The particle model for the Higgs' condensate and the anomalous geometric diffraction

The anomalous geometric diffraction in quantum mechanics and the time-like two slit experiment. The dark energy hypothesis. The possible invalidity of quantum mechanics at short distances.

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Abstract.

In the Standard model of elementary particles there is no concrete particle model for the Higgs' condensate (of bare Higgs' particles). The main goal of this study is to create and study the possible particle model for the Higgs' condensate. We create this model as a set of non-local tachyons. Non-local tachyons are a new type of objects proposed in our previous papers which have a 3-dimensional space-like surface as a trajectory. As a consequence of this model we obtain the existence of a time constant $\tau_0 > 0$ which is a parameter of our model. We show that then there exists a geometrical part of a diffraction in the time-like two-slit experiment which makes quantum mechanics invalid at short distances. Then we introduce the dark energy hypothesis which enable us to estimate τ_0 . As a main result we give the concrete experimental proposal which can be tested. Also the relation to the basic cosmological model is mentioned. At the end we discuss the generalized model for the Higgs' condensate in which it is possible to acquire some information from the outside of the light cone and possibly also some correlations from the outside of the light cone.

The content

1. Introduction.

This paper can be decomposed into two parts.

In the first part we state that under reasonable assumptions we are able to show that the Higgs' condensate has the discrete structure and that, as a consequence, there exists a **time constant $\tau_0 > 0$** describing this discrete structure and that the existence of such a constant implies the invalidity of quantum mechanics (QM) on short time intervals.

In the second part we show on the base of a **dark energy hypothesis** that it is possible to estimate this time constant τ_0 and to show that the proposed time-like two slit experiment could be realizable. The positive result of such experiment would show the discrete structure of the Higgs' condensate on small distances and the falsity of QM on these distances.

In this paper we propose a non-local tachyon model for the Higgs' condensate: we propose that this condensate is the set of (infinite velocity) non-local tachyons. We show that then there exists the anomalous geometric diffraction. We show that there exists a universal time constant $\tau_0 > 0$ which, a posteriori, defines the limits of the validity of quantum mechanics.

We propose a thought experiment testing the existence of the anomalous geometric diffraction.

We can complete our arguments from the first part of this text: there are logical arguments which imply that quantum mechanics has its limits of the validity at some $\tau_0 > 0$ and **under this limit** quantum mechanics is **necessarily false**.

We propose the dark energy hypothesis which enables us to make an estimate of the time constant τ_0.

We propose to do an experiment testing the existence of the anomalous geometric diffraction in quantum mechanics. Technically, we assume “Feynman” interaction between the standard particle and the non-local tachyon. All this is related to the new (finite) form of the Feynman integral.

In more details. The basic idea of this paper is to study possible particle models for the Higgs’ condensate based on the idea of non-local tachyons and to look for consequences. We proceed step by step:

- Bare Higgs’ particles must be massive tachyons

- These tachyons must be non-local tachyons

- Higgs’ condensate should be modeled as a set of non-local (infinite velocity) tachyons equidistant in time (time constant = τ_0)

- The granular (discrete) structure of the Higgs’ condensate (discrete in the time) implies the existence of the anomalous geometric diffraction in the time-like two slit experiment and then the invalidity of quantum mechanics at small distances.

The interaction between standard particle and the non-local tachyon is described by the concept of the “Feynman” interaction (see sect.7) and it is possible to show that the new Feynman integral converges to the standard Feynman integral when τ_0 goes to 0

The difference between the standard model and the model proposed here is the following.

In the standard model the Higgs’ mechanism is applied before the quantization on the classical level and only the resulting theory is then quantized. In our approach we think on the situation before the spontaneous symmetry breaking (i.e. before the application of the Higgs’ mechanism) and we ask: where are these bare Higgs’ particles which are expected to make a Higgs’ condensate?

In the standard model the Higgs’ condensate give masses to other particles (through the Higgs’ mechanism) etc. but the proper bare Higgs’ particles disappear from the standard model so that they were not quantized (the “dressed” Higgs’ particles make, of course, a part of the standard model). The discrete (quantized) bare Higgs’ particles are not taken into account.

In our approach we propose the simplest possible model for this quantized Higgs’ condensate. Then we describe possible consequences.

At the first place we obtain the existence of a geometric diffraction in the time-like two-slit experiment (proposed already in 1989 in [6]). Existence of the discrete structure in the particle model of a Higgs' condensate implies that there should be fundamental limits on the validity of QM.

The estimate of the basic parameter τ_0 of our model is our next task.

We formulate the **dark energy hypothesis** (saying that the cosmological dark energy is represented by the Higgs' condensate).

Using this hypothesis we are able to arrive at some estimate of the order of τ_0. This (very rough estimate) makes possible to think on the possible experimental test of the existence of the geometric diffraction.

We propose to do the experimental test of the possible existence of the geometric diffraction.

Now we shall describe the detailed content of the text.

In sect.2 we give the space-time classification of possible "particles" and we show that the bare Higgs' particles must be represented by the nonlocal tachyons which are described in some details.

In sect.3 we shall describe the proposed particle model for the Higgs' condensate as a set of non-local tachyons.

In sect.4 se shall introduce our main topic – the anomalous geometric diffraction in the time-like two slit experiment. The positive result of this experiment would imply that $\tau_0 > 0$ and that quantum mechanics describes the world only up to τ_0 .

In sect. 5 we describe the possible interaction between standard particles and non-local tachyons and we describe the “physical Feynman integral” and we also show here that in the limit where $\tau_0 \to 0$ our model converges to the standard model.

In sect.6 we give the complete derivation of the proposed model (without estimating τ_0) which implies that there are principal limits for the validity of QM.

In sect.7 we propose the dark energy hypothesis and using it we give an estimate of the basic time constant τ_0 which is a parameter of our model and which seems to make possible experiments realizable.

In sect. 8 we present the model-independent definition of the time constant τ_0 .

In sect. 9 we give a brief history of concepts of non-local tachyons and of anomalous geometric diffraction.

In sect. 10 we present the generalized model of these phenomena and as a consequence we obtain the possibility to obtain some information about the current Universe.

In sect 11. we present the generalized model and possible superluminal correlations.

In sect.12. we present conclusions and a summary.

The main idea of this text consists in the statement that in the Standard model the Higgs' condensate is not quantified. The Higgs' condensate is treated only on the classical level – as a formal Higgs' mechanism considering only classical fields.

The main feature of our approach can be interpreted as the **explicit quantization of bare Higgs' particles.**

In the Standard model the bare Higgs' particles are not taken into account. The quantization of all other segments is applied but the bare Higgs' particles remain un-quantized. This is the main disadvantage of the Standard model: all sectors are quantized but the Higgs' sector is un-quantized. This is the main disadvantage of the Standard model.

Thus the main difference between our model and the Standard model is the following. Our model is based on the on the quantization of Higgs' condensate while in the Standard model the Higgs' condensate is not quantized.

2. Bare Higgs' particles as non-local tachyons, space-time classification of particles

Quantum objects have, in general, two possible representations: the wave representation and the particle representation. These are considered as equivalent, but we shall consider the particle representation as the most important representation from the physical point of view.

Our proposed model will be based on the particle representation[1]. Individual systems should be interpreted as (a systems of) particles. The wave properties can be attributed only to ensembles of systems.

Usually the analysis of the Higgs' sector is done in terms of the co-called Higgs' mechanism. The standard Higgs' mechanism uses the wave representation of quantum objects. We shall proceed in another way using the particle representation of quantum objects.

It is clear that the Higgs' Lagrangian is tachyon, since the sign of the mass term is negative. This is the situation before the spontaneous symmetry breaking, where bare Higgs' particles are considered. After the spontaneous symmetry breaking the dressed Higgs' particles will acquire the positive mass (this is well known from the Standard model).

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[1] There exists also an argument for this choice. This is the probability model for quantum mechanics described in [1] and [2]. In this probability model for quantum mechanics it can be shown that particle properties can be attributed to individual systems, while wave properties can be attributed only to collectives (i.e. ensembles of particles).

There arises a question what is the particle representation of the **bare Higgs' particles**. Such a representation will be the main objective of our model.

Thus the starting point will be the clarification of the concept of a tachyon objects in quantum theory. It will be shown that the unique possibility for bare Higgs' particles is to be non-local tachyons.

There were proposed two particle models for tachyons:

(1)The standard tachyons, see for example [3]

(2)The **no-local tachyons** proposed in [4] and [5]

The idea of **non-local tachyons** is a **completely new idea of an object**. This new idea assumes that the trajectory of a non-local tachyon is a 3-dimensional surface (e.g. a hyperplane) in the space-time which is space-like at each point. The trajectory of a normal particle is the curve (e.g. a line) in the space-time which is time-like at each point.

The difference between these two forms is enormous. For example the state of a non-local tachyon at a given time is, in general, the 2-dimensional subspace of the space. Thus the non-local tachyon is non-local at each time.

The special case of this description is an infinite velocity tachyon whose trajectory is

$$\{(\mathbf{x}, t) \mid t = t_0\}$$

for some t_0 so that for $t = t_0$ the state of this tachyon is all space, while for $t \neq t_0$, its state is zero, i.e. it does not exist – i.e. it exists only at time t_0.

The non-local tachyons are completely new objects in physics introduced in [4], [5]. These new objects were discovered in the study of quaternion quantum mechanics in [4] and [5]. The goal was to describe the Dirac equation in the quaternion quantum mechanics. It was found that this equation can exist only for the case of tachyons.

This was the starting point of a development of a new theory of tachyons and the main result of this study was the concept of a non-local tachyon which is used here.

Now we shall describe the complete classification of possible space-time description of particles. We shall describe the free motion of particles, but the non-linear motion is, in general, such that at each point of the trajectory its tangent space is of the type described below.

The space-time classification of particles (here $\mathbf{x}$, $\mathbf{x_0}$, $\mathbf{v}$, $\mathbf{w}$ etc. are vectors from R^3 while t, t_0 are real numbers and $\mathbf{x}$, t are variables while $\mathbf{x_0}$, t_0, $\mathbf{v}$, $\mathbf{w}$ are parameters):

(i) The standard massive particle (the bold letters, like $\mathbf{x}$, $\mathbf{x}_0$, $\mathbf{v}$ denote 3-dimensional vectors)

$\mathbf{x} = \mathbf{x_0} + \mathbf{v} (t - t_0)$, where $| \mathbf{v} | < c$, and c = velocity of light

(ii) The standard relativistic massless particle

$\mathbf{x} = \mathbf{x_0} + \mathbf{v} (t - t_0),$ where $| \mathbf{v} | = c$

(iii) The standard super-luminal velocity tachyon

$\mathbf{x} = \mathbf{x_0} + \mathbf{v} (t - t_0),$ where $| \mathbf{v} | > c$

(iv) The standard infinite-velocity tachyon

$t = t_0$, $\mathbf{x} = \mathbf{x_0} + \lambda \mathbf{v_0}$, where $| \mathbf{v_0} | = c$ is a parameter,

while $\lambda \in R$ is a variable, and t_0, $\mathbf{x_0}$, $\mathbf{v_0}$ are parameters[2]

(v) Non-local massive tachyon

$t = t_0 + \mathbf{w} . (\mathbf{x} - \mathbf{x_0}),$ where $| \mathbf{w} | < 1/c$

(vi) Non-local massless tachyons

$t = t_0 + \mathbf{w} . (\mathbf{x} - \mathbf{x_0}),$ where $| \mathbf{w} | = 1/c$

Note that the physical dimension of the standard velocity **v** is meter/second, while the physical dimension of the non-local tachyon velocity **w** is second/meter.

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[2] We obtain this form when we write $\mathbf{x} = \mathbf{x_0} + \lambda \mathbf{v_0} . (t - t_0)$, where $| \mathbf{v_0} | = c$ and $\lambda \to \infty$. If $t > t_0$ we obtain $| \mathbf{x} | \to \infty$ and this is a non-sense. Thus it must be true that $(t - t_0) \to 0$. Then for $\lambda = \lambda_0 (t - t_0)^{-1} \in \mathbf{R}$ we have $\mathbf{x} = \mathbf{x_0} + \lambda_0 (t - t_0)^{-1} \mathbf{v_0} (t - t_0) = \mathbf{x_0} + \lambda_0 \mathbf{v_0}$ (assuming $(t - t_0) \to 0$). The trajectory of this standard infinite-velocity tachyon is $\{(\mathbf{x}, t_0) \mid \mathbf{x} = \mathbf{x_0} + \lambda_0 \mathbf{v_0},\ \lambda_0 \in \mathbf{R}\}$.

Trajectories of particles (i) – (iv) are straight lines in R^4 . Trajectories of particles (v), (vi) are 3-dimensional hyperplanes in R^4 .

Particles (i) – (iv) are, in principle, observable. This is clearly true for the standard massive tachyons with the finite velocity $| \mathbf{v} | > c$. This is also true for standard infinite-velocity tachyons[3].

Particles (v), (vi), i.e. non-local tachyons are **not observable** in any coordinate system, since their trajectory is non-local. (More details on this property can be found in [5]).

The non-observability of individual non-local tachyons is their **most important** feature.

This implies that the large number of such particles **could exist** without being individually observable. This means that the individual non-local tachyon cannot be observed but the consequences of a collective of many non-local tachyons could be, in principle, observed.

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[3] To see the locality of the infinite-velocity tachyon it is necessary to transform the coordinate system to another one. We shall consider the coordinate system moving with the co-linear velocity $\mathbf{V}$, $| \mathbf{V} | < c$. In this case the formula for the transformation of the velocity is simple $\mathbf{v}' = (\mathbf{v} - \mathbf{V}) / (1 - (\mathbf{V}.\mathbf{v} / c^2))$. For each velocity $\mathbf{v}$, $| \mathbf{v} | > c$, one can consider the new coordinate system with the relative velocity $\mathbf{V} = \mathbf{v} . (c^2 / | v |^2)$. We obtain that $1 - \mathbf{V}.\mathbf{v}/c^2 = 0$ and then $\mathbf{v}'$ is infinite and collinear with $\mathbf{v}$. This transform the finite velocity tachyon into the infinite-velocity tachyon and the inverse transformation transforms infinite velocity tachyon into the finite velocity one. For each infinite-velocity tachyon there exist coordinate systems such that the transformed tachyon has finite velocity and in this coordinate system it is localizable.

On the other hand, standard tachyons (cases (iii), (iv)) are, in principle, observable, so that (up to now) their existence is experimentally excluded. We think that the standard tachyons (cases (iii), (iv)) can be excluded also on the logical ground, since the topological structure of the outside part of the light cone is completely different from the topological structure of the inner part of the light cone (see[5]).

The concept of a non-local tachyon is appropriate for the topological structure of the outside part of the light cone.

The Higgs' condensate is usually obtained and described using the Higgs' mechanism in the wave representation of quantum objects.

The particle description of the Higgs' condensate (as a condensate of bare Higgs' particles) must be done by the condensate of tachyons. But the standard tachyons cannot be used, since they are observable (but not experimentally observed).

Thus the **non-local tachyons must be used** for the representation of the condensate consisting of bare Higgs' particles.

The problem to define the particle representation of the Higgs' condensate has to be solved. The solution consists in the representation of the condensate as a set of non-local tachyons (which are, of course, individually non-observable).

We have arrived at the basic consequences:

(i) The bare Higgs' particles must be represented by a set of non-local tachyons
(ii) The Higgs' condensate is a set of non-local tachyons.

We shall also assume that these non-local tachyons will be massive tachyons – see (v). This is based on the fact that the standard lagrangian in the Higgs' mechanism describes the massive non-local tachyons.

3. The particle model for the Higgs' condensate

Now we shall consider the particle model for the Higgs' condensate as a set of non-local tachyons. These massive non-local tachyons may have arbitrary form shown in the preceding section (v) (in general, they also can have non-linear trajectories).

We shall propose the simplest possible particle model for the Higgs' condensate. We shall use the following simplifications:

(i) We shall consider only "infinite velocity" massive tachyons, i.e. tachyons with **w = 0** having the trajectory (IVT = infinite velocity tachyon)

$$IVT(t_0) = \{ (\mathbf{x}, t) \mid t = t_0 , \mathbf{x} \in R^3 \} , \quad \text{where } t_0 \text{ is a parameter}$$

($IVT(t_0)$ = the trajectory of the infinite velocity tachyon at $t = t_0$.)

(ii) We shall assume that these non-local tachyons will be separated by the same interval of time τ_0

$$\mathbf{C} = \{ IVT(k.\tau_0) \mid k \in \mathbf{N} \}$$

where **N** denotes the set of natural numbers and t=0 is the beginning of time in the standard model of cosmology.

The condensate **C** is the set of infinite velocity tachyons equidistant in time. The constant distance in time τ_0 is a universal constant of the model.

This is the simplest way how to represent the particle model of the Higgs' condensate. We shall call it the basic model for the Higgs' condensate. We shall use it, since it contains the basic ingredients of the particle model of the Higgs' condensate.

We think that the main properties of the Higgs' condensate can be, in the lowest order, studied in this simplified model. In the next section it will be shown that the main feature – the anomalous geometric diffraction – is presented already in this model.

It is possible to consider the slightly more general model in which tachyons have still the infinite velocity (i.e. **w = 0**) but times when these tachyons occur are not equidistant. We shall suppose that there are times moments $0 < t_1 < t_2 < \dots$ in such a way that the distribution of times is governed by the Poisson distribution.

Then the condensate will have the following form

$$\mathbf{C} = \{ \mathrm{IVT}(t_k) \mid k \in \mathbf{N} \}$$

where $\{ t_k \mid k \in \mathbf{N} \}$ is the sequence of times discussed above.

This is the situation which we shall call the Poisson model of the Higgs' condensate. Up to now we have two models, the basic one and the Poisson one. Both models use the non-local infinite velocity tachyons.

We shall assume that standard particles will be scattered by non-local tachyons from the Higgs' condensate, but that between two such scatterings **they will move linearly** (the first Newton's law). The form of the interaction between the standard particle and the non-local tachyon will be described below.

Thus we shall assume that

(i) Standard particles are scattered by the non-local Higgs` tachyons

(ii) Between two scatterings (with non-local tachyons) particles move linearly (this is the first Newton's law).

4. The time-like two hole experiment and the anomalous geometric diffraction

There is a basic time-like two-slit experiment in our model for the Higgs' condensate. This is the time-like two-slit experiment (in the contrast to the standard space-like two-slit experiment) which gives the anomalous diffraction. The standard two-slit experiment will be referred as the space-like two-slit experiment, which describes the typical quantum interference.

The idea of the time-like two hole experiment was presented in [6] and then in [7] and [9]. There are two holes, but they are in such position that the particle has to go through both holes – one after the other. This situation is clear from the diagram.

A motion of particles (photons) is directed in the direction of the axis x. Each particle must pass through the first hole and then through the second hole and only after this it will arrive at the screen.

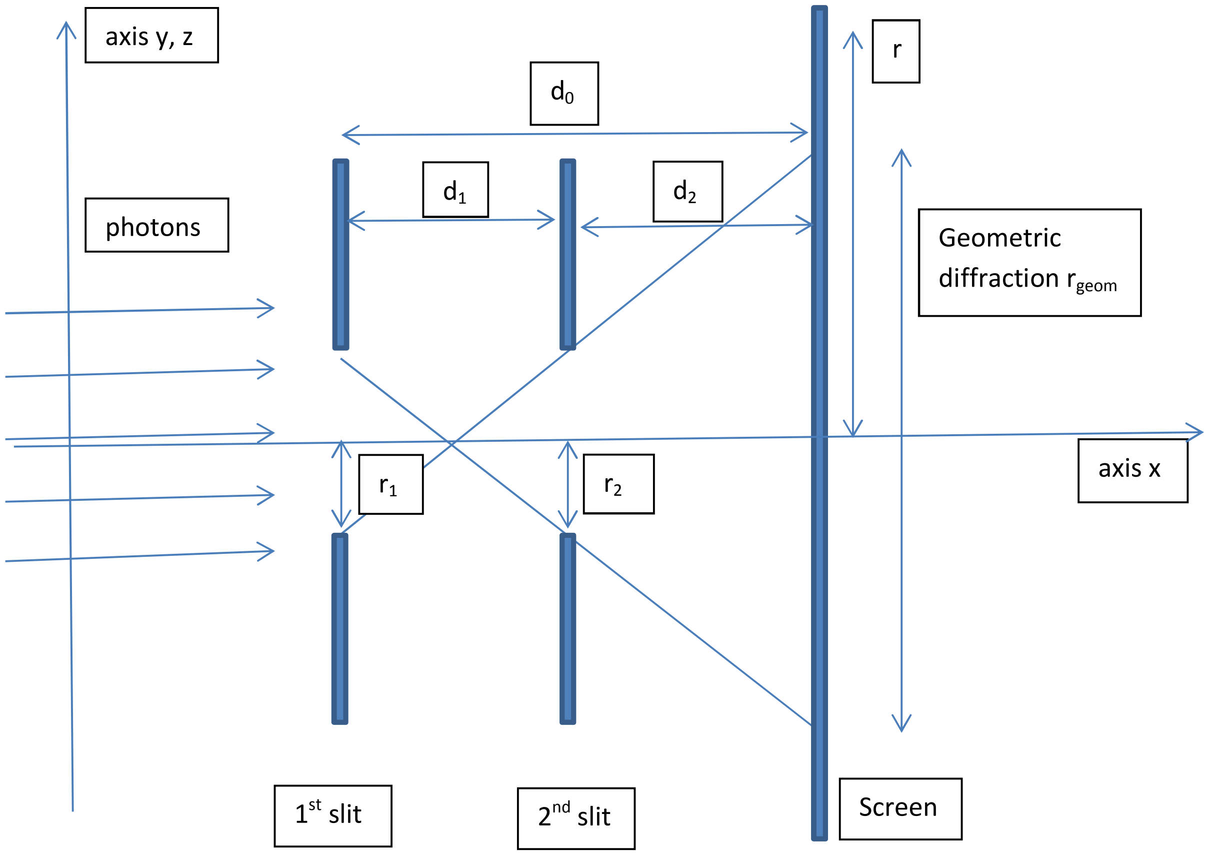

Diagram 1.

Let d_0 be the distance between the first slit and the screen. We shall consider this time-like two slit experiment done with photons. Then the time when the photon is inside the apparatus is

$$t_0 = d_0 / c.$$

If the time t_0 is bigger than τ_0 , then each photon will be scattered with some non-local tachyon during its passage in the apparatus and then after the scattering its trajectory will be unpredictable. The expected distribution of photons at the screen will be similar to the standard quantum mechanical distribution for the diffraction.

If, on the other hand, the time t_0 is smaller than τ_0 , then some photons will be scattered (by some non-local tachyon from the particle model for the Higgs' condensate), while others will not be scattered.

In the case when the photon will not be scattered with some non-local tachyon then its distribution will be the geometric diffraction (we have assumed that between scatterings with non-local tachyons the photon moves linearly).

In the case when the photon will be scattered the resulting distribution will be similar to the standard quantum mechanical distribution.

The probability of the first case (the photon is not scattered) will be $(1 - t_0/\tau_0)$, while the probability of the second case (the photon is scattered) will be t_0/τ_0 (assuming $t_0 < \tau_0$) .

Thus, in the **case $t_0 < \tau_0$** the resulting probability distribution on the screen will be the weighted sum of considered distributions

$$f(r; \lambda) = t_0/\tau_0 \, . \, f^{QM}(r; \lambda) + (1 - t_0/\tau_0) \, . \, f^{geom}(r; \lambda)$$

where $r = (y^2 + z^2)^{½}$, f^{QM} is the standard quantum mechanical distribution and f^{geom} is the distribution of the geometric diffraction and λ is the wave-length of photons. In fact, f^{geom} does not depend on λ .

Our main result: in the situation when d_0 is sufficiently small one can expect the anomalous geometric part of the diffraction in the time-like two holes experiment.

Now we shall describe exactly the parameters of the geometry, other parameters and free variables in the experiment.

- Parameters in the symmetric case ($d_1 = d_2$, $r_1 = r_2$) are:
  - $t_0 = 2d_1/c$ = the time which the photon spends inside the apparatus
  - $r_1 = r_2$ = the radius of holes
  - T = the length of the time window (= (t, t + T))
  - λ = the wave-length of photons
- Other parameters in the asymmetric case $d_1 > d_2$, $r_1 > r_2$) are:
  - $\delta_d = d_1/d_2 > 1$, $\delta_r = r_1/r_2 > 1$
- Free variables
  - r = the radius of the disk B_r in the screen
  - t = the starting time of the time window (t, t + T)

In most situations we assume the symmetric geometry.

Let r_1 be the radius of the first hole and $r_2 = r_1$ be the radius of the second hole. Let the distance between holes is equal to d_1 and the distance between the second hole and the screen be $d_2 = d_1$.

Then the support of the geometric distribution f^{geom} will be the ring at the screen with the radius $r^{geom} = r_1 + 2r_2 = 3r_1$ and the intensity of the flow of photons through this ring (the geometric part of the diffraction) will not depend on the wave length of photons.

On the other hand, the intensity of f^{QM} inside the ring in the screen with the radius $r_{geom} = r_1 + 2r_2 = 3r_1$ is small when the wave length of photons is sufficiently large (this intensity depends on the wave length of photons).

This is the main result of this paper: there is a non-zero intensity of the geometric diffraction in our model non-depending (presumably) on the wave length of photons, while in quantum mechanics the total intensity through the above ring must go to zero when the wave length is large.

Now we shall describe this result in more quantitative terms. We define the ring D_r in the screen by

$$D_r = \{(x,y,z) \in \text{screen} \mid (y^2 + z^2)^{1/2} < r\}$$

Then we denote the number of photons passing through both holes and the ring D_r during the time interval (t , t +T) by

$$N(t, r; T, t_0, r_1, \lambda) = N(t, T, d_1, d_2, r_1, r_2, r, \lambda)$$

This quantity can, in principle, depend on t.

Then we define the intensity by

$$I(t, r; t_0, r_1, \lambda) = \lim_{T\to\infty} (1/T) \,.\, N(t, r; T, t_0, r_1, \lambda) = I(r; t_0, r_1, \lambda)$$

since presumably this intensity does not depend on t .

Then the relative intensity is defined by

$$R\ (r;\ t_0,\ r_1,\ \lambda) = I\ (r;\ t_0,\ r_1,\ \lambda\ )\ /\ I\ (\infty;\ t_0\ ,\ r_1,\ \lambda\ )\ .$$

This relative intensity shows which part of the total diffraction ends in the disc D_r.

Now we shall also consider the same quantities but in quantum mechanics: N^{QM} , I^{QM}, R^{QM} which depend on the same parameters as N, I, R (i.e. on t_0, r_1, T, λ). These quantities can be calculated in QM.

The relation between our model and the standard quantum mechanics is given by the fact that the standard quantum mechanics is obtained when τ_0 goes to zero. But there exists a more interesting relation between our subquantum model and the standard QM.

Schrodinger equation in QM is first-order in time, i.e. the evolution depends only on the present state of the system. This implies that the relative QM-intensity does not depend on d_1 (assuming $d_1 > d_2$) and it also does not depend on r_1 (assuming $r_1 > r_2$). Thus

$$R^{QM}\ (r;\ d_1\ ,\ d_2\ ,\ r_1\ ,\ r_2\ ,\ \lambda\ ) \approx R^{QM}\ (r;\ d_2\ ,\ r_2,\ \lambda\ )$$

Assuming that $c.t_0 = d_0 = d_1 + d_2 >> c.\tau_0$, i.e. $t_0 >> \tau_0$, one can expect that the subquantum model will be approaching the standard QM

$$R\ (r;\ d_1\ ,\ d_2\ ,\ r_1\ ,\ r_2\ ,\ \lambda\ ) \approx R^{QM}\ (r;\ d_2\ ,\ r_2,\ \lambda\ )$$

This shows that if $t_0 < \tau_0$ then the behavior of our model is not first-order (the evolution depends not only on the present state but also on the previous history) while if $t_0 >> \tau_0$ then the evolution is first-order and the influence of the history is vanishing. This conclusion was already obtained in [6].

Thus the main feature of our model is the fact that τ_0 is non-zero.

Our main prediction means that there is a non-trivial geometric diffraction. This may be expressed in a way that there exist $d_1 = d_2$, $t_0 = 2d_1/c$, $r_1 = r_2$, r, λ such that

$$R\,(r;\, t_0,\, r_1,\, \lambda\,) > R^{QM}\,(r;\; t_0\,,\, r_1\,,\, \lambda\,)$$

We can define the anomalous geometric diffraction by

$$R^{anom}\,(r;\, t_0,\, r_1,\, \lambda\,) = R\,(r;\, t_0\,,\, r_1\,,\, \lambda\,) - R^{QM}\,(r;\; t_0,\, r_1\,,\, \lambda\,)$$

and then the above condition transforms into the condition

$$R^{anom}\,(r;\, t_0,\, r_1,\, \lambda\,) > 0\,.$$

This formula shows clearly that our model is **strictly different** from the standard quantum mechanics if $\tau_0 > 0$ and it approaches the quantum mechanics only when $\tau_0 \rightarrow 0$.

In the paper [7] this effect was called the concentration effect – this means that photons are more concentrated in the central part of the screen than in the QM case. But in [7] the argumentation was based on the consideration of the Ornstein-Uhlenbeck stochastic process and the idea of the geometric part of the diffraction was not used. The calculations in the Ornstein-Uhlenbeck situation is substantially more complicated than in the present case so that the resulting conclusions in [7] were only approximate.

5. The interaction between the standard particle and the Higgs' non-local tachyons and the physical Feynman integral

We assume that the standard particle moves linearly between moments of the scatterings with non-local tachyons from the Higgs' condensate. This piece-wise linear trajectory will be parametrized by positions at times of scatterings (plus the initial and final moment of time)

$x_0=x(t_0)$, $x_1=x(t_1)$, … , $x_{n-1}=x(t_{n-1})$, $x_n=x(t_n)$, denoted as $\{x_0, x_1, \dots , x_n\}$

where $t_0 \in [s\tau_0 , s\tau_0 + \tau_0)$[4] , $t_n \in ((s+n-1)\tau_0, (s+n)\tau_0]$ for some s and n and then $t_k = (s+k)\tau_0$, $k = 1, .., n-1$.

The corresponding velocities are $v_k = (x_{k+1} - x_k)/\tau_0$, $k = 0, \dots, n$, i.e. $x_{k+1} = x_k + v_k \tau_0$.

In the interaction with the non-local tachyon the velocity of the standard particle is changed. The velocity is changed in such a way that the resulting new velocity will have the uniform probability distribution independent from the preceding velocity

$$\Pr [v_k \in (v, \Delta v) \mid v_{k-1}] = \alpha \Delta v \ , \quad v \in \mathbf{R}, \quad \Delta v > 0, \ \alpha > 0 .$$

Probability distribution of the position will be

[4] $x \in [a, b)$ means that $x \geq a$ and $x < b$.

$$\Pr [\, x_{k+1} \in (x, \Delta x) \mid x_{k-1} , \; x_k \,] = (\alpha/\tau_0)\, \Delta x \quad , \quad x \in \mathbf{R}, \;\; \Delta x > 0, \;\; \alpha > 0 \,.$$

This type of interaction will be called the Feynman interaction since this interaction is the base of the Feynman integral. Then we obtain for the propagator prop (x_0, t_0 ; x_n, t_n) the standard formula

$$\int \exp i\, A\, (\{x_0, x_1, \dots , x_n \})\, dx_1 \dots dx_{n-1}$$

where A ({x_0, x_1, … , x_n }) is the standard (relativistically symmetric) action for the piece-wise linear trajectory {x_0, x_1, … , x_n }.

In this way we have obtained the physical Feynman integral as a result of the Feynman interaction of a particle with the non-local tachyons from the Higgs' condensate. We call this formula the physical Feynman integral since it is a result of a concrete physical process and not only certain mathematical formula.

This physical Feynman integral is finite, since the time step $\tau_0 > 0$ is positive. The mathematical Feynman integral is obtained as a limit $\tau_0 \rightarrow 0$. In this way we obtain that our subquantum theory converges to the standard quantum mechanics if $\tau_0 \rightarrow 0$.

Thus in the limit $\tau_0 \rightarrow 0$ we obtain the standard quantum theory.

But we have obtained much more:

- We have obtained the physical base for the standard quantum theory

- The fixation $\tau_0 > 0$ makes the (infinite) renormalization theory not necessary – of course, there may exist a finite renormalization procedure, but the infinite renormalization is not needed and has no sense in this situation.

- The terms of the first order in τ_0 will be the subquantum corrections to the standard quantum theory

- The particle model for the Higgs' condensate and the interaction of the standard particle with these non-local tachyons creates the **origin of the in-determinism** of quantum mechanics.

6. The complete logical derivation of the proposed model

Our model was developed and analyzed above. In this part we shall give the almost pure logical derivation of our model.

This derivation shows that our model is not an arbitrary invention but it is a result of the strict logical process. Of course, this means that this model is not only an interesting invention but it is an (almost) consequence of known facts and previous results.

(i) In papers [1] and [2] it was shown that Quantum Mechanics (QM) can be considered as an applied probability theory – but not as the applied classical Kolmogorov probability theory but as the applied new probability theory called the quadratic probability theory ([1]). This implies that the wave properties can be attributed only to ensembles of systems while the particle properties can be attributed to individual systems. This means that every **individual** elementary quantum object must be considered as a particle and cannot be considered as a wave.

(ii) From the form of the Higgs' Lagrangian it is clear that the bare Higgs` particles must be massive tachyons.

(iii) Bare Higgs` particles are not observed so there is only one possibility that the bare Higgs` particles are massive non-local tachyons (see the classification above) – non-local tachyons are individually non-observed but also individually non-observable, i.e. they can exist in arbitrary large number.

(iv) The particle representation of the Higgs` condensate must have a form of a set of non-local tachyons.

(v) The simplest possible particle model for the Higgs` condensate is the model proposed above in the Sect. 3 where non-local massive tachyons have the zero tachyon velocity (**w** = 0) and they are equidistant in time (with the distance equal to τ_0).

(vi) The interaction between the standard particle (e.g. some photon) and the non-local tachyon is described by the concept of the “Feynman” interaction introduced in the Sect. 7. This form implies that the standard Feynman integral is a limiting case of our model when τ_0 goes to zero. The particle representation of the Higgs` condensate is considered as a background and the back reaction of the condensate is neglected.

(vii) The anomalous geometric diffraction in the time-like two slit experiment is the direct consequence of the particle model for the Higgs` condensate. In fact, any $\tau_0 > 0$ is good. This implies that our model is different from QM. The observation of the geometric diffraction in quantum mechanics would imply that quantum mechanics is not correct at short distances.

(viii) The existence of a universal time constant $\tau_0 > 0$ is the consequence of the particle model for the Higgs` condensate.

Thus the sequence of logical arguments implies that $\tau_0 > 0$ and that QM is not true at such small time intervals. The basis of this argument is the priority of the particle representation, i.e. the quantization of the Higgs' condensate.

This is our logical argument that QM cannot be an absolutely true theory.

Briefly: the particle model of the Higgs' condensate *implies* $\tau_0 > 0$ and this *implies* that QM is not an absolute truth and should be replaced by the subquantum mechanics at distances of the order $c.\tau_0 > 0$.

In other words: the absolute validity of QM implies the impossibility of the discreteness (i.e. of the quantization) of the Higgs' condensate. This goes against the atomistic principle governing all modern physics.

The estimate of the basic time constant τ_0 **needs** more assumptions, namely the **dark energy hypothesis** and other hypotheses concerning the structure of the dark energy. Thus the estimate of τ_0 cannot be considered as a purely logical consequence of the previous knowledge.

Of course, the existence of the anomalous geometric diffraction directly contradicts to QM. This implies that our model cannot be considered as a part of QM and must be considered as a sort of some sub-quantum theory.

This is the logical consequence of (vii) and this conclusion does not depend on the value of the time constant τ_0 – it is sufficient that $\tau_0 > 0$.

The fact that $\tau_0 > 0$ is the consequence of the granularity – quantization of the particle model for the Higgs` condensate. In the Standard model of the Higgs` condensate the dark energy is continuously distributed and $\tau_0 = 0$.

In our model the dark energy is continuously distributed in the space but it is dis-continuously (discretely) distributed in time.

We have shown that the main part of our model is a **logical consequence** of the previous results (but the estimate of the time constant τ_0 requires also other assumptions).

The other important consequence is the fact that the particle model for the Higgs' condensate can explain the **physical origin of the indeterminism** (randomness) **of quantum mechanics**. This means that the source of the indeterminism of QM is not the "God", but the interaction with the non-local tachyons from the Higgs' condensate - i.e. that the indeterminism of QM has purely physical origin.

Thus the randomness of QM is not a result of an axiomatic definition (as it is usually assumed) but a consequence of the physical state of universe, i.e. of the discrete structure of the Higgs' condensate.

7. The dark energy hypothesis and the estimate of the time constant τ_0

Now we come to the second main topic which is the estimate of the time constant τ_0 which is a parameter of our model. To find some estimate it is necessary to relate this constant of the model to some real physical phenomena. To do this we shall use some hypotheses. This is related to the concept of the dark energy created in the cosmology.

The dark energy hypothesis:

Our model for the Higgs' condensate is the model for the dark energy: I.e.

- **(i) The particle representation of the dark energy is the set of non-local tachyons**
- **(ii) These non-local tachyons are the bare Higgs' particles from the Higgs' condensate**

Let us immediately remark that our model of the Higgs` condensate fulfils the basic requirement that the dark energy is everywhere in the universe and it is not localized: this is the direct consequence of the fact that our particle model for Higgs` condensate is composed from the non-local massive tachyons. (Moreover, in our model these non-local tachyons have the zero tachyon velocity but this is not necessary for the discussed property.)

Let us remark the following: it is clear that our model for the Higgs' condensate is non-relativistic. But the standard limit of the model ($\tau_0 \to 0$) goes to the standard model of quantum mechanics which is relativistic (see Sect. 5) and thus for the time interval much greater than τ_0 predictions of our model are close to predictions of the standard model (see Sect. 5).

The breaking of the relativistic symmetry in our model is not created by the theory but by the distribution of the matter (in fact, the distribution of non-local tachyons from the Higgs's condensate) in the universe. Thus this breaking of the relativistic symmetry is the spontaneous symmetry breaking created by the real distribution of the mass in the universe. The recovery of the relativistic symmetry in the limit $\tau_0 \to 0$ is clear, mainly from the Feynman integral described above in Sect. 5.

For us this hypothesis is extremely important since it is then possible to estimate the density of the Higgs' condensate.

We know already that the density of the dark energy is (approximately) 25 larger than the density of the standard mass. This means that the dark energy density is approximately one order greater than the standard energy density.

Now we shall also assume that the distribution of the energy into particles will be similar for the standard energy and for the dark energy. This make possible to estimate the constant τ_0 from our model.

Let us choose the space unit δ_0 in such a way that the density of the standard mass will be such that it gives (in the mean) the one particle in the volume of the dimension δ_0^3.

Now we can estimate the value of δ_0. It is known that the approximate mean value of the baryonic mass density is (approximately) one baryon in the meter cube in the universe. But there are many other particles different from baryons (photons, neutrinos, leptons etc). We would like to estimate that there are, say, 10^{12} particles in the volume of meter cube. This implies that we can take $\delta_0 = 10^{-4}$ meter = 100 microns. The corresponding value of $\tau_0 = \delta_0 / c$ will be of the order $\tau_0 \approx 10^{-4} * 10^{-9}$ δ_0 second = 10^{-13} second = 100 femtoseconds (we set approximately c = 10^9 meter/second). If one considers the situation with $\delta_0 = 10^{-5}$ meter = 10 microns then we obtain $\tau_0 \approx 10$ femtoseconds.

Thus our estimate is

$$\tau_0 \approx 10 \text{ femtoseconds .}$$

This corresponds to the value of δ_0 that will be (approximating $c \approx 10^{-9}$ meter/second)

$$\delta_0 = 10 \text{ microns.}$$

To make the proposed time-like two holes experiment with the parameter

$$d_0 = d_1 + d_2 \approx 10 \text{ microns}$$

is (in principle) possible.

Our proposed experiment:

To do the time-like two holes experiment with d_0 of the order 10 microns and $r_1 = r_2$ of the order 5 microns and to look for the anomalous geometric diffraction.

In general, it would be good to make the proposed time-like two-slit experiment at the smallest dimension as possible, for example, for d_0 of the order of 100 nm = 0.1 microns.

Perhaps the nano-technologies will make possible to test the time-like two holes experiment and the anomalous geometric diffraction on substantially shorter distances, e.g. for d_0 of the order of 10 nm and $r_1 = r_2$ of the order of 5 nm.

The contemporary technology is perhaps able to arrive at these distances.

8. The quantization of the time

It is clear that the time constant τ_0 is model dependent. Our goal in this section is to define a universal time constant τ in a model independent way – i.e. in the way which depends only on the well-defined experimental situation and does not depend on the model which is used.

In this section we shall give a definition of the constant τ which is model independent and we shall show that if we assume the basic subquantum model described above (containing the time constant τ_0) we are, in particular, able to obtain τ.

The starting quantity is the intensity defined in Sect 5:

$$I\ (r;\ d_1\ ,\ d_2\ ,\ r_1\ ,\ r_2\ ,\ \lambda)\ .$$

At this moment it is necessary to fix five parameters d_1, d_2, r_1, r_2, λ. At first we shall fix parameters r_1, r_2, d_1, d_2, r using t_0, λ by formulas

$$d_0/2 = d_1 = d_2 = 2r_1 = 2r_2\ ,\quad r^{geom} = 3.r_1 \quad \text{and} \quad t_0 = d_0/c\ .$$

Using this parametrization we define

$$I\ (r;\ t_0.\ \lambda) = I\ (r;\ d_1\ ,\ d_2\ ,\ r_1\ ,\ r_2\ ,\ \lambda)\ .$$

Our idea says that if t_0 is sufficiently small then the most of particles will be found in the geometrical zone on the screen. On the other hand we can suppose that for t_0 sufficiently large the number of particles found in the geometrical zone will be relatively small if $\lambda > \lambda_0$ for λ_0 reasonably large (in the next step se shall consider $\lambda \to \infty$).

Thus we can suppose that there will exist (for a given λ) certain t_0 such that

$$I\,(r^{geom};\, t_0\,,\, \lambda) = \tfrac{1}{2}\, I\,(\infty;\, t_0,\, \lambda)$$

We shall denote this t_0 as $\tau\,(\lambda)$, i.e. we define

$$\tau\,(\lambda) = t_0 \;\text{ for which }\; I\,(r^{geom};\, t_0\,,\, \lambda) = \tfrac{1}{2}\, I\,(\infty;\, t_0,\, \lambda)\ .$$

Now we shall consider the situation where λ is very large , i.e. where

$$\lambda \to \infty\ .$$

Then we can define

$$\tau = \lim_{\lambda\to\infty} \tau\,(\lambda)\ .$$

This is our time constant based on the discrete structure of the Higgs' condensate.

The appropriate question is what is the relation of τ to the time constant τ_0 from our basic model of the Higgs' condensate. We are not able to give the precise answer. This would require to develop more concretely the basic model. We can only expect $\tau \approx \tau_0$.

Our aim in this section was to give an experimentally well-defined procedure how to obtain a definite time constant τ. Of course, it may happen that the resulting τ will be equal to 0 or that the limit of τ (λ) will not exist. But the general principle that in the situation of the particle structure of the Higgs' condensate there should exist a positive time constant τ is nevertheless true.

On the other hand there is a question of the possible modification of the basic cosmological model reflecting the proposed model of the dark energy.

9. A brief history of non-local tachyons, the Ornstein-Uhlenbeck stochastic process and the anomalous diffraction

The concepts of the non-local tachyons and of the anomalous geometric diffraction in the time-like two slit experiment were developed in a series of papers but in a different form than in the present paper. We shall describe the relation of these previous papers to the present paper.

- The first publication on non-local tachyons was [4] in 1979 where the starting point was the QM based on real quaternions instead complex numbers. There was shown that such QM should describe tachyons and it was also shown that the classical approximation of these tachyons must be described as hyperplanes from Sect. 3 (v). This was the first appearance of the idea that the trajectory of a freely moving tachyon should be the 3-dimensional space-like hyperplane (or a 3-dimensional surface) and not the 1-dimensional line.

- The second paper on non-local tachyons was [5] in 1981 where more structure to the quaternion QM was given and the classical approximation was analyzed in more details.
  There was clearly stated that the classical tachyons should be described by hyperplanes (in general by the space-like 3-dimensional sub-manifolds in R^4).

- In the paper [6] in 1989 the structure of the background formed by non-local tachyons was used as an assumption. This was the first paper where the time-like two-slit experiment was proposed and the hypothesis of the anomalous diffraction was proposed. The anomalous diffraction was considered inside (the quantum analog of) the Ornstein-Uhlenbeck stochastic process which describes the more detailed version of the Brownian motion. In this process the phenomenon of the anomalous diffraction occurs.

- The analysis of the Ornstein-Uhlenbeck process is much more complicated than the basic subquantum model proposed here. Nevertheless the time-like two-slit experiment and the anomalous diffraction were for the first time proposed in [6], moreover the universal time constant was also introduced in this paper.

- In the paper [7] (2001) the originally linear theory developed in [6] (free systems without any interaction) was generalized to the non-linear theory containing the possible interactions. In many cases the effects proposed in [6] are in [7] mathematically (at least partially) analyzed.

- The time-like two-slit experiment was fully described and analyzed in the paper [9] in 2004. There was proposed the more detailed form of this experiment.

10. The generalized model for the Higgs' condensate and the new superluminal observational window in the Cosmology – the contemporary state of the Universe

In the Section 6 we have defined the intensity of the flow of photons through the time-like two-slit experiment by

$$I (t , r ; d_1 , d_2 , r_1 , r_2 , \lambda) = \lim_{T\to\infty} (1/T) . N (t , r ; T , d_1 , d_2 , r_1 , r_2 , \lambda) .$$

This is the mean intensity during the time interval $(t_0, t_0 + T)$ where $T\to\infty$. Then we have observed that this intensity does not depend on t

$$\text{i.e. } I (t ,r ; d_1 , d_2 , r_1 , r_2 , \lambda) = I (r ; d_1 , d_2 , r_1 , r_2 , \lambda) .$$

Let us now consider the intensity through the interval $(t, t + T_o)$ where T_0 is fixed. This intensity naturally depends on t, thus we have the "local intensity" defined by

$$N (t , r ; T_0 , d_1 , d_2 , r_1 , r_2 , \lambda) .$$

This local intensity naturally depends parametrically on T_0 and also on t. This would require to construct pulses with the duration less than T_0.

Let us assume that this quantity has certain non-trivial dependence on t (assuming that T_0 is fixed and sufficiently small). In this way we are able to obtain certain information about the current Universe outside of the light cone.

In this way it could be open the new observational window in the Cosmology which contains an information outside of the past light cone. This is the information on the local (in time) structure of the Higgs' condensate.

It is clear that this phenomenon is rather far from being actually observable. This discussion wanted only to explain that such considerations could open the completely new observational window in cosmology which could allow us to observe something outside of the standard light cone horizon.

It is clear that the physics of the outside-light cone region is at the moment completely speculative. There were some possible first steps done in the [4], [5]. But it can be expected that the outside-light cone physics will be the physics of the particle representation of the Higgs' condensate.

Up to now we have no information related to the outside of the past light cone. In clear words, we have no information about the current state of the Universe. Our information is limited to the past light cone.

The present approach is able to obtain small pieces of information about the situation outside of the past light cone.

This is one of our aspiration of this paper to open the question of the physics outside of the light cone.

The frontier of the light cone is one of the open frontiers for people to be fought. We hope that it is possible to enter into the world outside of the light cone and that our approach opens this way.

If people want to be an intergalactic entity then they have to be able to surpass the light cone barrier. The first step is to acquire some knowledge about the world outside of the light cone.

11. The generalized model for the Higgs' condensate, the superluminal correlations and the stable coordinate system in the cosmology

At the end of the preceding section we have obtained the formula

$$N\ (t, r\ ; T_0\ , d_1\ , d_2\ , r_1\ , r_2\ , \lambda\ ).$$

We assume that T_0 is fixed and sufficiently small. We shall fix also the other parameters d_1, d_2, r_1, r_2, λ. This is related to the apparatus A.

We can make another new copy B (of the apparatus A) at the different place such that the relative vector between these two places will be $\Delta\mathbf{x}$.

Now we can define two time series (starting at the time t)

$$f_A\ (k) = N\ (t + kT_0, r\ ; T_0\ , d_1\ , d_2\ , r_1\ , r_2\ , \lambda\ ) \text{ for the apparatus A and}$$
$$f_B\ (k) = N\ (t + kT_0, r\ ; T_0\ , d_1\ , d_2\ , r_1\ , r_2\ , \lambda\ ) \text{ for the apparatus B}$$

where k = 1, .., n. We shall be interested in the possible existence of a correlation between these two time series f_A and f_B .

To define the sample Pearson correlation coefficient r (see [10]) we consider two data sets: $\{x_1, .., x_n\}$, $\{y_1, .., y_n\}$ where $x_i = f_A(i)$, $y_i = f_B(i)$, i = 1, .. , n .

We use mean values $Ex = (1/n)\ \Sigma_{i=1}^{n}\ x_i$, $Ey = (1/n)\ \Sigma_{i=1}^{n}\ y_i$ and

$$\sigma_x = (n^{-1} \Sigma_{i=1}^{n} (x_i - Ex)^2)^{1/2} , \sigma_y = (n^{-1} \Sigma_{i=1}^{n} (y_i - Ey)^2)^{1/2}$$

and then the correlation coefficient r is defined by

$$r = [n^{-1} \Sigma_{i=1}^{n} ((x_i - Ex) (y_i - Ey))] / [\sigma_X \sigma_y] .$$

We shall consider also the displayed datasets $\{x_{m+1}, .., x_n\}$, $\{y_1, .., y_{n-m}\}$ and their correlation coefficient $r^{(m)}$. In the same way we can consider the datasets $\{x_1, .., x_{n-m}\}$, $\{y_{1+m}, .., y_n\}$ and their correlation coefficient $r^{(-m)}$.

At first we consider the situation where the coordinate system we use is the system where non-local infinite-velocity tachyons make the content of the Higgs' condensate. Then we could expect that the correlation coefficient r will be positive, i.e. $r > 0$. If $r > 0$ is the case then we see that there exists a superluminal correlation between place A and the place B. The unique possible origin of such a correlation will be non-local tachyons from the Higgs' condensate. This would be the **direct proof** of the existence of the condensate composed from non-local tachyons.

It may happen, of course, that our current coordinate system is different from the coordinate system where non-local tachyons have infinite velocity. This will have an effect on correlations in this sense that instead of the correlation r one has to consider correlations $r^{(m)}$ and $r^{(-m)}$ for an appropriate m. We can say that having $r^{(m)} > 0$ or $r^{(-m)} > 0$ for some m there should exist a "displayed" correlation between A and B.

In general, one can expect that knowing “displayed” correlations in the three different directions of Δ**x**’s then it will be possible to determinate the “stable” coordinate system of the universe.

Clearly, this is far from the possibility to be really observed. But we wanted to explain here that such possibilities, while theoretical, there exist and may be considered seriously.

This means that theoretically it is possible to discover the stable coordinate system in the universe. This possibility does not break the Lorenz symmetry since this possible breaking will be the consequence of the actual distribution of the mass in the universe.

This knowledge will be one of the first information about the world outside of the light cone.

This observations would show clearly the true existence of the non-local tachyon content of the Higgs’ condensate.

12. Conclusions.

We have started with the following hypotheses

- Non-local massive tachyons define the particle representations of bare Higgs' particles (see sect. 2)
- The Higgs' condensate is a set of infinite velocity non-local tachyons equidistant in time (see sect. 3)
- The interaction between the standard particle and the non-local tachyon is described as a "Feynman's interaction" (see sect. 7)
- Particles move linearly between interactions with non-local tachyons

We have shown that then there exists a time constant $\tau_0 > 0$ such that **below this constant the standard QM is not valid**. This is a consequence of the proposed time-like two holes thought experiment (see sect. 4).

We have shown also that there exists a "logical deduction" of the fact that $\tau_0 > 0$ (sect. 8).

Then we have continued with the possible estimation of the constant τ_0. In this estimation we have used the following dark energy hypothesis:

Dark energy hypothesis: the proposed model for the Higgs' condensate is the model for the cosmological dark energy (see sect. 5)

Using this hypothesis we can estimate the time constant τ_0 and to propose the **realistic time-like two holes experiment** (see sect. 4).

We predict the existence of the anomalous geometric diffraction in the time-like two-holes experiment for photons at short time intervals smaller then τ_0.

Then we have been able to give the physical meaning to the finite Feynman integral (sect. 7) and to show that in the limit $\tau_0 \rightarrow 0$ this integral converges to the standard Feynman integral. In this way we have shown that our theory converges to the standard model if $\tau_0 \rightarrow 0$.

The discussion:

- The basic input is the discrete (quantized) structure of the Higgs' condensate – instead of the continuous representation of the condensate in the Higgs' mechanism in the Standard model

- The second basic input is the idea of the Higgs' condensate as a set of infinite velocity non-local tachyons equidistant in time

- The third input is the idea that all indeterminism of QM originates from the interaction of standard particles with non-local tachyons from the Higgs' condensate

- The fourth input is the dark energy hypothesis saying that the Higgs' condensate can be represented as a set of non-local tachyons representing the dark energy – i.e. that the particle content of the dark energy should be represented as a set of non-local tachyons

- In general, we believe that the quantized (i.e. discrete) structure of the Higgs' condensate is an important element in quantum theory

- The estimate of τ_0 makes possible to think on real experimental testing of the existence of the geometric diffraction

Main conclusions obtained in our paper:

- The particle model for the Higgs' condensate

- The existence of the time constant $\tau_0 > 0$

- The existence of the anomalous geometric diffraction in the time-like two-slit thought experiment

- The invalidity of QM on small distances if $\tau_0 > 0$

- The possibility to observe the geometric diffraction in a real experiment

The consequences of the dark energy hypothesis

- The "physical" Feynman integral with $\tau_0 > 0$

- The estimate of τ_0
- The possibility of testing the time-like two-slit experiment experimentally

The one of main goals of this study is to explore the possibility to gain some information from the outside of the light cone. Up to now we have ho information from the outside of the light cone.

Our argumentation is oriented in the direction to obtain some outside of the light cone information. Of course, the first steps into this region will be only small.

But the first steps are the most important steps, as usual. This opens the new area before physicists and we have to make these first steps.

The possibility to look outside of the light cone will be a great adventure for people and these adventurers should be enthusiastic

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