Light in metric space-time and its deflection by the screw dislocation

Miroslav Pardy

Prague Asterix Laser System, PALS
Za Slovankou 3, 182 21 Prague 8
Czech Republic

and

Department of Physical electronics
and
The Laboratory of the Plasma Physics
Masaryk University
Kotlářská 2, 611 37 Brno, Czech Republic
e-mail:pamir@physics.muni.cz

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Abstract

We explain the geometrical meaning of the metric of space-time. Then, we derive the light deflection caused by the screw dislocation in space-time. The derivation is based on the idea that space-time is a medium which can be deformed in such a way that the deformation of space-time is equivalent to the existence of metric which is equivalent to gravity. The existence of the screw dislocation in the cosmology is hypothetically confirmed by observation of light bursts which can be interpreted as the annihilation of the giant screw dislocations with anti-dislocations. The origin of gravitational bursts are analogical to the optical ones. Hubble telescope is able to detect only the optical bursts. The gravitational bursts then can be detected by LIGO, VIRGO, GEO, TAMA and so on. The dislocation theory of elementary particles is discussed.

Key words: Metric, deformation, screw dislocation, elementary particles.
1 Introduction

There is a possibility that during the big bang, supernova explosion, gravitational collapse, collisions of the high-energy elementary particles and so on, the dislocations in space-time are created. In this article we derive the deflection of light caused by the screw dislocation in space-time.

In order to derive such deflection of light, it is necessary to explain the origin of metric in the Einstein theory of gravity.

Einstein gives no explanation of the origin of the metric, or, metrical tensor. He only introduces the Riemann geometry as the basis for the general relativity [1]. He "derived" the nonlinear equations for the metrical tensor [2] and never explained what is microscopical origin of the metric of space-time. Einstein supposed that it is adequate to the metric that it follows from differential equations as their solutions. However, the metric has an microscopical origin similarly to the situation where the phenomenological thermodynamics has also the microscopical and statistical origin.

Let us remember the different origins of metric. First, let us show that metric is generated by the coordinate transformations. We demonstrate it using the spherical transformations:

\[ x = r \sin \theta \cos \varphi, \quad y = r \sin \theta \sin \varphi, \quad z = r \cos \theta. \]  
\[ (1) \]

The square of the infinitesimal element is as follows:

\[ ds^2 = dx^2 + dy^2 + dz^2 = dr^2 + r^2 d\theta^2 + r^2 \sin^2 \theta \, d\varphi^2. \]  
\[ (2) \]

We see that the nonzero components of the metrical tensor are

\[ g_{11} = 1, \quad g_{22} = r^2, \quad g_{33} = r^2 \sin^2 \theta. \]  
\[ (3) \]

For \( r = \text{const} \), it is \( dr = 0 \) and the element of the length is the element of the 2-dimensional sphere in the 3-dimensional space. The resulting metric is not the three dimensional one but only two dimensional in the 3D space. So, in order to generate the 2D metric, it is necessary to use the 3D transformations in 3D space. If we want the generate the metric on the 3D sphere, then it is necessary to use the 4D transformations for \( x, y, z, \xi \), where \( \xi \) is the extra-coordinate. So, the metric is generated by the curvilinear transformations. Einstein suggested the possibility that metric can be generated by gravitational field. He created the general theory of relativity and gravitation. Henri Poincaré never accepted the metric generated by the gravitational field.

The Riemann element \((ds)^2\) is defined as

\[ ds^2 = g_{\mu\nu} dx^\mu dx^\nu \]  
\[ (4) \]

and it is composed from the four infinitesimal coordinate differentials. It means if we want to generate the metric of this four dimensional space-time by the coordinate transformations, then it necessary to use the coordinate transformations in 5D space-time. Or, in other words, it is necessary to introduce the extra-dimension. Einstein radically refused the extra-dimensions and he pedagogically explained the curvature of a space-time.
by introduction the metric which depends on the temperature of the surface [3]. Of course such explanation of the origin of metric is not generally accepted in the textbooks and monographs [4]. It was only pedagogical explanation. Some mathematicians [5],[6] tried to proof that our space is three-dimensional and they automatically excluded the extra-dimensions. However such proofs are misleading because we know from the Bertrand Russel philosophy of mathematics that the mathematical theorems are not existential. In other words, mathematics cannot say nothing on the existence of electron, proton, quarks, strings and so on, because these things does not follow from the mathematical axiomatic system. They are things of the external world and not of the world of mathematics. At the same time pure mathematics cannot predict any physical constant, because every physical constant is of dynamical origin.

Extra-dimensions can be introduced only by the definition and the existence of them cannot be mathematically proved. We know that the three dimensional space was confirmed by the most precise theory in the history of physics - QED, and it means that the extra-dimensions were not confirmed. Also the Planck law of the blackbody radiation in 4D space differs form the Planck law in 3D space. Similarly in genetics, the existence and the form of the molecule DNA can be considered as a proof of the three dimensionality of space. The formation of galaxies in the 3D space substantially differs from the formation of galaxies in the four dimensional space.

We know that the extra-dimensions can be compactified. However, there is no physical law which enables compactification. Compactification is only the mathematical method of the string theory.

Einstein avoids the extra-dimensionality and compactification. He uses argumentation [3] on the existence of the noneuclidean geometry using the 2D hot plane, where the magnitude of a rule changes from point to point being dependent on the temperature at a given point. This method was also used by Feynman [7]. Rindler does not use this method of argumentation [4].

2 Deformation origin of the space-time metric

So, the question we ask, is, what is the microscopical origin of the metric of space-time. We postulate that the origin of metric is the specific deformation of space-time continuum. We take the idea from the mechanics of continuum and we apply it to the space-time medium. The similar approach can be found in the Tartaglia article and his e-print [8], where space-time is considered as a deformable medium.

The mathematical description of the three dimensional deformation is given for instance in [9]. The fundamental quantity is the tensor of deformation expressed by the relative displacements \( u^i \) as follows:

\[
\begin{align*}
    u_{ik} &= \left( \frac{\partial u_i}{\partial x^k} + \frac{\partial u_k}{\partial x^i} + \frac{\partial u^l}{\partial x^i} \frac{\partial u_l}{\partial x^k} \right) ; \quad i, k = 1, 2, 3. 
\end{align*}
\]

The last definition can be generalized to the four dimensional situation by the following relation:
\[ u_{\mu\nu} = \left( \frac{\partial u_\mu}{\partial x^\nu} + \frac{\partial u_\nu}{\partial x^\mu} + \frac{\partial u_\alpha}{\partial x^\mu} \frac{\partial u^\alpha}{\partial x^\nu} \right); \quad \mu, \nu = 0, 1, 2, 3, \tag{6} \]

with \( x^0 = ct, x^1 = x, x^2 = y, x^3 = z \).

In order to establish the connection between metric \( g_{\mu\nu} \) and deformation expressed by the tensor of deformation, we write for the metrical tensor \( g_{\mu\nu} \) of the squared space-time element

\[ ds^2 = g_{\mu\nu} dx^\mu dx^\nu, \tag{7} \]

the following relation

\[ g_{\mu\nu} = (\eta_{\mu\nu} + u_{\mu\nu}), \tag{8} \]

where

\[ \eta_{\mu\nu} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix}. \tag{9} \]

Instead of work with the metrical tensor \( g_{\mu\nu} \), we can work with the tensor of deformation \( u_{\mu\nu} \) and we can consider the general theory of relativity as the four-dimensional theory of some real deformable medium as a corresponding form of the metrical theory. First, let us test the deformation approach to the space-time in case of the nonrelativistic limit.

### 3 The nonrelativistic test

The Lagrange function of a point particle with mass \( m \) moving in a potential \( \varphi \) is given by the following formula [10]:

\[ L = -mc^2 + \frac{mv^2}{2} - m\varphi. \tag{10} \]

Then, for a corresponding action we have

\[ S = \int Ldt = -mc \int dt \left( c - \frac{v^2}{2c} + \frac{\varphi}{c} \right), \tag{11} \]

which ought to be compared with \( S = -mc \int ds \). Then,

\[ ds = \left( c - \frac{v^2}{2c} + \frac{\varphi}{c} \right) dt. \tag{12} \]

With \( d\mathbf{x} = vdt \) and neglecting higher derivative terms, we have

\[ ds^2 = (c^2 + 2\varphi)dt^2 - d\mathbf{x}^2 = \left( 1 + \frac{2\varphi}{c^2} \right) c^2 dt^2 - d\mathbf{x}^2. \tag{13} \]

The metric determined by this \( ds^2 \) can be be obviously related to the \( u_\alpha \) as follows:
\[ g_{00} = 1 + 2 \partial_0 u_0 + \partial_0 u^\alpha \partial_0 u_\alpha = 1 + \frac{2 \varphi}{c^2}. \]  
\( (14) \)

We can suppose that the time shift caused by the potential is small and therefore we can neglect the nonlinear term in the last equation. Then we have

\[ g_{00} = 1 + 2 \partial_0 u_0 = 1 + \frac{2 \varphi}{c^2}. \]  
\( (15) \)

The elementary consequence of the last equation is

\[ \partial_0 u_0 = \frac{\partial u_0}{\partial (ct)} = \frac{\varphi}{c^2}, \]  
\( (16) \)
or,

\[ u_0 = \frac{\varphi}{c} t + \text{const.} \]  
\( (17) \)

Using \( u_0 = g_{00} u^0 \), or, \( u^0 = g^{-1}_{00} u_0 = \frac{\varphi}{c} t \), we get with \( \text{const.} = 0 \) and

\[ u^0 = ct' - ct, \]  
\( (18) \)
the following result

\[ t'(\varphi) = t(0) \left( 1 + \frac{\varphi}{c^2} \right), \]  
\( (19) \)
which is the Einstein formula relating time in the zero gravitational field to time in the gravitational potential \( \varphi \). The time interval \( t(0) \) measured remotely is so called the coordinate time and \( t(\varphi) \) is local proper time. The remote observer measures time intervals to be deleted and light to be red shifted. The shift of light frequency corresponding to the gravitational potential is, as follows \([10] \).

\[ \omega = \omega_0 \left( 1 + \frac{\varphi}{c^2} \right). \]  
\( (20) \)

The precise measurement of the gravitational spectral shift was made by Pound and Rebka in 1960. They predicted spectral shift \( \Delta \nu / \nu = 2.46 \times 10^{-15} \) \([1] \). The situation with the red shift is in fact the closed problem and no additional measurement is necessary.

While we have seen that the red shift follows from our approach immediately, without application of the Einstein equations, it is evident that the metric determined by the Einstein equations can be expressed by the tensor of deformation. And vice versa, to the every tensor of deformation the metrical tensor corresponds.

4 **The deflection of light by the screw dislocation**

The problem of the light deflection by the screw dislocation is the problem of the recent years \([11], [12], [13], [14], [15], \) and so on. The motivation was the old problem of the deflection of light by the gravitational field which according to Einstein causes the curvature of space-time.
We know from the history of physics that the deflection of light by the gravitational field of Sun was first calculated by Henri Cavendish in 1784 and it was never published. The first published calculation was almost 20 years later in 1911 by the Prussian astronomer Johann Soldner. Einstein’s calculation in 1911 was 0.83 seconds of arc. Cavendish and Soldner predicted a deflection 0.875 seconds of arc. So, the prediction of Cavendish, Soldner [16] and Einstein in 1911 were approximately half of the correct value which was derived in 1919 by Einstein.

Einstein in 1911 used the principle of equivalence for the determination of the light deflection. As was shown by Ferraro [17] the Einstein application of this principle was incorrect. The correct application was given only by Ferraro in order to get the correct value. The deflection of light by the topological defects as dislocations, disclinations and so on was to my knowledge never calculated by Einstein. In the recent time such calculation was performed by [11], [12], [13] [14], [15] and so on. Here we use the different and more simple method and the definition of the screw dislocations which differs from the above authors.

According to [9], the screw deformation in the mechanics of continuum was defined by the tensor of deformation which is in the cylindrical coordinates as

\[ u_{z\varphi} = \frac{b}{4\pi r}, \]  

(21)

where \( b \) is the \( z \)-component of the Burgers vector. The Burgers vector of the screw dislocation has components \( b_x = b_y = 0, b_z = b \). The Burgers vector is for the specific dislocation a constant geometrical parameter.

The postulation of the space-time as a medium enables to transfer the notions of the theory of elasticity into the relativistic theory of space-time and gravity. The considered transfer is of course the heuristical operation, nevertheless the consequences are interesting. To our knowledge, the problem, which we solve is new.

We know that the metric of the empty space-time is defined by the coefficients in the relation:

\[ ds^2 = c^2 dt^2 - dr^2 - r^2 d\varphi^2 - dz^2. \]  

(22)

If the screw deformation is present in space-time, then the generalized metric is of the form:

\[ ds^2 = c^2 dt^2 - dr^2 - r^2 d\varphi^2 - 2u_{z\varphi} dz d\varphi - dz^2, \]  

(23)

or,

\[ ds^2 = c^2 dt^2 - dr^2 - r^2 d\varphi^2 - \frac{2b}{4\pi r} dz d\varphi - dz^2. \]  

(24)

The motion of light in the Riemann space-time is described by the equation \( ds = 0 \). It means, that from the last equation the following differential equation for photon follows:

\[ 0 = c^2 - \dot{r}^2 - r^2 \dot{\varphi}^2 - \frac{b}{2\pi r} \dot{z} \dot{\varphi} - \dot{z}^2. \]  

(25)

Every parametric equations which obeys the last equation are equation of motion of photon in the space-time with the screw dislocation. Let us suppose that the motion of light is in the direction of the \( z \)-axis. Or, we write approximately:
Then, we get equation of $\varphi$:
\begin{equation}
2\pi a^3 \dot{\varphi}^2 + bv \dot{\varphi} = 2\pi a(c^2 - v^2).
\end{equation}
We suppose that the solution of the last equation is of the form
\begin{equation}
\varphi = At.
\end{equation}
Then, we get for the constant $A$ the quadratic equation
\begin{equation}
2\pi a^3 A^2 + bv A + 2\pi a(v^2 - c^2) = 0
\end{equation}
with the solution
\begin{equation}
A_{1/2} = \frac{-bv \pm \sqrt{b^2 v^2 - 16\pi^2 a^4(v^2 - c^2)}}{4\pi a^3}.
\end{equation}

Using approximation $v \approx c$, we get that first root is approximately zero and for the second root we get:
\begin{equation}
A \approx \frac{-bc}{2\pi a^3},
\end{equation}
which gives the function $\varphi$ in the form:
\begin{equation}
\varphi \approx \frac{-bc}{2\pi a^3} t.
\end{equation}

Then, if $z_2 - z_1 = l$ is a distance between two points on the straight line parallel with the axis of screw dislocation then, $\Delta t = l/c$, $c$ being the velocity of light. For the deflection angle $\Delta \varphi$, we get:
\begin{equation}
\Delta \varphi \approx \frac{-bl}{2\pi a^3}.
\end{equation}

So, we can say, that if we define the screw dislocation by the metric of eq. (24), then, the deflection angle of light caused by such dislocation is given by eq. (33). The result (33) is only approximative and we do not know what is the accuracy of such approximation. This problem can be solved using the approximation theory.

Let us remark that the exact trajectory of photon in the field of the screw dislocation can be determined from the trajectory equation
\begin{equation}
\frac{d^2 x_\mu}{ds^2} + \Gamma^\mu_{\alpha\beta} \frac{dx_\alpha}{ds} \frac{dx_\beta}{ds} = 0.
\end{equation}
which was used in many textbooks. However, According to Landau et al. [10], the equation is contradictory for photon, because in this case $ds = 0$, and it means that the last equation is not rigorously defined. Landau et al. derived the deflection of light from the Hamilton-Jacobi equation for particle with the rest mass $m = 0$, which moves with the light velocity. However, this approach is not also absolutely correct because
in the classical field theory it is not possible to define photon. Photon is a quantum object. Rigorous derivation of the deflection of light was given by Fok [18], who used the mathematical object ”the front of wave” and his result is valid without any doubt.

Let us remark that equation (34) has two meanings: geometrical and physical. The geometrical meaning uses $g_{\mu\nu}$ which follows from the curvilinear transformations and the physical meaning of $g_{\mu\nu}$ is metric of the gravitational field calculated by means of the Einstein equation. The second meaning is the Einstein postulate and cannot be derived from so called pure mathematics. Only experiment can verify the physical meaning of equation (34).

The problem of interaction of light with the gravitational field is not exhausted by our example. We can define more difficult problems such as deflection of the coherent light, laser light, squeezed light, soliton light, massive light with massive photons, light of the entangled photons and so on. No of these problems was still solved because they are only for brilliant experts very well educated. And this is the pedagogical problem.

5 The physical generation of the screw dislocation of the space-time

Now the question arises, how to determine the mechanical or electrodynamical or laser system which will generate the screw dislocation in space-time. We know, that for real crystals the generation of the screw dislocation is the elementary problem of the physics of crystals. If we use Einstein’s equations, then the problem is mathematical one. Or, to see it, let us write the Einstein equations with the cosmological constant $\lambda$.

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R + \lambda g_{\mu\nu} = -\kappa T_{\mu\nu}, \quad (35)$$

where $T_{\mu\nu}$ is the tensor of the energy and momentum.

In case of the perfect fluid and pressure, tensor of the energy and momentum is as follows:

$$T_{\mu\nu}(\text{mech}) = (\rho + p)u_\mu u_\nu + pg_{\mu\nu}, \quad (36)$$

where $\rho$ is a density and $p$ is a pressure of the fluid. The quantities $u_\mu$ are four velocities of the fluid.

In case that the tensor of the energy and momentum is created electromagnetically, then,

$$T_{\mu\nu}(\text{elmag}) = \frac{1}{4\pi} \left( F_{\mu\alpha} F^{\alpha}_\nu - \frac{g_{\mu\nu}}{4} F_{\alpha\beta} F^{\alpha\beta} \right). \quad (37)$$

where $F_{\alpha\beta}$ is the tensor of the electromagnetic field.

So, because $g_{\mu\nu}$ is determined as the metrical tensor corresponding to the screw dislocation of the space-time, the left side of the Einstein equations is given and the problem is to find the mechanical and electrodynamical quantities, which determine corresponding tensors of energy and momentum.

The surprising thing is the fact that if there is no curvature of space time, than thanks to the existence of the cosmological constant, the solution corresponding to the mechanical
or electrodynamical systems is not absolutely zero. The cosmological constant is in such a way very important quantity and evidently cannot be zero. The dislocations of space-time are in harmony with the cosmological constant.

Let us remark that Einstein equations were derived intuitively by Einstein [2] and rigorously by Hilbert from the Lagrangian using the variational method [1]. The Hilbert derivation is pure mathematical one and it means it is very simple. This variational method enables to start relativity physics from the general theory and to derive the special relativity as a classical limit of the general theory. This approach was presented by Rindler [19]. To our knowledge, such unconventional but very elegant approach was not presented in any textbook on relativity theory.

The tensor of the energy momentum in equation (36) is rigorously defined. The problem is, how to identify the distribution of the cosmological objects with this tensor. To our knowledge, there is no mathematical theorem for such rigorous identification.

6 Cosmological consequences

The verification of our theory and at the same time the existence of the nonzero cosmological constant can be performed during the measurement of the cosmical microwave background radiation. In case of the existence of some defects in space-time the distributions of this radiation will be inhomogeneous and it will depend on the density and orientations of the dislocations, screw dislocations, disclinations and other topological defects of the space-time.

It is evident that also in case that the curvature caused by the some topological defect is zero, then, thanks to the existence of the cosmological constant in the Einstein equations the defects can be generated mechanically or electrodynamically as it follows from the Einstein equations. So, investigation of the cosmical microwave background can inform us on the distribution of the topological defects in the space-time and on the possible origins of these defects [20].

7 The laboratory verification of a theory

We can consider the situation which is analogical to the space-time situation. In other words, we can consider the modified Planckian experiment with the black body radiation. The difference from the original Planck situation is that we consider inside of the black body some optical medium with dislocations. Then, in case that the optical properties depend also on the presence of dislocations, in other words, that the local index of refraction depend on presence of dislocations, then we can expect the modification of the Planck law of the blackbody radiation. We know that the most simple problem with the constant index of refraction was calculated [21]. To our knowledge, although this is only so called table experiment, it was never performed in some optical laboratory. It is possible to expect that during the experiments some surprises will appear. However, the practical situation can be realized, if we prepare some crystal with the screw dislocations with given orientation. Then, in case that the optical properties are expressed by means of metric in crystal, the metric will determine the optical path of light in the crystal and
it means that the screw dislocations can be investigated by optical methods and not only by the electron microscope.

8 Discussion

We have defined in the harmony with the author article [22], [23] gravitation as a deformation of a medium called space-time. We have used equation which relates Riemann metrical tensor to the tensor of deformation of the space-time medium and applied it to the gravitating system, which we call screw dislocation in space-time. The term screw dislocation was used as an analogue with the situation in the continuous mechanics. We derived the angle of deflection of light passing along the screw dislocation axis at the distance \(a\) from it on the assumption that trajectory length was \(l\). This problem was not considered for instance in the Will monograph [24]. The screw dislocation was still not observed in space-time and it is not clear what role play the dislocations in the development of universe after big bang. Our method can be applied to the other types of dislocations in space-time and there is no problem to solve the problem in general. We have used here the specific situation because of its simplicity. We have seen that the problem of dislocation in space-time is interesting and it means there is some scientific value of this problem.

It is well known from the quantum field theory and experiment, that every particle has its partner in the form of the antiparticle [25]. For instance the antiparticle to the electron is positron. It is well known that after annihilation of particle-antiparticle pair, photons are generated. For instance

\[
e^+ + e^- \rightarrow 2\gamma. \tag{38}
\]

Now, if we define that to every dislocation \(D\) exists antidislocation \(\bar{D}\), (which can be considered also as an analogue of the antistring, [26]), then, we can write the following equation which is analogical to (38)

\[
D + \bar{D} \rightarrow N\gamma \tag{39}
\]

where \(N\) is natural number and gamma denotes photon. The next equation is also possible:

\[
D + \bar{D} \rightarrow Ng \tag{40}
\]

where \(g\) denotes graviton.

It is possible also to consider the high-energy process with the incident particles \(a\) and \(b\) as follows:

\[
a + b \rightarrow c_1 + c_2 + c_3 + \ldots c_n, \tag{41}
\]

where \(c_i\) are denotations of identical or different particles. It is well-known that the equation (41) will be fundamental equation of LHC.

In case of the existence of the dislocations in universe, equations (39) and (40) represents the burst of photons or gravitons in the cosmical space. So, we defined the further possible interpretation of the photonic and gravitational bursts in cosmical space.
Let us remark that the dislocation approach to the particle physics are in harmony with the Einstein dream and later Misner-Wheeler geometrodynamics where all existing elementary objects can be defined as some form of space-time. Misner and Wheeler [27], [28] consider also that neutrino is the specific form of the space-time. Let us still remark that we know from the history of philosophy that long time before Christ, Anaximandros introduced *apeiron* as a medium from which all particles, and therefore all visible universe was created. So, we can say that the famous trinity of men, Einstein-Misner-Wheeler, is the follower of Anaximandros.

The identification of the fundamental particles by the dislocations is in harmony with the relation for the energy of the dislocation [29]

\[ E = \frac{E_0}{\sqrt{1 - \frac{v^2}{c^2}}}, \quad (42) \]

where \( E_0 \) is the energy of dislocation when its velocity \( v \) is zero and \( c \) is the velocity of sound in the crystal. In case of medium called space-time the velocity \( c \) is the velocity of light in vacuum. So, vacuum is in a certain sense medium which is similar to the crystal medium. The analogy with the dislocations in crystal is of course heuristical step which is the integral part of the methodology of discoveries and it cannot be rigorously algorithmically defined.

Although equation (42) can be identified with the relativistic equation for dependence of energy on velocity of elementary particle, we cannot identify electron with the screw dislocation in space-time. Why? Because we know that the attractive or repulsive force between two screw dislocations are different than the force between two electrons, two positrons and electron and positron. The second reason is that the anomalous magnetic moment of electron is of the dynamical origin as it follows from the Feynman diagram technique while the classical dislocation does not involve such dynamics. On the other hand, we do not know how other dislocations such as circular dislocations, cylindrical dislocations, helix, double helix, triple helix dislocations and so on are related to elementary particles, specially to neutrinos. We know that all physical constant in the standard model are of the dynamical origin, but at present time it is not clear what is their derivation from the more fundamental theory (subquark theory, string theory and so on), or, from the dislocation theory of elementary particles. We think that dislocation theory of elementary particles is not at present time prepared to give the answer to these difficult questions.

The 3D screw dislocation can be extended mathematically to the N-dimensional space, or, space-time. However the interpretation of the N-dimensional theory needs introducing of the compactification.

So, we can say that the Einstein dream of the unification of all objects and forces in nature in the framework of geometrodynamics is far from the successful realization because the identification of ultimate blocks of nature with dislocations and with the topological defects is not possible at this time.

According to Veltman, there are plenty of mysteries in particle physics [30]. We also know one mystery in mathematics. This is the imaginary number \( i = \sqrt{-1} \). It is considered usually as the mysterious number because there is no geometrical meaning of this number. The mathematical relation
is not mysterious, because the proof of this relation is elementary. In physics the situation is a such, that if we do not know what is the physical meaning of some relation, then it is mysterious.

We know that Parmenides was not able to understand motion. Motion was mysterious for him. Why? Because he was not able to introduce time in his system of thinking. In particle physics and in the string theory [31] the confinement of quarks is mysterious and the solution of his problem in the dislocation theory of fundamental constituents is open. We think, that appropriate understanding of the stringlike dislocations [32] and definition of the ultimate building blocks of nature can solve all problems of particle physics together with removing all mysteries.

While the verification of the existence of the optical bursts caused by the annihilations of the giant screw dislocations and anti-dislocations can be detected by the Hubble telescope, the gravitational bursts can be probably detected by LIGO [33], VIRGO [34], GEO [35], TAMA [36], and so on.

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