Ghost spinors in quantum particles interference

Elena V. Palesheva

Department of Mathematics, Omsk State University
644077 Omsk-77 RUSSIA

E-mail: m82palesheva@math.omsu.omskreg.ru

ABSTRACT

In this article a question of the ghost spinors influence to the quantum particles interference is investigated. The interaction between spinors and ghost spinors are considered. Furthermore the conditions of zero-point energy-momentum tensor in private cases are found. Also we consider a question about the experimental test of Deutsch shadow particles existense.
Introduction

In this article we consider some development of Deutsch idea [2]. David Deutsch consider the known experiment of quantum mechanics, namely the experiment with a quantum particles interference, and then the received interference pattern is explained by shadow particles existence, there are particles in parallel universes. The offered approach to description of our reality [2] get a mathematical motivation in [3, 4]. The Guts-Deutsch Multiverse contain set of parallel universes, herewith, as David Deutsch expect [2], particles in our universe can interact only with own shadow particles. The sintetical differential geometry is used in Guts model of Multiverse. As ghost spinors have a zero-point energy-momentum tensor, identification of Deutsch shadow particles in case of spinor fields and ghost spinors was made in [9, 10]. In this article we consider a question of ghost spinors influence to interference pattern. Herewith in first we consider some conditions of zero-point energy-momentum tensor which will be used hereinafter.

1 Zero-point energy-momentum tensor

We consider only a spacetime of special relativity. As known the Dirac equation for free particle in spacetime of Minkowski hase the next form

$$i\hbar \gamma^{(k)} \frac{\partial \psi}{\partial x^k} - mc\psi = 0,$$

(1)

where $\gamma^{(k)}$ are Dirac matrixes in standart presentation:

$$\gamma^{(0)} = \begin{bmatrix} I & 0 \\ 0 & -I \end{bmatrix}, \quad \gamma^{(\alpha)} = \begin{bmatrix} 0 & \sigma_{\alpha} \\ -\sigma_{\alpha} & 0 \end{bmatrix},$$

$$\sigma_1 = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}, \quad \sigma_2 = \begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}, \quad \sigma_3 = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}, \quad I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}.$$

In this case the energy-momentum tensor of spinor field is defined by expression

$$T_{ik} = \frac{i\hbar c}{4} \left\{ \psi^* \gamma^{(0)} \gamma_i \frac{\partial \psi}{\partial x^k} - \frac{\partial \psi^* \gamma^{(0)} \gamma_i \psi}{\partial x^k} + \psi^* \gamma^{(0)} \gamma_k \frac{\partial \psi}{\partial x^i} - \frac{\partial \psi^* \gamma^{(0)} \gamma_k \psi}{\partial x^i} \right\}.$$

(2)

Herewith the symbol * means Hermite conjugation and

$$\gamma_i = g_{ik} \gamma^{(k)}.$$
In [5, 6, 7, 8, 9, 10] the solutions of Dirac equation with zero-point energy-momentum tensor and non-zero-point current density were found. The formula

\[ j^{(k)} = \psi^* \gamma^{(0)} \gamma^{(k)} \psi \]  

(3)

define current density in Minkowski spacetime. Herewith \( j^{(0)} \) is a square of modulus of probability amplitude \( \psi \) which characterize the probability of appearance of this particle in spacetime. In special relativity \( j^{(0)} = \psi^* \psi \) and \( j^{(a)} \) is a velocity of change of probability density \(^1\).

**Theorem 1.** Let \( \psi = u \cdot G(x) \) is a solution of Dirac equation herewith

\[ \psi^* \psi \neq 0, \quad G(x) = f(x) + i \cdot g(x), \]

where \( f(x) \) and \( g(x) \) are real smooth functions and bispinor

\[ u = \begin{bmatrix} u_0 \\ u_1 \\ u_2 \\ u_3 \end{bmatrix} \]

such that \( \forall i \quad u_i \in \mathbb{C} \). In these conditions \( \psi \) is a ghost spinor iff \( g(x) = a \cdot f(x) \) where \( a = \text{const} \in \mathbb{R} \).

**Proof.** From definition the solution of Dirac equation is a ghost spinor iff \( T_{ik} \equiv 0 \) and Dirac current \( j^{(k)} \neq 0 \). That \( j^{(k)} \neq 0 \) follow from \( \psi^* \psi \neq 0 \).

Now we must show that \( T_{ik} \equiv 0 \) iff \( g(x) = a \cdot f(x) \). For this we notice that \(^2\)

\[ \psi^* = u^* \overline{G} = u^*(f(x) - i \cdot g(x)). \]

Hereinafter we consider some stages.

a) We notice that identity \( T_{oo} \equiv 0 \) exist iff

\[ 0 = \psi^* \gamma^{(0)} \gamma^{(0)} \frac{\partial \psi}{\partial x^0} - \frac{\partial \psi^*}{\partial x^0} \gamma^{(0)} \gamma^{(0)} \psi = \psi^* \frac{\partial \psi}{\partial x^0} - \frac{\partial \psi^*}{\partial x^0} \psi = u^* \overline{G} \frac{\partial G}{\partial x^0} - u^* \frac{\partial \overline{G}}{\partial x^0} \frac{\partial G}{\partial x^0} \]

\[ -u^* \frac{\partial \overline{G}}{\partial x^0} u G = u^* u \left( \overline{G} \frac{\partial G}{\partial x^0} - \frac{\partial \overline{G}}{\partial x^0} G \right). \]

As \( \psi^* \psi \neq 0 \) we have \( u^* u \neq 0 \). So we get that \( T_{oo} \equiv 0 \) iff

\[ \overline{G} \frac{\partial G}{\partial x^0} - \frac{\partial \overline{G}}{\partial x^0} G = 0. \]

\(^1\)Greek indexes are 1,2,3.

\(^2\)Here \( \overline{G} \) is a complex conjugate function.
That is right iff
\[ f \frac{\partial g}{\partial x^0} = g \frac{\partial f}{\partial x^0}. \]

b) Now we consider a condition on \( T_{01} \). We have that \( T_{01} \equiv 0 \) iff the next equality is right:
\[
0 = \psi^* \gamma^{(0)} \gamma^{(0)} \frac{\partial \psi}{\partial x^1} - \frac{\partial \psi^*}{\partial x^1} \gamma^{(0)} \gamma^{(0)} \psi - \psi^* \gamma^{(0)} \gamma^{(1)} \frac{\partial \psi}{\partial x^1} + \frac{\partial \psi^*}{\partial x^1} \gamma^{(0)} \gamma^{(1)} \psi = \\
= \psi^* \frac{\partial \psi}{\partial x^1} - \frac{\partial \psi^*}{\partial x^1} \psi - u^* \gamma^{(0)} \gamma^{(1)} u \frac{\partial G}{\partial x^0} + u^* \frac{\partial \gamma}{\partial x^0} \gamma^{(0)} \gamma^{(1)} u G = \\
= u^* u \left( \frac{\partial G}{\partial x^1} - \frac{\partial \gamma}{\partial x^1} G \right) - u^* \gamma^{(0)} \gamma^{(1)} u \left( \frac{\partial G}{\partial x^0} - \frac{\partial \gamma}{\partial x^0} G \right).
\]

From results of stage a) we have that second summand is equal to zero. So \( T_{01} \) is equal to zero iff
\[ f \frac{\partial g}{\partial x^1} = g \frac{\partial f}{\partial x^1}. \]

c) Let the similar procedure for components \( T_{02} \) and \( T_{03} \) is consecutively executed. Then we shall find that \( T_{0k} \equiv 0 \) iff
\[ f \frac{\partial g}{\partial x^k} = g \frac{\partial f}{\partial x^k}. \]

This sistem hase solution
\[ g(x) = af(x), \quad (4) \]
where \( a = \text{const} \in \mathbb{R}. \)

Now we shall show that an expression
\[ \forall \alpha, \beta \quad T_{\alpha \beta} \equiv 0 \]
follow from (1). We have that \( T_{\alpha \beta} \equiv 0 \) iff
\[
0 = \psi^* \gamma^{(0)} \gamma^{(\alpha)} \frac{\partial \psi}{\partial x^\beta} - \frac{\partial \psi^*}{\partial x^\beta} \gamma^{(0)} \gamma^{(\alpha)} \psi + \psi^* \gamma^{(0)} \gamma^{(\beta)} \frac{\partial \psi}{\partial x^\alpha} - \frac{\partial \psi^*}{\partial x^\alpha} \gamma^{(0)} \gamma^{(\beta)} \psi = \\
= \psi^* \frac{\partial \gamma^{(\alpha)}}{\partial x^\beta} \frac{\partial G}{\partial x^\beta} - \frac{\partial \gamma^{(\alpha)}}{\partial x^\beta} G + \psi^* \gamma^{(0)} \gamma^{(\beta)} u \left( \frac{\partial G}{\partial x^\alpha} - \frac{\partial \gamma}{\partial x^\alpha} G \right).
\]

For type of function \( G(x) \) we have a right equation. Theorem is proved.
Corollary 1. Let the conditions of theorem 1 is executed and
\[ G(x) = e^{\alpha(x) + i\beta(x)} \]
where \( \alpha(x) \) and \( \beta(x) \) are smooth real functions. Then \( \psi \) is a ghost spinor iff \( \beta(x) = \text{const} \in \mathbb{R} \).

Proof.
\[ G(x) = e^{\alpha(x) + i\beta(x)} = e^{\alpha(x)} \cos[\beta(x)] + ie^{\alpha(x)} \sin[\beta(x)]. \]
From theorem 1 we have that \( \psi \) is a ghost spinor iff \( \text{ctg}[\beta(x)] = \text{const} \).  

Theorem 2. Let us assume that
\[
\psi = \begin{bmatrix} G_0(x) \\ G_1(x) \\ G_2(x) \\ G_3(x) \end{bmatrix}
\]
is a solution of Dirac equation, herewith \( \psi^* \psi \neq 0 \) and
\[
\forall k \quad G_k(x) = f_k(x) + ig_k(x)
\]
where \( f_k(x) \) and \( g_k(x) \) are smooth real functions. If
\[
\forall i,k \quad f_i(x) = c_{ik} \cdot g_k(x),
\]
here \( c_{ik} = \text{const} \in \mathbb{R} \), then \( \psi \) is a ghost spinor.

Proof. For considering spinor the next equality is corrected
\[
\psi^* \gamma^{(0)} \gamma_i \frac{\partial \psi}{\partial x_k} - \frac{\partial \psi^*}{\partial x_k} \gamma^{(0)} \gamma_i \psi = 0.
\]
So \( T_{ik} \equiv 0 \). As \( \psi^* \psi \neq 0 \) the Dirac current is not equal to zero. Theorem is proved.  

Corollary 2. Let we have a solution of Dirac equation
\[ \psi = uf(x), \]
where \( f(x) \) is smooth real function and components of bispinor \( u \) are complex numbers such that a statement \( \psi^* \psi \neq 0 \) is right. Then \( \psi \) is a ghost spinor.

Proof. Proof is obviously.


2 Interactions between real spinors and ghost spinors

David Deutsch assume that shadow electrons act to appearance of interference pattern [2]. A question about nature of interactions between real and shadow particles is appeared. Deutsch expect that shadow photons interact only with own real photons. Here we will describe that if a real spinor wave and a ghost spinor wave are interacted we observe the interference pattern. Moreover in some cases of these interactions the resulting wave is a ghost spinor. Also we will show that if we take into account shadow spinor waves in the two-slit experiment then it is not disagree to known experimental data.

2.1 Fluctuation of matter in universe

Let the Dirac wave function have a type

$$\psi = u(f(x) + ig(x)),$$

$f(x)$ and $g(x)$ are smooth real functions with conditions

$$f(x) \neq \text{const} \cdot g(x), \quad [g(x) + f(x)]^2 \neq 0.$$ 

Herewith we consider a spinor

$$u = \begin{bmatrix} u_0 \\ u_1 \\ u_2 \\ u_3 \end{bmatrix}$$

such that $\forall i \quad u_i \in \mathbb{R}$ and $u^*u \neq 0$. From theorem 1 we have that such wave is not a ghost spinor.

Let us consider a new particle in state $\theta = u[g(x) - f(x)]$ which also is a solution of Dirac equation. From results of theorem 1 we notice that this spinor is not a ghost spinor. Let us assume that $\psi$ and $\theta$ such that in some point of spacetime these waves interact. Then after this interaction the resulting wave is defined by state $\psi + \theta = u(1 + i)g(x)$. Once again we use theorem 1 and receive that $\psi + \theta$ is a ghost spinor.

In result we received that sometimes a shadow particle can interact with a real particle and after this a shadow wave is received. In general case we have that sometimes a real electron move over to a shadow state without collision.
with another real particle. But a shadow electron is an electron in a parallel universe. From these results we have that particles in our universe can ”spontaneously disappear” and ”spontaneously appear”. Herewith fluctuations of matter is not arise from interaction of particles in one universe, i.e. fluctuations of matter may be caused nameemly by interaction of different universes of a Multiverse which model was presented in [3, 4].

2.2 Interference between real spinors and ghost spinors

Let us assume that the solution of Dirac equation (1) is

\[ \psi = \begin{bmatrix} u_0 \\ u_1 \\ u_2 \\ u_3 \end{bmatrix}. \] (6)

Then insert (6) into (1) we get the next system of the linear differential equations of first order in partial derivatives:

\[
\begin{align*}
\dot{u}_{0,0} + u_{3,1} - iu_{3,2} + u_{2,3} &= -\frac{mc}{\hbar}u_0 , \\
\dot{u}_{1,0} + u_{2,1} + iu_{2,2} - u_{3,3} &= -i\frac{mc}{\hbar}u_1 , \\
-u_{2,0} - u_{1,1} + iu_{1,2} - u_{0,3} &= -i\frac{mc}{\hbar}u_2 , \\
-u_{3,0} - u_{0,1} - iu_{0,2} + u_{1,3} &= -\frac{mc}{\hbar}u_3 .
\end{align*}
\]

Here \( u_{i,k} \) is a differentiation from k-coordinate. Let our solution satisfy to \( u_0 = u_1 = -u_2 = u_3 = u \). More over we assume that

\[ \frac{\partial u}{\partial x^2} = \frac{mc}{\hbar}u. \]

Then \( \psi \) is such that

\[ \frac{\partial u}{\partial x^0} = \frac{\partial u}{\partial x^3}, \quad \frac{\partial u}{\partial x^1} = 0. \]

From this we have that

\[
\psi = \begin{bmatrix} 1 \\ 1 \\ -1 \\ 1 \end{bmatrix} e^{\frac{mc}{\hbar}x^2 + f(x^0 + x^3) + ig(x^0 + x^3)} \] (7)
Figure 1: The intensity of the distribution of probability amplitude in point $8e^{2\frac{mc}{\hbar}x^2} = 1$, $x^0 = 0$.

is a solution of the Dirac equation without gravitational field. Here $g(x^0 + x^3)$ and $f(x^0 + x^3)$ are smooth real functions.

From theorem 1 we get that (7) is a ghost spinor iff $g(x^0 + x^3) = \text{const} \in \mathbb{R}$.

We take the solutions for real wave

$$\psi = \begin{bmatrix} 1 \\ 1 \\ -1 \\ 1 \end{bmatrix} e^{\frac{mc}{\hbar}x^2 + i(x^0 + x^3)}$$

and for ghost wave

$$\theta = \begin{bmatrix} 1 \\ 1 \\ -1 \\ 1 \end{bmatrix} e^{\frac{mc}{\hbar}x^2}.$$ (9)

As (8) as (9) have four-vector of the Dirac current

$$j^{(k)} = (4e^{\frac{mc}{\hbar}x^2}, 0, 0, -4e^{\frac{mc}{\hbar}x^2}).$$

As both solutions have alike current densities we can calculate the resulting wave after collision of these particles. We shall find the square of modulus of probability amplitude $\psi + \theta$. We have

$$|\psi + \theta|^2 = (\psi + \theta)^*(\psi + \theta) = 8e^{2\frac{mc}{\hbar}x^2}(1 + \cos(x^0 + x^3)).$$ (10)

If $x^0$ and $x^2$ are fixed we get interference picture (Fig.1). In result we have else one variant of the interaction between ghost and real spinors.

### 2.3 Two-slit experiment and ghost spinors

In result we have that interaction between ghost and real spinors may be differents. But we want to research namelly the participation of shadow particles in two-slit experiment (Fig.5).
Figure 2: Two-slit experiment.

Let the particle is in point \( s \), on the screen \( B \) in point \( x \) particle detector is fixed. It defines an appearance of the particle at the region of screen. On the screen \( A \) the symmetricals about axis \( S \) slits \( a_1 \) and \( a_2 \) are fixed. The wave spreads along axis \( S \). The distribution of the particles on the screen \( B \) is interested. Let electrons are emited on one. As known an interference pattern exist as in this case as the flow is emited.

Let \( \psi_1 \) is probability amplitude of electron which passed through slit \( a_1 \) and \( \psi_2 \) is probability amplitude of electron which passed through slit \( a_2 \). In this case a distribution of the resulting wave is defined by expression \( |\psi_1 + \psi_2|^2 \). Let interference exist, i.e. the distances between \( a_1 \) and \( a_2 \) and screens \( A \) and \( B \) so that we have interleaving of maximums and minimums on the screen \( B \).

Let now \( \theta_1 \) is a shadow electron which passed through slit \( a_1 \) and \( \theta_2 \) is a shadow electron which passed through slit \( a_2 \). Further we shall use the hypothesis that a shadow electron is a ghost electron [9, 10], i.e. a shadow electron is a solution of the Dirac equation.

Now we shall use the khown indications of the quantum mechanics. Let the state \( |y\rangle \) means that an electron in initial state in point \( y \), the state \( \langle y | \) means that an electron in final state in point \( y \). Herewith also let us assume that symbol \( \langle | \rangle \) means the resulting state of system while experiment and also \( \langle | \rangle_{\psi} \) and \( \langle | \rangle_{\theta} \) mean the states for real spinor field \( \psi \) and ghost spinor \( \theta \). In considering indications

\[
\psi_1 = \langle x|a_1\rangle_{\psi_1}\langle a_1|s\rangle_{\psi_1}, \tag{11}
\]
\[
\psi_2 = \langle x|a_2\rangle_{\psi_2}\langle a_2|s\rangle_{\psi_2}, \tag{12}
\]
\[
\theta_1 = \langle x|a_1\rangle_{\theta_1}\langle a_1|s\rangle_{\theta_1}, \tag{13}
\]
\[ \theta_2 = \langle x | a_2 \rangle_{\theta_2} \langle a_2 | s \rangle_{\theta_2}. \]  

Let us define the probability distribution that a real particle gets to point \( x \) or through slit \( a_1 \) or through slit \( a_2 \) from starting point \( s \). This probability distribution is defined by the state

\[ \langle x | s \rangle_1 = \langle x | a_1 \rangle_{\psi_1} \langle a_1 | s \rangle_{\psi_1} + \langle x | a_2 \rangle_{\psi_2} \langle a_2 | s \rangle_{\psi_2}. \]  

Herewith we can not know which slit was passed by particle. We also not take into account the interaction between a real electron and ghost electrons. The state \( \langle x | s \rangle_2 \) defines an intensity that a real electron gets on the screen \( B \) from point \( s \). Herewith interactions between real and shadow particles are taken into consideration and we can not know which slit was passed by a real electron. Now we shall calculate this state. There are four variant in experiment. A real electron and a shadow electron can pass through one slit or different slits. The states \( \langle a_1 | s \rangle_{\theta_2}, \langle a_2 | s \rangle_{\theta_1}, \langle a_1 | s \rangle_{\psi_2} \) and \( \langle a_2 | s \rangle_{\psi_1} \) are not possible. It follow from definition of wave functions \( \psi_i \) and \( \theta_i \). Now we get

\[ \langle x | s \rangle_2 = \langle x | a_1 \rangle_{\psi_1} \langle a_1 | s \rangle_{\psi_1} \langle x | a_1 \rangle_{\theta_1} \langle a_1 | s \rangle_{\theta_1} + \langle x | a_2 \rangle_{\psi_2} \langle a_2 | s \rangle_{\psi_2} \langle x | a_2 \rangle_{\theta_2} \langle a_2 | s \rangle_{\theta_2} + \]

\[ + \langle x | a_1 \rangle_{\psi_1} \langle a_1 | s \rangle_{\psi_1} \langle x | a_2 \rangle_{\theta_2} \langle a_2 | s \rangle_{\theta_2} + \langle x | a_2 \rangle_{\psi_2} \langle a_2 | s \rangle_{\psi_2} \langle x | a_1 \rangle_{\theta_1} \langle a_1 | s \rangle_{\theta_1}. \]  

In result we use (11) - (14) and find

\[ |\langle x | s \rangle_2|^2 = |\psi_1 \theta_1 + \psi_1 \theta_2 + \psi_2 \theta_1 + \psi_2 \theta_2|^2 = |\psi_1 + \psi_2|^2 \cdot |\theta_1 + \theta_2|^2. \]  

Let us notice that we take into account the influence of shadow electrons to the interference. If in this case we can not observe an interference pattern then this influence is absent. From this we conclude that we must show the existence of interleaving of maximums and minimums at the function (17) as a function which depend on point \( x \) of the screen \( B \).

As known the function \( |\psi_1 + \psi_2|^2 \) is the square of modulus of expression (15) and it defines the intensity of appearance of an electron to the screen \( B \). The interference pattern and interleaving of maximums and minimums at this function are simultaneously observed. For example the respective graph has the resemblance in kind with graph on (Fig.3). As known in an one-slit experiment the probability of appearance of an electron to the screen \( B \) is defined by Gauss distribution. So the wave functions \( \psi_1 \) and \( \psi_2 \) must be as

\[ \psi_1 = u \cdot e^{-A(x+d)^2+i\alpha(x)}, \quad \psi_2 = u \cdot e^{-A(x-d)^2+i\beta(x)}. \]  

\(^3\)In this case \( i = 1, 2. \)

\(^4\)In spite of the fact that we consider a case with (17), we must assume the existence of the interleaving of maximums and minimums and for function \( |\psi_1 + \psi_2|^2 \). This function
Herewith $u^*u \neq 0$ and $u$ is bispinor with complex numbers in components, $A \neq 0$ is not depended by $x$, and $\alpha(x), \beta(x)$ such that the square of modulus of sum of the functions (18) is corresponded to observation of a light-shadow pattern. Moreover $d$ is a half-distance between slits.

Let us also notice as shadow particles are particles in parallel universes, much the same to our universe, then the wave $\theta_1$ must have distribution such as distribution for $\psi_1$ and wave $\theta_2$ must have distribution such as distribution for $\psi_2$. Then from results of theorem 1 we conclude that

$$\theta_1 = u \cdot e^{-A(x+d)^2+i\cdot c_1}, \quad \theta_2 = u \cdot e^{-A(x-d)^2+i\cdot c_2}, \quad c_i \in \mathbb{R}. \quad (19)$$

It means that for sufficiently small $d$ the probability distribution $|\theta_1 + \theta_2|^2$ is corresponded to absence of interference pattern. This distribution is a Gauss distribution.

So we have the interliving of maximums and minimums for graph of the function (17). Moreover this function and function $|\psi_1 + \psi_2|^2$ have minimums in the same points, but they have different maximum meanings. It is right as function $|\theta_1 + \theta_2|^2$ is not equal to zero, as (19) is right. In result we have that interference pattern exists if we take into account shadow electrons [2] and if we take that a shadow electron same a ghost electron [9, 10].

corresponds to variant (15) which not take into account the shadow particles. Since if the hypothesis of the Deutsch shadow particles is right then, in approximation, i.e. without shadow particles, the earlier existing explanation of the quantum particle interference is must executed. And this means that expression $|\psi_1 + \psi_2|^2$ has the above-mentione type. So in case of shadow particles existence the definition (18) of the amplitudes $\psi_1$ and $\psi_2$ is corrected.
3 Possibility of experimental test

We considered a two-slit experiment (Fig. 2), the existence of the Deutsch particles was taken into account. But in corresponding experiment (Fig. 2) we assume that only one shadow electron gets after screen $A$. Many shadow electrons can get after screen $A$. What is an interference pattern in this case? Let us notice that we can not define the number of shadow particles which get after the screen $A$. Because we can not fixed shadow particles.

Let real electrons which passed through slits $a_1$ or $a_2$ are defined, as earlier, by wave functions $\psi_1$ or $\psi_2$. The number of shadow electrons which passed through slits $a_1$ or $a_2$ is equal to $n$. These shadow electrons are defined by wave functions $\{\theta_1^{(m)}\}$ or $\{\theta_2^{(m)}\}$, accordingly. Here $m = 1, n$. The wave functions have the type (18), $\{\theta_1^{(m)}\}$ and $\{\theta_2^{(m)}\}$ are defined by (19), where $\forall m = 1, n \quad c_i = c_i^m$. Then, as for formula (19), we have the next expression for square of modulus of probability amplitude

$$\langle x|s \rangle_2 = (\psi_1 \theta_1^{(1)} \cdots \theta_1^{(n)} + \psi_1 \theta_1^{(1)} \cdots \theta_1^{(n-1)} \theta_2^{(n)} + \psi_1 \theta_1^{(1)} \cdots \theta_1^{(n-2)} \theta_2^{(n-1)} \theta_1^{(n)} + \cdots) \theta_1^{(n)}$$

Now we convert (20) and get

$$\langle x|s \rangle_2 = (\psi_1 \theta_1^{(1)} \cdots \theta_1^{(n-1)} + \psi_1 \theta_1^{(1)} \cdots \theta_2^{(n-1)} + \cdots + \psi_2 \theta_1^{(1)} \cdots \theta_1^{(n-1)} + \cdots + \psi_2 \theta_1^{(1)} \cdots \theta_1^{(n-1)} + \cdots) \theta_1^{(n)}.$$

From this we have

$$\langle x|s \rangle_2 = (\psi_1 \theta_1^{(1)} \cdots \theta_1^{(n-1)} + \psi_1 \theta_1^{(1)} \cdots \theta_2^{(n-1)} + \cdots + \psi_2 \theta_1^{(1)} \cdots \theta_1^{(n-1)} + \cdots + \psi_2 \theta_1^{(1)} \cdots \theta_2^{(n-1)} \left(\theta_1^{(n)} + \theta_2^{(n)}\right).$$

(21)

If we shall consecutively run this procedure for expression (21) we get

$$|\langle x|s \rangle_2|^2 = |\psi_1 + \psi_2|^2 \cdot \prod_{i=1}^{n} \left|\theta_1^{(i)} + \theta_2^{(i)}\right|^2,$$

(22)

here $n$ is the number of shadow particles which passed through slits after screen $A$. The intensity of appearance of electrons on the screen $B$ is defined by expression (22).
We shall take into account the types of the functions $\theta_1^{(i)}$ and $\theta_2^{(i)}$. For every number $i$ functions $|\theta_1^{(i)} + \theta_2^{(i)}|$ are defined by Gauss distribution if a distance between slits is sufficiently small. As earlier we conclude that expression (22) defines some interference pattern. Also as earlier we notice that the minimums of corresponding functions are in same points too.

Let us see to the getting results with standpoint of the experimental data existence. In all experiments of quantum particles interference we have that the getting with experiment intensity of an electrons distribution corresponds to the function $|\psi_1 + \psi_2|^2$ which is multiplied on the scale factor. It is right as $|\psi_1 + \psi_2|^2$ must be a function of distribution.

So A.K. Guts suggest to involve the multiplying on the product

$$\prod_{i=1}^{n} |\theta_1^{(i)} + \theta_2^{(i)}|^2$$

(23)

with multiplying on a scale factor. Every new electron will adds a new positive factor. If in (23) the coinverses factors meet then their influence is canceled. So if we consider infinite number of shadow particles, i.e. we let $n = \infty$, the multiplier (23) will be equal to number one. We have that intensity of particles distribution with consideration shadow particles is equal to intensity of distribution of particles without one.

As known slits have a finite size and electrons have a finite size too. So on the experiment result only finite number of ghost particles are acted, i.e. $n \neq \infty$. It is we observe in experiment: scale factors in different cases are differed.

Can we test the existence of shadow particles from received data? This probability exists. For this the checking of shadow electrons which influence on experiment is sufficient condition. The problem is that we can not fixed the Deutsch particles with some particle detector. But may be a solution of this problem in next.

Actually the knowlege about number of shadow particles which passed through slits $a_1$ and $a_2$ is not necessities condition. Let us remember to one of the which way experiment (Fig.4a). For this between screens $A$ and $B$, as closer to screen $A$ as possible, the flow of photons is emited. As known the information about system is conteined in this measurement and in this case we have a disappearance of interference picture. It is the measurement act on the result of experiment. Let us see on this case with view of existence of Deutsch particles. When this measurement is conducted the interaction between system and environment is conducted too. But interaction between system and environment is interaction between Deutsch particles and measurement which
we take. It is explained by further. If the flow of photons is not emitted the interference picture exist as shadow and real particles are fased [4]. But if we have a which way experiment, i.e. the flow of photons is measurement which act on observed result, the shadow electron is repulsed by some shadow photon and the conflict between these particles can not proceed. This discourse is correct as the formal model of Multiverse exist and shadow photons was found [3, 4] (these problems was not solved in [2, 9, 10]). Moreover we assume that may be than closer flow of photons to screen \( A \) that less of shadow electrons interact with real electron and, as result, less multipliers in factor (23). From this imaginary experiment we conclude that may be we can control, with some way, a number of shadow particles which act to interference pattern.

Let now before screen \( A \) the flow of photons is emited (Fig.4b). We assume that the number of shadow electrons which act on the result of experiment is reduced by some movement of flow of photons to the right along axis \( S \) and it is enlarged by some movement of flow of photons to the left along one. Let we fixed some point of intersection of flow of photons with axis \( S \) and conducted the experiment. In result we have some interference picture. Then we little move the source of this photons flow along axis \( S \) to the right, for example, and take some interference pattern too. Then the differention between values of two nearby maximums in second case must be less then differention between values of two nearby maximums on first interference pattern. It is follow from our results and assumption that flow of photons control the number of Deutsch particles which act on interference, in above described meaning. If in offered experiment this result will fixed we can speak about existence of shadow particles and about existence of Guts-Deutsch Multiverse. We notice when flow of photons will be sufficiently near to screen \( A \) for that the information about

\[\text{Figure 4: Here a) classical experiment, b) proposed experiment.}\]
way of particle will be received the influence of shadow particles is greatly reduced and interference pattern will be disappeared. Herewith as we shall receive the information about way of particle the probability amplitude will be satisfy no expression (22) but next expression:

\[ |\langle x|s\rangle_2|^2 = \left( |\psi_1|^2 + |\psi_2|^2 \right) \cdot \prod_{i=1}^{n} |\theta_1^{(i)} + \theta_2^{(i)}|^2. \]  

(24)

So this sequence of experiments is that when source of flow of photons move along axis S (Fig 4b) the interference pattern is probed.

Except experiment (Fig 4b) we can see else one experiment which was suggested by M.S. Shapovalova. In this case the number of shadow particles which act on an interference pattern is changed by sizes of slits: than smaller the slits than smaller the number of these particles. But in this case the function \( |\psi_1 + \psi_2|^2 \) also will be changed. But we think that we can receive some results about interaction shadow and real particles and in this case.

Conclusion

In this paper the some questions of development of Theory of Multiverse are considered. We assumed that our reality is the Guts-Deutsch Multiverse \[3, 4\]. In this aspect the interference between quantum particles is described. As know in this time the problem of quantum measurements is researched. The Deutsch shadow particles contribute some essential explanations to this problem. In first, the some aspects of quantum particles interference are explained by Deutsch \[2\]. In this article we got that shadow electrons can really act to the interference and this may be tested by some experiment, i.e. we considered the experiment which may to solve the problem which theory is more exact: Theory of Universe or Theory of Multiverse. One is contained in Theory of Multiverse. But can we describe our world by this theory? Only the experiment will defines this.

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