsilon^{k+1}\right)=0,\qquad k>n \tag{2.24}$$

where Ω_ε is an infinitesimal vicinity of the point P_0, defined by the relation

$$\left|\sqrt{2\sigma\left(P_0,P\right)}\right|<\varepsilon,\quad \varepsilon\rightarrow +0 \tag{2.25}$$

If these conditions (2.24) take place, one can use formalism of the linear space locally. For instance, the Riemannian geometry is obtained at application of restrictions (2.12) in the form (2.24). A use of restriction (2.24) admits one to suppress multivariance of the vector equivalence for vectors having common origin. But multivariance of the vector equality remains for vectors having different origin. Consideration of equality of vectors with different origin is forbidden in the Riemannian geometry or it is connected with the way of the vector transport. It is necessary for a use of the linear space formalism.

3 Space-time geometry of Minkowski

There is a very important question. May the space-time geometry be multivariant? Or the space-time geometry is single-variant, and the linear space is a necessary attribute of the space-time geometry. To answer this question, we consider the space-geometry of Minkowski. In this case conditions (2.12) - (2.16) are fulfilled, and one can introduce rectilinear coordinate system, where the world function σ_{M} has the form

$$\sigma_{\mathrm{M}}(x,x)=\frac{1}{2}g_{ik}\left(x^i-x'^i\right)\left(x^k-x'^k\right),\quad g_{ik}=\mathrm{diag}\left(c^2,-1,-1,-1\right) \tag{3.26}$$

where c is the speed of the light.

At the axiomatic approach to geometry vectors $\mathbf{P}_0\mathbf{P}_1=(x^0,x^1,x^2,x^3)$ and $\mathbf{P}_0\mathbf{P}_2=(y^0,y^1,y^2,y^3)$ are equal (equivalent), if and only if $x^k=y^k$, $k=0,1,2,3$. At the metric approach the condition of equality of vectors $\mathbf{P}_0\mathbf{P}_1=(x^0,x^1,x^2,x^3)$ and $\mathbf{P}_0\mathbf{P}_2=(y^0,y^1,y^2,y^3)$ depends on sign of the world function (3.26). If vectors are timelike $\sigma_{\mathrm{M}}(P_0,P_1)>0$, then vectors are equal (equivalent), if $x^k=y^k$, $k=0,1,2,3$

In the case of spacelike vector $\mathbf{P}_0\mathbf{P}_1$ ($\sigma_{\mathrm{M}}(P_0,P_1)<0$) one can choose the coordinate system in such a way, that coordinates of vector $\mathbf{P}_0\mathbf{P}_1=(0,0,0,x^3)$. The equivalent vector $\mathbf{P}_0\mathbf{P}_2$ has coordinates $\mathbf{P}_0\mathbf{P}_2=(r,r\cos\phi,r\sin\phi,x^3)$, where r and ϕ are arbitrary real numbers. Thus, at the metric approach the space-time geometry of Minkowski is single-variant with respect to timelike vectors and it is multivariant with respect to spacelike vectors.

In the dynamics we deal only with tardions (particles with timelike world line). Tachyons (particles with spacelike world line) were not discovered experimentally. Does it mean that the real space-time should be described in the framework of axiomatic approach, when linear space is a necessary attribute of the space-time geometry? It is not so, because in the framework of axiomatic approach the tachyon world lines are smooth and differentiable [6] - [10].

Consideration of tachyons in the framework of metric approach, when space-time geometry is described in terms of world function leads almost to the same result. A single tachyons cannot be discovered, because of infinite wobbling of its world line. This wobbling is conditioned by multivariance of spacelike vectors in the space-time geometry of Minkowski [11]. Although a single tachyon cannot be discovered experimentally, the tachyon gas may be discovered by its gravitational field.

Astronomers have discovered additional gravitational field of some galaxies, which can be explained as a gravitational field of some invisible matter (dark matter) [12]. This dark matter can be freely explained as a galo of tachyon gas. The tachyon gas has a very strong pressure, which can explain a possibility of the galo formation [11]. Discovery of dark matter testifies in favour of metric approach to the space-time geometry.

4 Multivalence as a natural property of the space-time geometry and the Galiley phenomenon

The proper Euclidean geometry is a degenerate geometry, because its world function has a special form and it is not multivariant. On one hand, it is fine, because the single-variance admits one to use the linear space formalism and to construct the Euclidean geometry axiomatically. On the other hand, a generalization of a degenerate conception is difficult, because in the general case one obtains new properties which are absent in the degenerate conception. One does not accept appearance of new properties at the geometry construction by means of the degenerate version generalization. These new properties look unnatural. They meet opposition from researchers, who do not guess on the degenerate character of the proper Euclidean geometry. This preconception becomes very strong, when it becomes clear that the physical (multivariant) geometry is nonaxiomatizable and it cannot be deduced from axioms. Beginning since Euclid, the geometry was constructed by a logic way, i.e. it was deduced from axioms. It is very difficult to accept the fact that a geometry can be constructed by means of a deformation of the Euclidean geometry, i.e. replacing the world function (that is not a logical operation). Necessity of a new mathematical formalism construction does not generate enthusiasm of researchers, learning the multivariant geometry.

Nobody wants to take into account that at the Euclidean geometry construction the axiomatic approach appears to be possible, because the proper Euclidean geometry is continuous and infinitely divisible. This circumstance admits one to construct any geometrical object from finite number of blocks. Their properties are known and described by axioms. In concrete their number is small (point segment of straight and angle). The real space-time geometry may not be continuous and infinitely divisible, especially if one considers physical phenomena in microcosm.

Note that a discrete geometry, i.e. the geometry which is not continuous, can be given not on a lattice set. In the discrete geometry there are no infinitely close points and it is described by the condition

$$|\rho\left(P,Q\right)| \notin \left(0,\lambda_0\right), \quad \forall P,Q\in\Omega \tag{4.27}$$

where ρ is the distance between points and λ_0 is the elementary length of the discrete geometry. Condition (4.27) is a restriction on the form of the distance function ρ. Usually this condition is considered as a restriction on the set of points, where the geometry is given. The Euclidean function of distance is considered as a distance function. If the condition is considered as a restriction on the form of the distance function, the discrete geometry may be given on the same set of points (events), where the geometry of Minkowski is given. For instance, the world function σ_{d} of the discrete geometry may have the form

$$\sigma_{\mathrm{d}}=\sigma_{\mathrm{M}}+\frac{\lambda_0^2}{2}\operatorname{sgn}\left(\sigma_{\mathrm{M}}\right), \quad \rho=\sqrt{2\sigma_{\mathrm{d}}} \tag{4.28}$$

where σ_{M} is the the world function of the geometry of Minkowski. Then the axiomatic approach to the geometry appears to be impossible. The discrete geometry is arranged in such a way that points with close coordinates may be not close by distance between them. It means that the (metric) dimension of the geometry cannot be introduced correctly.

Dynamics constructed on the basis of axiomatic geometry appears to be imperfect. It cannot explain what the dark matter is. Dynamics constructed on the basis of multivariant space-time geometry appears to be more perfect. It resolve freely the dark matter problem [11]. However, the multivariant dynamics contains a new concept of multivariance, which is met sceptically by the scientific community. To understand , what is the matter, it is useful to consider the case of transition from Aristotelian dynamics to the Newtonian one.

In the Newtonian dynamics one uses a new concept which was absent in the Aristotelian dynamics. The concept of inertia was such a new concept which is generated introduction of acceleration in dynamics. In XVI century one dealt with balanced motion of bodies when the bodies moved evenly and the motive force was balanced with the force of friction. Transition from the rest to the state of motion was very short. This transition was considered as a transitive process which did not demand a construction of special dynamics. Of course there were processes, where the cumulative energy was used, for instance, plugging of a nail by a hammer. But apparently, one used concept of a force for description of such processes. For instance, Leibniz has introduced the concept of living force (vis viva),which meant the kinetic energy. In other words, the kinetic energy connected with inertia was perceived as an appearance of a force. It is difficult to image now how it was made in XVI century. However, the concept of inertia introduced by Galiley has been not accepted by researchers of XVI century more than hundred years. I call effect of long non-recognition of a new fundamental concept as Galiley phenomenon, because it was applied first time namely to Galiley.

The Aristotelian dynamics did not work in application to the planet motion, as far as the force of friction did not appear in this motion. A special mechanism consisting of many gears - epicycles has been invented for explanation of the cyclic plant motion. Choosing gears in proper way, one can explain any cyclic motion of planets. However, one failed to explain the comet motion, whose cyclic character of motion was not evident. The fitting method used for construction of Ptolemaic epicycles reminds contemporary method of the elementary particle description.

A use of new fundamental concept (concept of inertia) admits one to construct a new (Newtonian) dynamics. The Newtonian dynamics used a formalism essentially other, than the formalism of the Aristotelian dynamics. This admits one to replace the complicated system of epicycles by simple free motion of planets in the gravitational field of Sun. Analogously one may hope that a use of the skeleton conception of dynamics, based on the multivariant space-time geometry admits one to simplify the method of the elementary particles description [13].

Apparently, the Galiley phenomenon is conditioned by the difficulty of perception of the new fundamental concepts changing the dynamics formalism. Apparently, the concept of multivariance is difficult for perception of physicists of the XX century as the concept of inertia was for scientists of XVI century.

The scientific community has a preconception against the concept of multivariance not only in geometry, but in dynamics also. In his papers Boltzman explained deterministic motion of a gas by multivariant (stochastic) motion of its molecules. Scientific community did accept these papers during several years. As far as I know the reasons of this abruption of Boltzman papers remained unknown. I think, that the reason was a use of the new concept of dynamic multivariance (or stochasticity conditioned by the molecular collisions). In the usual life one does not meet the concept of multivariance (stochasticity). It is not clear how one can describe it mathematically. The kinetic equation of Boltzman is more complicated and more informative, than known equation of the gas dynamics which can be obtained as a result of averaging the kinetic equation. A preconception against the concept of multivariance arose,in particular, because its application needs a new mathematical formalism using concept of multivariance. The multivariance is perceived psychologically as anything unnatural. Only experimental discovery of Brounian motion reconciled the scientific community with the dynamic multivariance.

As it concerns multivariant space-time geometry, its multivariance is also perceived as anything unnatural. The conventional axiomatic approach to geometry is perceived as habitual and natural. It is especially valid, if one takes into account, that multivariance turns the space-time geometry to nonaxiomatizable geometry, whose mathematical formalism does not use infinitesimal quantities and differential equations connected with them. Distinction of the mathematical formalism of the multivariant geometry appears to be essential as in microcosm as in cosmology.

The discrete geometry appears to be multivariant automatically. If one admits that the space-time geometry may be discrete, one leads to necessity of multivariant space-time geometry in description of microcosm. Quantum effects may be considered as effects of the discrete space-time geometry [14], if the quantum constant is connected with the elementary length of the discrete geometry.

It appears that in microcosm the particle state is not described by its position and momentum. The particle state is described by the particle skeleton. It consists of $n+1$ points ($n>1$), connecting rigidly between themselves. The $n(n+1)/2$ distances between points form $n(n+1)/2$ invariant characteristics of the particle. These characteristic include the mass and other parameters of the particle. For instance, a fermion is a tachyon with $n>2$. In the simplest case $n=2$. Then the world line of the tachyon is a spacelike helix with timelike axis. Such a helix explained freely spin and magnetic moment of the particle [15, 16, 17]. This result agrees with the Dirac equation. The number of dynamic equation describing the skeleton motion is equal to $n(n+1)$, whereas the number of dynamic variables which are to be determined is equal to $4n$. In the case, when $n<3$, the world line (chain) wobbles. In the case of $n>3$ some restrictions on the skeleton parameters arise. The fact that the electric charge of an elementary particle is not greater than the elementary charge is explained by uniqueness of the world function in multivariant geometry [18]. Axiomatic approach cannot explain this fact.

The observed symmetries of elementary particles [19] can be explained by the arrangement of the particle skeleton, like a crystal symmetry is explained by the arrangement of the elementary cell of crystal.

A use of the multivariant space-time geometry is essential in the gravitation theory. It leads to extended general relativity, where dynamic equations are written directly for the world function (but not for metric tensor as in general relativity) [20]. It appears that in the extended general relativity the event horison is not formed at the strong compression of a star, because the antigravitation is induced at some stage of compression [21]. This antigravitation prevents from a black hole formation.

The physics geometrization, generated by the metric approach to space-time geometry is a serious alternative to the quantum theory in microcosm. It is also an alternative to general relativity in cosmology.

References

[1] Yu.A.Rylov, Geometry without topology as a new conception of geometry. *Int. Jour. Mat. & Mat. Sci.* **30**, *iss. 12, 733-760, (2002)*, (see also *e-print math.MG/0103002*).

[2] J.L.Synge, A characteristic function in Riemannian space and its applications to the solution of geodesic triangles. *Proc. London Math Soc.* **32**,*241 (1932).*

[3] H.S.Ruse, Some teorem in tensor calculus. *Proc.London Math.Soc.* **31,***225 (1930).*

[4] J.L.Synge, *Relativity: the general theory.* Amsterdam, North-Holland publishing company.

[5] Yu. A. Rylov, Different conceptions of Euclidean geometry and their application to the space-time geometry *e-print 0709.2755v4*

[6] A. Sommerfeld, Simplified deduction of the field and the forces of an electron moving in any given way". *Knkl. Acad. Wetensch* **7**, *345–367, (1904).*

[7] O.-M. P. Bilaniuk, V. K. Deshpande, E. C. G. Sudarshan, "'Meta' Relativity". *American Journal of Physics* **30***(10), 718, (1962).*

[8] Ya.P. Terletsky, Positive, negative and imaginary rest masses. *J. de Physique at le Radium* **23,** *iss 11, 910-920 (1963).*

[9] G. Feinberg, "Possibility of Faster-Than-Light Particles". *Phys. Rev.* **159 (5)**: *1089–1105. (1967)*

[10] G. Feinberg, *Phys. Rev. D* **17**, *1651 (1978)*

[11] Yu.A.Ryov, Dynamic equations for tachyon gas. *Submitted to IJTP (*now this paper can be found on my site *http://rsfq1.physics.sunysb.edu/˜rylov/detg1e.pdf)*

[12] D.Merritt, et al. , Empirical Models for Dark Matter Halos. I. Nonparametric Construction of Density Profiles and Comparison with Parametric Models *The Astronomical Journal,* **132**, *Issue 6, pp. 2685-2700, (2006)*

[13] Yu.A. Rylov, Discrete space-time geometry and skeleton conception of particle dynamics. *Int. J. Theor Phys.* **51**, Issue 6, pp. 1847-1865 (2012), see also *e-print 1110.3399v1*

[14] Yu.A. Rylov, Non-Riemannian model of the space-time responsible for quantum effects. *Journ. Math. Phys.* **32**(8), *2092-2098, (1991).*

[15] Yu. A. Rylov, Is the Dirac particle composite? *e-print physics/0410045*

[16] Yu. A.Rylov, Is the Dirac particle completely relativistic? *e-print physics/0412032.*

[17] Yu. A.Rylov, Geometrical dynamics: spin as a result of rotation with superluminal speed. *e-print 0801.1913*

[18] Yu. A. Rylov, Discriminating properties of compactification in discrete uniform isotropic space-time. *e-print 0809.2516v2.*

[19] V.A.Rubakov, On Large Hadron Collider's discovery of a new particle with Higgs boson properties. *Uspekhi Fizicheskikh Nauk* **182***(10), 1017- 1025 (2012)* (in Russian)

[20] Yu. A. Rylov, General relativity extended to non-Riemannian space-time geometry. *e-print 0910.3582v7.*

[21] Yu. A. Rylov, Induced antigravitation in the extended general relativity. *Gravitation and Cosmology*, **2012**, *Vol. 18, No. 2, pp. 107–112,(2012).*