Proper present interpretation of Quantum Mechanics. This article has been registered and is copyrighted

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Abstract

The empirical violation of Bell's inequality shows that the relativistic speed limit is incompatible with the quantum entanglement. 'Proper Present Interpretation' shows a local relativistic theory without using hidden variables that is consistent with quantum entanglement. The method used is a change of present. For every observer, his present in each moment is the universe he observes. It involves a change of coordinates. It is explained quantum problems related to quantum entanglement such as Einstein–Podolsky–Rosen paradox, 'Schrödinger's cat' and the Young's double-slit experiment. Are obtained simpler equations for the relativistic transformations of physical magnitudes by using the same transformation in all cases. With this new concept, quantum and relativistic mathematics keep being both valid and stop being mutually exclusive in relation to the concept of locality. The results suggest a relational space-time reality.

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I. INTRODUCTION

Nowadays there are two theories that describe the nature, The Relativity and The Quantum Mechanics. Both theories describe a different parcel of that nature. But there is a known problem, both theories are contradictory in relation to the locality of space-time. Relativity tells us that nature is local, that is, the speed of light can not be overcome. Contrary Quantum Mechanics tells us that nature is non-local. Alain Aspect empirically demonstrated this non-locality through quantum entanglement phenomena predicted by quantum theory (Aspect *et al.*, 1982). Thereby this demonstration brings the conclusion that the space-time is non local (so Relativity is wrong) or, it is necessary to change the concept of space-time somehow.

The 'Proper Present Interpretation of Quantum Mechanics' describes a local relativistic nature according to quantum results. Our local theory explains the effects of quantum entanglement and it changes the concept of reality. All we do is to change the idea of 'present' for each observer, concept that we reflect in the single postulate of this theory. With this postulate, the theory shows the cause of Einstein–Podolsky–Rosen paradox (Einstein *et al.*, 1935). It also simplifies and uncouples the relativistic equations for photon kinematics, for the transformation of the electromagnetic field and for the relativistic transformation of the mass, momentum and energy. Always applying the same transformation to those physical magnitudes. Our theory explains many quantum results related to quantum entanglement, such as the problem of Young's double-slit experiment (Young, 1804) and the Schrödinger's cat paradox (Schrödinger, 1935).

II. DEFINITIONS.

A. Proper Present

The definition of 'proper present' is our postulate. 'For each observer, his present is the universe which he observes in that proper moment'.

The postulate does not change the value of the speed of light, in the sense of covered space in an elapsed time, but it changes the idea of 'present' for each observer, in the sense that in every proper time the observer notices what is happening at this moment in any place of the universe because the fact he is observing it.

B. Observation

We understand here that an observer observes an event if it changes the observer in a different way from if it does not happen. That is, when he receives direct or indirect information that the event has happened. It is different that the observer can see or understand that information or he is aware of it. From now on we shall talk in this context about observer and observation.

C. Locality

The concept of locality has a crucial importance in physics and in our theory, because of that we remember here this concept.

Locality means that nothing, not even information, can travel quicker than the speed of light, where the speed is the space covered in an elapsed time. Later we shall prove that this postulate entails a local theory in the sense described here, because its application does not violate the maximum speed limit.

D. Reality

Another way to think about our change of present is the following: ‘For each observer an event has not happened until he receives the information about it has happened’.

This reasoning alters the concept of reality that Einstein proposed. His concept of reality could either be read as: the aspects of nature have their values clearly defined even before being measured; or as: an event is happening now even if we do not receive that information. Einstein used to sum up this concept as ‘The Moon is out there even though we do not observe it’ (this is contrary to the quantum entanglement phenomenon). Taking into account our new theory, this concept will be changed for the following concept of reality. ‘If we do not see an event (we do not receive the information) it has not happened for us yet’ because it is below our ‘proper present’ (see next section).

E. The present and particles that transmit information.

For an observer receives information that an event has occurred, such information must be transmitted from the event to the observer. This transmission is usually performed by electromagnetic waves (photons), but also by any other type of slower particles. Given this, and watching our postulate, the new ‘present lines’ would be the path of the photons. Any other particle would transmit the information in a more slowly way, this information will refer to an event that has already past, because the same information has been provided by photons before.

So the idea of ‘proper present’ means that, for each observer in a particular proper time, the new present will be all the events contained in his, until this moment, known as ‘past light cone’ of Minkowsky space-time (Minkowski, 1908/9). As a result, any second observer will see the first one, in that instant, in a particular ‘proper present’. That event is contained in one of his ‘past light cones’ and, at the same time, in a ‘future light cone’ for the first observer. Then we see that the events below the ‘proper present’ plane, will be past for the corresponding observer and those events that are above will be future for him, even the contents in the ‘horizontal’ present plane (we label the concept of time and present, used before this theory, as ‘horizontal’ in order to avoid confusions).

We have only changed the concept of present. What is happening ‘now’ in this star we are looking at? So far the answer was that we had to wait many light years to know it. However, with the change of concept, we shall say: what is happening now in the star we are looking at is, precisely, what we are seeing.

Every observer will observe only one present at each proper time; we shall call it ‘proper’ because this present will differ from the ‘observed proper present’ of any other observer.

F. Received time t^+ and emitted time t^-.

From a graphic point of view, the postulate considers our presents are not the current horizontal hyper planes in the Cartesian frame of reference (ct, x, y, z) any more, but they are the hyper cones that form 45 grades with those horizontal hyper planes.

Therefore we have two time hyper planes (‘proper presents’) for each observer in each proper time (measured by his own watch). These time hyper planes are the following:

- The ‘Observed proper present’. It is the ‘proper present’ for each observer. (We label it as ‘observed’ to avoid confusions respect the concept explained in the next paragraph). It is the universe seen by the observer which coincides graphically, as we mentioned before, with the past light cone. We shall call it ‘observed time cone’.

- The ‘Emitted proper present’ is the hyper cone formed when that observer is observed in that proper time by the rest observers of the universe. It will coincide with the future light cone. We shall call it ‘emitted time cone’. Really it is not another type of present, it is simply the intersection of all the observed proper present of those other observers that observe the first one.

We can consider these cones of time as all the straight lines that make them up (see Fig. 1).

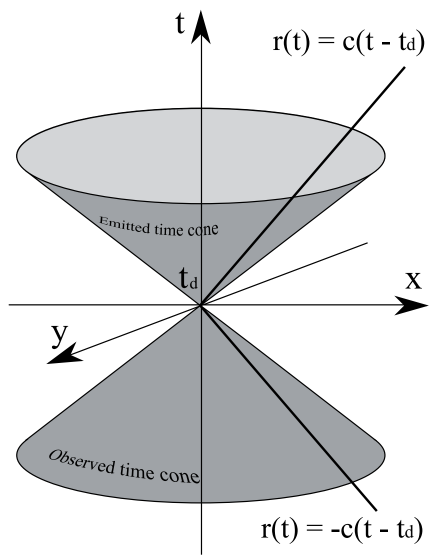

FIG. 1 New present hyper planes at t_d . We have removed a spatial dimension for graphically represent the concept.

Those straight lines will be placed for each cone in different values of spherical angles φ, θ. We shall call them ‘received lines’ and ‘emitted lines’ respectively. Obviously the equations for these lines at any time t_d and in a system centered on the observer are

$$\left.\begin{array}{r}\text{Emitted line: } r(t) = c(t - t_d) \\ \text{Received line: } r(t) = -c(t - t_d)\end{array}\right\} . \tag{1}$$

Where, for every cone, all its straight lines will have the same values for r and t and different values for φ and θ. Those lines coincide with the old trajectories of emitted and received photons. Since each line is part of the observer proper present in that proper time, it will be assigned the value of that proper time to each line. It means the events happened for an observer in an 'observed proper present' will be in a particular received line for him that corresponds to a particular proper time; we shall call received time (t^+). But this event is also in an 'emitted line' with its corresponding proper time, that we shall call emitted time (t^-).

We are faced with the next change of coordinates:

$$\left.\begin{array}{c} t^+ = t + \frac{r}{c} \\ t^- = t - \frac{r}{c} \\ \varphi = \varphi \\ \theta = \theta \end{array}\right\}, \tag{2}$$

and the inverse

$$\left.\begin{array}{c} r = \frac{c(t^+ - t^-)}{2} \\ t = \frac{t^+ + t^-}{2} \\ \varphi = \varphi \\ \theta = \theta \end{array}\right\}. \tag{3}$$

We have changed from spherical coordinates (t, r, φ, θ) to the new ones (t^-, t^+, φ, θ). So if an event happens in a star, in that proper moment of that star, this star will see our watch, and that time it sees in our own watch will be our proper time t^-. On the other hand we shall see that same event happened in that star in our proper time t^+. The emitted line corresponding to t^- coincides with the trajectory of a photon we emitted and arrives to the star in the moment of that event. And at that moment the star can emit another photon to us forming the trajectory of t^+ for us (see Fig. 2).

This simple coordinate transformation is the mathematical translation of our postulate (proper present concept), and it will cause that all the equations of Special Relativity are simplified and uncoupled, as we shall see later.

We emphasize that 'horizontal' time axes t and the new times t^+ and t^- will coincide for the frames of reference focused on each observer. And the old present will only coincide, for each observer, with the new notion of proper presents in the observer himself. So the 'horizontal' time t, the time t^- and the time t^+ will have the same value for the observer at the same observer. That is, the proper time that the observer measures is the same for

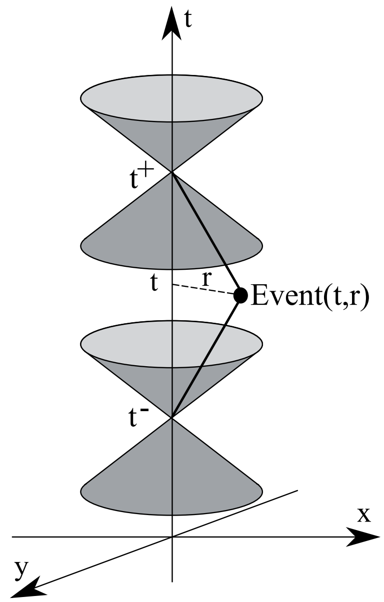

FIG. 2 New t^-, t^+ coordinates.

'horizontal' t, t^- and t^+ .What is different is the assignment of those values to the rest events in the universe. We can demonstrate it if we put in Eq. (2) the position of the observer himself ($r = 0$), so $t = t^- = t^+$.

Note that the line t^- of an emitter is the same line $t^{+\prime}$ for the corresponding receptor. No matter the value of t^- and $t^{+\prime}$, the physical line that connects these events (emission and reception) is the same for both systems of reference. So we shall note that line as $[t^-,\, t^{+\prime}]$ too.

It is also interesting to consider the change of coordinates related to the Cartesian coordinates. That is, we move from (t, x, y, z) to $(t^\alpha, t^\beta, y, z)$. This change is

$$\left.\begin{aligned} t^\alpha &= t + \tfrac{x}{c} \\ t^\beta &= t - \tfrac{x}{c} \\ y &= y \\ z &= z \end{aligned}\right\} \tag{4}$$

and the inverse

$$\left.\begin{array}{r} x = \frac{c(t^\alpha - t^\beta)}{2} \\ t = \frac{t^\alpha + t^\beta}{2} \\ y = y \\ z = z \end{array}\right\}. \tag{5}$$

We shall work on photon exchange processes between an emitter and a receptor (observer), so that we can always choose the coordinate axes such that $y = 0$ and $z = 0$ for the entire process. In this case the relation between spherical and Cartesian coordinates is

$$\left.\begin{array}{rl} x = r & x > 0 \\ x = -r & x < 0 \end{array}\right\}. \tag{6}$$

So, for these cases, the relationship between our new spherical and Cartesian coordinates is

$$\left.\begin{array}{ll} t^+ = t^\alpha & \text{(received line)} \\ t^- = t^\beta & \text{(emitted line)} \\ \varphi = 0 & \end{array}\right\} \text{when} \qquad x > 0 \tag{7}$$

and

$$\left.\begin{array}{ll} t^+ = t^\beta & \text{(received line)} \\ t^- = t^\alpha & \text{(emitted line)} \\ \varphi = \pi & \end{array}\right\} \text{when} \qquad x < 0. \tag{8}$$

Since, as we have said, we shall work with an emitter and an observer, we can choose the systems of reference so that x and x' are always positive. In this way we simplify the equations, leaving us with the first identity Eq. (7) for most cases we study from now on:

$$\left.\begin{array}{r} t^+ = t + \frac{x}{c} \\ t^- = t - \frac{x}{c} \\ y = y \\ z = z \end{array}\right\} \tag{9}$$

One can easily prove that we reached the same conclusions expressed herein for any other values of x and x'.

G. Proper instantaneity and simultaneity

We see that the photon interaction between an emitter k and a receptor k' is totally instantaneous for the receptor (observer), since the emission and its reception are produced in the same line of proper time $t^{+\prime}$ (i.e. $[t^-,\, t^{+\prime}]$) for the receptor and in the same t^- (i.e. $[t^-,\, t^{+\prime}]$) for the emitter. It means, if the emitter generates a photon, its coordinates will be 'horizontal' t_1 and $r_1 = 0$ because it is in the origin itself. And if it consecutively arrives to a receptor in a subsequent 'horizontal' time t_2 situated in a distance d, we have that, the emission event coordinates and the reception event coordinates for the emitter k and the receptor k' will be

For the reference system located in the emitter:

$$\begin{array}{ll} \textit{Emission} & \textit{Reception} \\ (t_1, 0, \varphi, \theta) & (t_2 = t_1 + \frac{d}{c}, d, \varphi, \theta). \end{array} \tag{10}$$

For the reference system located in the receptor:

$$\begin{array}{ll} \textit{Emission} & \textit{Reception} \\ (t_1', -d', \varphi', \theta') & (t_2' = t_1' + \frac{d'}{c}, 0, \varphi', \theta'). \end{array} \tag{11}$$

Replacing these values in Eq. (2):

For the reference system located in the emitter:

$$\begin{array}{ll} \textit{Emission} & \textit{Reception} \\ t_1^- = t_1 & t_2^- = t_1 \\ t_1^+ = t_1 & t_2^+ = t_1 + 2\frac{d}{c} \\ \varphi & \varphi \\ \theta & \theta \end{array} \tag{12}$$

For the reference system located in the receptor:

$$\begin{array}{ll} \textit{Emission} & \textit{Reception} \\ t_1^{-\prime} = t_1' - \frac{d'}{c} & t_2^{-\prime} = t_1' + \frac{d'}{c} \\ t_1^{+\prime} = t_1' + \frac{d'}{c} & t_2^{+\prime} = t_1' + \frac{d'}{c} \\ \varphi' & \varphi' \\ \theta' & \theta' \end{array} \tag{13}$$

So $t_1^{+\prime} = t_2^{+\prime}$ and since the values of φ' and θ' do not change, both events, emission and reception, are in the same line of present for the receptor, therefore that process will be 'proper instantaneous' for that receptor. We have $t_1^- = t_2^-$ for the emitter, but we can not say that both events are instantaneous to the emitter because emission cone is not really a present of the emitter as explained in II.F.

It is important to understand that, because it is proper instantaneous for receptor, all the line $[t^-, t^{+\prime}]$ will actually be a point for this receptor, where the emitter and the receptor are joined for the receptor during that interaction.

It is also important to observe that this photon interaction will not be instantaneous for an observer situated out of this line $[t^-, t^{+\prime}]$, because the emission will be in a different line $t_1^{+\prime\prime}$ from the line $t_2^{+\prime\prime}$ where this another observer will see the reception by the receptor.

From now on, when we say that a photon interaction is 'proper instantaneous', it will be meant that it is 'proper instantaneous' for the receptor of that interaction.

It could be remembered that this instantaneity is concerned for the photon in the relativistic equation of lengths contraction when we say that the relative speed v is the speed of light c, where L_0 is any length measured by a frame of reference at rest with respect to this length and L_1 is that same length measured by the mobile (a photon). Let us see it:

$$L_1 = L_0\sqrt{1 - \left(\frac{v}{c}\right)^2}, \qquad \text{if } v = c \qquad L_1 = 0.$$

It means, the distance between the emission and the receptor is zero for the photon.

III. KINEMATICAL PART.

A. Sinusoidal travel of the photon

We have realized that with this concept it makes no sense, for the receptor (observer), to think that photons travel through the space. But if the travel of a photon is 'proper instantaneous' for the receptor like we saw in II.G, should not vary nothing in the photon, even the electromagnetic field. So, what is the electromagnetic field oscillation during the 'apparent' journey of the photon?. What does its sinusoidal travel through the space mean for our theory? We shall demonstrate that, for the receptor, 'that sinusoidal variation is produced in the focus' and that variation will take a value for each line t^- in each proper instant. It means that if an exchange of that photon with a destination in a proper moment t^- happened; in that moment it would be a particular value of that sinusoidal function in the focus itself. This value will be the one which will see the destination. We shall show that, indeed, there is no variation in the presumed path of the photon.

Photon is considered as an electromagnetic wave that travels through the space. As we know the general solution of the electromagnetic wave equation is a linear superposition of waves:

$$\left.\begin{array}{c} \vec{E} = g(\vec{k}\cdot\vec{r} - wt) \\ \vec{B} = g(\vec{k}\cdot\vec{r} - wt) \end{array}\right\}. \tag{14}$$

If we take up the case for the photons in which ($\vec{k}\cdot\vec{r} = kx$). And since $k = \frac{w}{c}$:

$$\left.\begin{array}{c} E = g(\frac{w}{c}x - wt) = g(-wt^-) \\ B = g(-wt^-) \end{array}\right\}. \tag{15}$$

Then we see the field applies to this scenario in a proper instantaneous way. As well as the sinusoidal variation takes place in the focus itself for the receiver.

Let us see graphically:

If we represent Eq. (14) when ($\vec{k}\cdot\vec{r} = kx$) and t = 0, we obtain the known wave function (see Fig. 3).

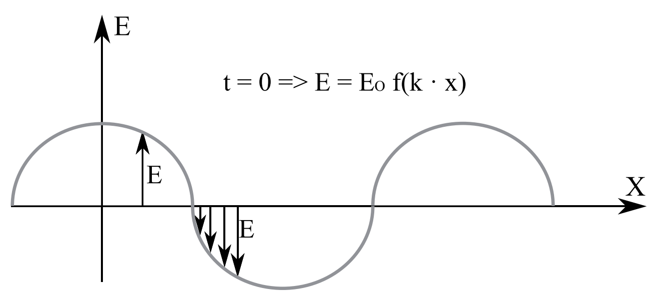

FIG. 3 Wave function (t=constant, x).

But if we represent the same function depending on time and space, by drawing the same function for times (separated by the constant λ) $t_0, t_1, ..., t_n$ such that $c = \frac{x}{t}$ (see Fig. 4),

we can see that for the photon path we have that

For the point (x_0, t_0), we have

$$E_0 = g(w(\frac{x_0}{c} - t_0)).$$

For the point $(x_1, t_1) = (x_0 + c\lambda, t_0 + \lambda)$, we have

$$E_1 = g(w(\frac{x_0}{c} + \lambda - t_0 - \lambda)) = g(w(\frac{x_0}{c} - t_0) = E_0.$$

$$\vdots$$

For the point $(x_n, t_n) = (x_0 + nc\lambda, t_0 + n\lambda)$, we have

$$E_n = g(w(\frac{x_0}{c} + n\lambda - t_0 - n\lambda)) = g(w(\frac{x_0}{c} - t_0)) = E_0.$$

We realize that for all the points in the trajectory of the photon, the value E is constant. We can make the same argument with B.

So far we have seen that for the photon path (line $[t^-, t^{+\prime}]$), no sinusoidal variation occurs. The photon does not travel sinusoidally, not even it travels, we have seen before that it is an instantaneous process.

B. Space-time role in our theory

If we emit a photon in a proper 'horizontal' time t_a from A to a star situated in B and it will be received in its proper 'horizontal' time t_b, it makes no sense to think that for the star the photon travels through space because we have said it is a 'proper instantaneous' process for the receptor. And if that star in B emits it again to us in a 'horizontal' time t'_b, in its next proper time (we receive it in our proper 'horizontal' time t_a), that exchange will be proper instantaneous for us too, according to the concept of 'proper presents'. But this new concept does not require that the lapse of proper 'horizontal' time $t'_b - t_b$, that takes

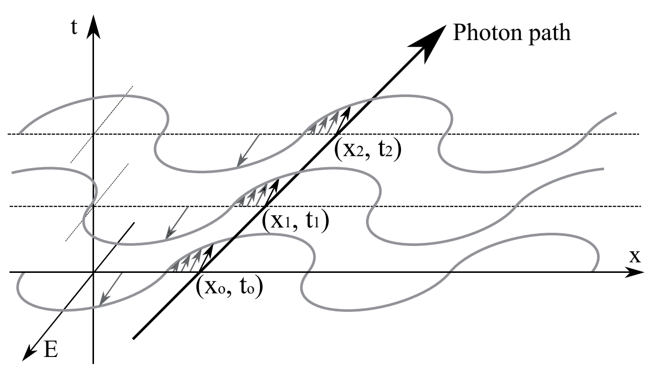

FIG. 4 No wave on photon path.

the star to emit it again, is equal to the lapse of proper 'horizontal' time $t'_a - t_a$ that takes since we emit the photon until we receive it again. That difference $((t'_a - t_a) - (t'_b - t_b))$ 'makes the space' (as we deduce from Eq. (3)). As consequence the space concept has no sense when we consider only the exchange of an only photon. This fact turns the theory into a relational theory of space-time.

C. The mass-energy conservation law and the speed of light

Under this new interpretation, the law of mass-energy conservation implies the upper speed limit (the speed of light). Let us prove this assertion by showing that the violation of this law carries a higher speed than the speed of light. Suppose a particle (o) traveling with constant velocity v from the negative side of the x axis toward the positive one (of the observer's reference system k). If we take into account two points of its path $P_1(x_1, t_1)$ (at the negative side) and $P_2(x_2, t_2)$ (at the positive side), the equation of the line that the particle describes is

$$(t_1 - t_2) = \frac{c}{v}(\frac{x_1}{c} - \frac{x_2}{c}). \tag{16}$$

This observer k can see the particle (o) at the point P_1 and at the point P_2. If we apply our change of coordinates for these points we have

$$t_1^+ - t_1 = -\frac{x_1}{c} \tag{17}$$

and

$$t_2^+ - t_2 = \frac{x_2}{c}. \tag{18}$$

That, as stated above, these equations are the trajectories of the photons that connect these points P_1 and P_2 with the observer k at time and place of the observation ($t = t_1^+$, $x = 0$) for P_1 and ($t = t_2^+$, $x = 0$) for P_2.

Substituting Eq. (17) and Eq. (18) in Eq. (16) we obtain

$$t_1^+ - t_2^+ = -\frac{x_1 + x_2}{c} + \frac{c}{v}(\frac{x_1}{c} - \frac{x_2}{c}). \tag{19}$$

Suppose now that the observer k sees the point P_1 and the point P_2 at the same instant, ie $t_1^+ = t_2^+$. Given this fact and our postulate we obviously see that it violates the law of mass-energy conservation. That is, for the observer k there will **be** two objects (o) at time $t_1^+ = t_2^+$ located at two different points in space (P_1 and P_2).

We have P_1 in the negative side of the x axis, and P_2 in the positive, thus $x_1 = -|x_1|$ and $x_2 = |x_2|$ so, clearing v from Eq. (19) and considering $t_1^+ = t_2^+$ we have

$$v = c\frac{|x_1| + |x_2|}{|x_1| - |x_2|}. \tag{20}$$

It is clear that, for any value of x_1 and x_2, $v < -c$ or $v > c$ which means a higher speed than the speed of light. On the other hand, it also means that a lower speed than the speed of light will not void the second member of Eq. (19).

We have shown that for every moving object, the existence of a higher speed than the speed of light is a violation of the law of mass-energy conservation and vice versa. We can generalize our statement because we can always put a reference system between two points of a path.

It is easy to understand it from a visual point of view (see Fig. 5).

D. Velocities

If we are observing an object (o) moving with a constant velocity v, approaching or moving away from us along our x axis, we can locate that object with the values of the new coordinates t^+ and t^- for this object in each our proper moment (we can choose φ and θ in such a way that it equals zero as the object moves along the x axis). By taking t^- as parameter, we define a new speed ϑ as the change tax of received time t^+ with respect to that parameter t^-. The new speed will be

$$\vartheta = \frac{dt^+(o)}{dt^-}.$$

Note: Do not confuse ϑ with the usual speed v (space/time).

Let's consider the relationship between our new velocity ϑ and the velocity v (space / time)

$$v(o) = \frac{dx(t)}{dt},$$

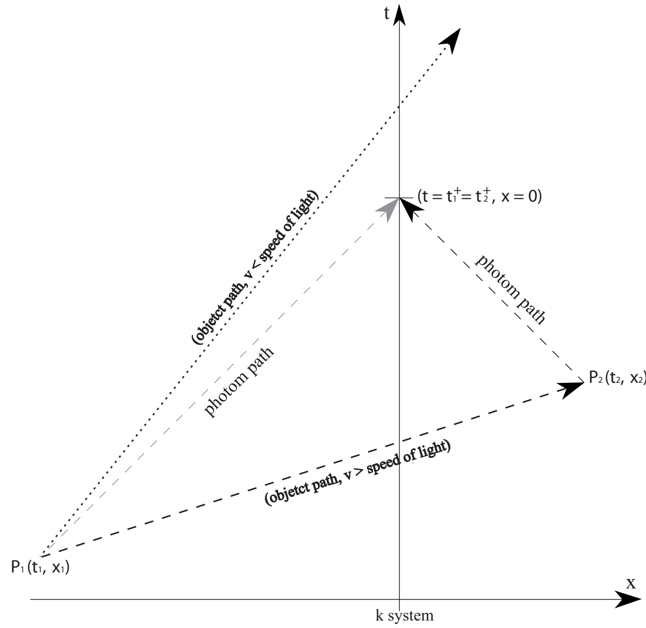

FIG. 5 A velocity faster than the speed of light leads to the mobile to be seen by the observer, at one same instant, at two different points. This assertion violates the law of mass-energy conservation. By contrast, a slower speed than the speed of light leads the mobile to be seen by the observer at a single point at each instant and there will be no violation of the law.

taking our change of coordinates

$$v(o) = \frac{d}{dt^-}\left(c\frac{t^+(t^-) - t^-}{2}\right)\frac{dt^-}{dt},$$

we easily obtain that

$$\vartheta = \frac{c+v}{c-v} \tag{21}$$

and the inverse

$$v = c \cdot \frac{\vartheta - 1}{\vartheta + 1}. \tag{22}$$

If that object stops moving ($v = 0$) we come to the conclusion that

$$\vartheta = 1, \qquad \text{that is} \qquad \frac{dt^+(o)}{dt^-} = 1.$$

If that object moves at speeds near the speed of light ($v \to c$), then ϑ will tend to infinite, that is, $\frac{dt^+(o)}{dt^-}$ will tend to infinite. So there is not an upper speed limit for our new speed ϑ.

If that object moves at speed of light ($v = c$) with respect a reference system k, we shall obtain that, according to Eq. (21), ϑ is undetermined since this object would move along a line $[t^-,\ t^{+\prime}]$ which means $v = c$, therefore, for k', that object will have always the same value for the coordinate $t^{+\prime}$, but it will have infinite values for $t^{-\prime}$. It means that every travel at speed of light is, in our theory, an instantaneous process for the arrival point but not for all other points of space-time, which is the concept of proper instantaneity defined before.

We shall prove that we are faced with a local theory. It means, we shall demonstrate that the speed of light, as covered space in an elapsed time v, continues having the superior limit c. That is, if we observe the equation described before Eq. (22), whatever value of ϑ, the relation $\frac{\vartheta-1}{\vartheta+1}$ will be always lower than the unit, and therefore v will be always lower than c. It means that this value keeps being the superior threshold of speeds.

As review, we can identify our new speed ϑ with the concept of rapidity ϕ provided by Whittaker (1910) as

$$e^{\phi} = \sqrt{\vartheta}.$$

E. Coordinates transformation of two reference systems in relative movement

Let us consider the events in which $y = 0$ and $z = 0$. It means, those events situated in the plane containing two systems (k and k') that are in relative movement v. This case is important because the lines of the proper presents for those events (old trajectories of photons emitted by these events) are shared by both observers.

If we put into practice our change of coordinates Eq. (9), we have for each reference system:

$$\left.\begin{array}{ll} t^+ = t + \frac{x}{c} & t^{+\prime} = t' + \frac{x'}{c} \\ t^- = t - \frac{x}{c} & t^{-\prime} = t' - \frac{x'}{c} \\ y = y = 0 & y' = y' = 0 \\ z = z = 0 & z' = z' = 0 \end{array}\right\}. \tag{23}$$

The Lorentz transformation was

$$\left.\begin{aligned} x &= \gamma(x' - vt') \\ t &= \gamma\left(t' - \tfrac{vx'}{c^2}\right) \\ y &= y' = 0 \\ z &= z' = 0 \end{aligned}\right\}, \tag{24}$$

where

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}.$$

Note: we shall obviate the transformation of coordinates y and z because they are always void.

Replacing Lorentz equations in the first relation of Eq. (23):

$$\begin{aligned} t^+ &= \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\left[t' - \frac{vx'}{c^2} + \frac{(x'-vt')}{c}\right] \\ &= \frac{c}{\sqrt{c^2 - v^2}}\left[t'\left(1 - \frac{v}{c}\right) + \frac{x'}{c}\left(1 - \frac{v}{c}\right)\right] \\ &= \frac{(c-v)}{\sqrt{c^2-v^2}}(t' + \frac{x'}{c}) = \sqrt{\frac{c-v}{c+v}} \cdot (t' + \frac{x'}{c}) = \frac{1}{\sqrt{\vartheta}} t^{+\prime}. \end{aligned}$$

It can also be demonstrated that

$$t^- = \sqrt{\vartheta} \cdot t^{-\prime}.$$

Therefore the equivalents of Lorentz equations in our theory for this case are

$$t^- = \sqrt{\vartheta} \cdot t^{-\prime}, \qquad t^+ = \frac{1}{\sqrt{\vartheta}} t^{+\prime}. \tag{25}$$

We observe that equations are uncoupled and simplified.

In order to see the inverse transform we clear up $t^{-\prime}$ and $t^{+\prime}$ in function of t^- and t^+ respectively. We must consider the frame of reference k' will not see v but $-v$ and if we observe the transformation of velocities Eq. (21) we shall see that if we swap v for $-v$ then ϑ will turn into $\frac{1}{\vartheta}$. Therefore that inverse transformation will be

$$t^{-\prime} = \sqrt{\vartheta} \cdot t^-, \qquad t^{+\prime} = \frac{1}{\sqrt{\vartheta}} t^+.$$

That is exactly the same transformation that we had seen for the system k. This transformation will obviously work with all the magnitudes we shall see next, which use the same transformation.

F. The Composition of Velocities

If a frame of reference k sees an object moving along the x axis at a velocity w, then another frame of reference k' at relative velocity v with respect to k along the x axis direction, will see the object moving at velocity w'. Where, according to the Special Relativity Theory (Einstein, 1905), that composition is given by

$$w = \frac{w' + v}{1 + \frac{w'v}{c^2}}. \tag{26}$$

If we use the transformation of velocities previously deducted, we see:

$$v = c \cdot \frac{\vartheta - 1}{\vartheta + 1}, \qquad w = c \cdot \frac{\varphi - 1}{\varphi + 1}, \qquad w' = c \cdot \frac{\varphi' - 1}{\varphi' + 1}.$$

Where $\vartheta, \varphi, \varphi'$ are the corresponding velocities in the new coordinates for both systems. If we replace those velocities in the relativistic equation of composition of velocities Eq. (26) we shall obtain the equation of composition of velocities for our theory:

$$\varphi = \frac{\varphi'}{\vartheta}. \tag{27}$$

That it is simplified again.

Special Relativity incorporates the principle that the speed of light is the same for all inertial observers. We can see that if the object is moving at the speed of light ($w = c$) with respect to the observer k, then if we use our transformation of velocities Eq. (21), the corresponding velocity in our theory will be $\varphi = \infty$. If we replace this value $\varphi = \infty$ in the above equation Eq. (27), then we can see that the speed φ' with which the other observer k' sees the object is also infinite. We see that it still meets the relativistic principle that ensures that the speed of light is the same for all inertial frames.

IV. DYNAMICAL PART

A. Energy and momentum transformation

Let us consider a frame of reference k that sees an object with mass m moving along the x axis at a velocity v_x. Let us also consider another frame of reference k' at relative velocity v with respect to k along the x axis direction. That second frame of reference k'

will measured that object with a velocity v'_x. The Special Relativity Theory (Einstein, 1905) says that the momentum and energy transformation of the object that is measured at each reference system is given by

$$\left.\begin{aligned} E &= \gamma(E' - vP'_x) \\ P_x &= \gamma(P'_x - \tfrac{v}{c^2}E') \\ P_y &= P'_y = 0 \\ P_z &= P'_z = 0 \end{aligned}\right\}, \tag{28}$$

$$\text{where } \gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}.$$

If we include in Eq. (28) our speeds transformation Eq. (22) we get easily

$$\left.\begin{aligned} E &= \tfrac{1}{\sqrt{\vartheta}}\tfrac{(E'+cP'_x)}{2} + \sqrt{\vartheta}\tfrac{(E'-cP'_x)}{2} \\ cP_x &= \tfrac{1}{\sqrt{\vartheta}}\tfrac{(E'+cP'_x)}{2} - \sqrt{\vartheta}\tfrac{(E'-cP'_x)}{2} \end{aligned}\right\}. \tag{29}$$

Note: We have removed the equations for the components y and z of momentum because they are always void.

In Eq. (29) we can identify a pattern very similar to that developed in the coordinate transformation Eq. (2). This fact leads us to make the following transformation of momentum and energy to their corresponding quantities for our theory:

$$\left.\begin{aligned} E^+ &= E + cP_x \\ E^- &= E - cP_x \end{aligned}\right\}, \tag{30}$$

where E^+ and E^- are the resulting from the x momentum and the energy component (time momentum).

Their inverses are

$$\left.\begin{aligned} E &= \tfrac{E^+ + E^-}{2} \\ cP_x &= \tfrac{E^+ - E^-}{2} \end{aligned}\right\}. \tag{31}$$

Substituting Eq. (30) in Eq. (29) and adding and subtracting the resulting equations we get

$$\left.\begin{aligned} E^+ &= \tfrac{1}{\sqrt{\vartheta}}E^{+\prime} \\ E^- &= \sqrt{\vartheta}E^{-\prime} \end{aligned}\right\}. \tag{32}$$

So we have new physics magnitudes E^+ and E^- instead Energy E and Lineal momentum P.

In the particular case in which the frame of reference k' is at rest with respect the object ($P'_x = 0$), we obtain

$$E^{+\prime} = E^{-\prime} = E$$

and also

$$\left.\begin{array}{r} E^+ = \frac{1}{\sqrt{\vartheta}} E' \\ E^- = \sqrt{\vartheta} E' \end{array}\right\}. \tag{33}$$

If we further assume that the reference systems now have a relative speed c ($\vartheta = \infty$), we have that

$$\left.\begin{array}{r} E^+ = 0 \\ E^- = \infty \end{array}\right\}. \tag{34}$$

B. De Broglie hypothesis and the energy and momentum transformation

Considering the conditions of movement between the reference systems k, k' and object (o) described in point IV.A. De Broglie showed in his thesis (Broglie, 1924) that every object (o) of mass m has a wavelike nature, obtaining the following relationship between energy, momentum and frequency for each reference system k and k':

$$\left.\begin{array}{r} E = h\nu \\ P = \frac{h}{\lambda} = hf = \frac{h\nu}{v_x} \end{array}\right\} \text{for the reference system } k, \tag{35}$$

$$\left.\begin{array}{r} E' = h\nu' \\ P' = \frac{h}{\lambda'} = hf' = \frac{h\nu\prime}{v'_x} \end{array}\right\} \text{for the reference system } k', \tag{36}$$

where ν and ν' are the temporal frequencies in hertz and f and f' are the spatial frequencies in cycles per meter.

Substituting Eqs. (35) and (36) in Eq. (28), and adding and subtracting we can easily obtain

$$\left.\begin{array}{l}\nu^{+} = \frac{1}{\sqrt{\vartheta}}\nu^{+\prime} \\ \nu^{-} = \sqrt{\vartheta}\nu^{-\prime}\end{array}\right\},\tag{37}$$

where

$$\left.\begin{array}{l}\nu^{+} = \nu + cf = \nu(1 + \frac{c}{v_x}) \\ \nu^{-} = \nu - cf = \nu(1 - \frac{c}{v_x})\end{array}\right\} \text{for } k\tag{38}$$

and

$$\left.\begin{array}{l}\nu^{+\prime} = \nu' + cf' = \nu'(1 + \frac{c}{v'_x}) \\ \nu^{-\prime} = \nu' - cf' = \nu'(1 - \frac{c}{v'_x})\end{array}\right\} \text{for } k',\tag{39}$$

where its inverse are

$$\left.\begin{array}{l}\nu = \frac{\nu^{+}+\nu^{-}}{2} \\ cf = \frac{\nu^{+}-\nu^{-}}{2}\end{array}\right\} \text{for } k\tag{40}$$

and

$$\left.\begin{array}{l}\nu' = \frac{\nu^{+\prime}+\nu^{-\prime}}{2} \\ cf' = \frac{\nu^{+\prime}-\nu^{-\prime}}{2}\end{array}\right\} \text{for } k'.\tag{41}$$

Let's see what are the physical meanings of these new frequencies ν^{+} and ν^{-}.

We can define ν^{+} of an object that an observer (system k) measures as: The number of 'received lines', spaced by a time $\frac{1}{\nu}$ for the observer, cutted by this object while traveling c meters (see Fig. 6).

We can define ν^{-} of an object for a reference system k as: The number of 'received lines', spaced by a time $\frac{1}{\nu}$ for the system k, that the object sees that the system of reference cuts while the object travels c meters (see Fig. 7).

Note: For seeing this concept graphically we have chosen a simplified case in which we have considered the reference system k' comoving with the object ($v' = 0$) for both figures.

Note: The system of reference k will measure $\frac{1}{\nu}$, but the system of reference in the object will measure $\frac{1}{\nu'}$. Obviously both are related by Eq. (25).

C. Force transformation

Differentiating Eq. (28) we can obtain the known transformation of forces that exists over an object (o). This transformation relates the forces measured by an observer k at rest with

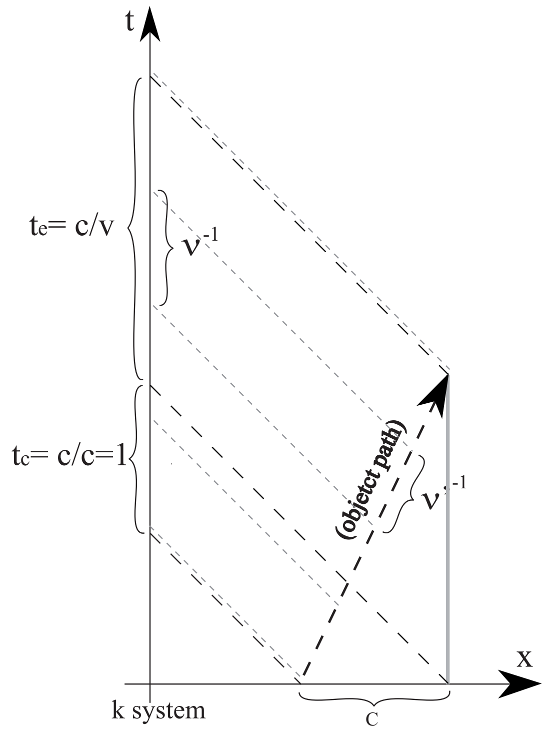

FIG. 6 Graphical explanation of Eq. (38) for ν^+.

that object (o), with the forces measured by another observer k' in relative motion, on a common axis x, with the previous reference frame. We can easily get that this transformation is

$$\left.\begin{array}{c} F_o = \gamma(F'_o - vF'_x) \\ F_x = \gamma(F'_x - \frac{v}{c^2}F'_o) \\ F_y = F'_y = 0 \\ F_z = F'_z = 0 \end{array}\right\}. \tag{42}$$

If we follow the same pattern we have taken so far in Eqs. (30), we can call

$$\left.\begin{array}{c} F^+ = F_o + cF_x \\ F^- = F_o - cF_x \end{array}\right\}. \tag{43}$$

Because $F_o = \frac{\partial E}{\partial t}$ and $F_x = \frac{\partial P_x}{\partial t}$ and using the relations we have seen above Eq. (35) and Eq. (36) we can deduce

$$\left.\begin{array}{c} F^+ = h\frac{\partial \nu^+}{\partial t} \\ F^- = h\frac{\partial \nu^-}{\partial t} \end{array}\right\}. \tag{44}$$

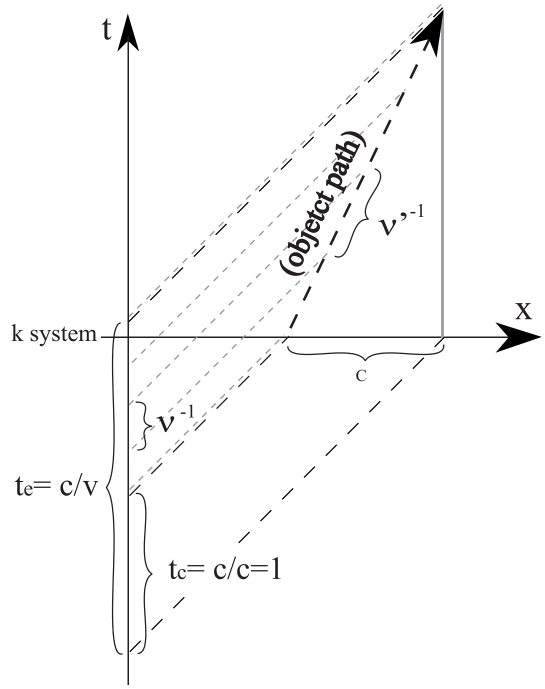

FIG. 7 Graphical explanation of Eq. (38) for ν^{-}.

These equations show a graphic evidence: 'The variation in the value of the number of cutted lines (ν^{+}, ν^{-}) indicates the presence of a force (modification of linear momentum) and vice versa'.

Substituting in Eqs. (43) the values of force transformation Eq. (42) and using our change of speed Eq. (21) we get our new force transformation

$$\left.\begin{array}{l} F^{+} = \frac{1}{\sqrt{\vartheta}} F^{+\prime} \\ F^{-} = \sqrt{\vartheta} F^{-\prime} \\ F_y = F'_y = 0 \\ F_z = F'_z = 0 \end{array}\right\} . \qquad (45)$$

V. ELECTRODYNAMICAL PART

A. Relativistic Doppler effect

Assume the observer k and a light source k' are moving away from each other with a relative velocity v. Let us consider the problem from the reference frame of the source.

Suppose one light wavefront arrives at an observer at rest relative to the source k'. The next wavefront is then at a distance $\lambda' = c/\nu'$ away from him (where λ' is the wavelength, ν' is the frequency of the wave the source emitted, and c is the speed of light). Since the light wavefront moves with velocity c and the observer moves with velocity v, the time observed between crests is

$$t' = \frac{\lambda'}{c - v} = \frac{1}{(1 - v/c)\nu'}.$$

However, due to the relativistic time dilation, the observer k will measure this time to be

$$t = \frac{t'}{\gamma} = \frac{1}{\gamma(1 - v/c)\nu'},$$

where

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

and taking the inverse

$$\nu = \frac{1}{t} = \gamma(1 - \frac{v}{c})\nu'.$$

If we make our change of velocities Eq. (22) we shall obtain

$$\nu = \frac{1}{\sqrt{\vartheta}}\nu'. \tag{46}$$

To keep the notation used in Eq. (25) we shall call $\nu^+ = \nu$ so

$$\nu^+ = \frac{1}{\sqrt{\vartheta}}\nu^{+\prime}, \tag{47}$$

where

$$\frac{1}{\sqrt{\vartheta}} \tag{48}$$

is the Doppler factor of the source relative to the observer in our theory.

If we draw the path of the light wavefront in Fig. 7 we can easily deduce that $\nu^- = \nu^{-\prime} = 0$. We can also reach this same conclusion considering that, for the observer, there is not variation in the photon during it's journey, as we saw in Section III.A. So, for a photon we have

$$\left.\begin{array}{l} \nu^+ = \frac{1}{\sqrt{\vartheta}}\nu^{+\prime} \\ \nu^- = \nu^{-\prime} = 0 \end{array}\right\}. \tag{49}$$

B. Photon energy

Since the energy of the photon in two reference systems k and k' with relative movement v are respectively

$$E = h\nu \qquad \text{and} \qquad E' = h\nu',$$

where h is Planck's constant.

Taking the Doppler Effect relation Eq. (46) and substituting in the equation of energy, we can obtain the photon energy relation for both systems:

$$E = \frac{1}{\sqrt{\vartheta}} h\nu'.$$

And comparing this equation with the concept of energy that we saw earlier in section IV.A Eq. (29). Or easier, by multiplying Eqs. (49) by the Planck's constant h, we deduce for the photon

$$E^{-} = E^{-\prime} = 0,$$
$$E^{+} = h\nu^{+} = \frac{1}{\sqrt{\vartheta}} h\nu^{+\prime} = \frac{1}{\sqrt{\vartheta}} E^{+\prime}.$$

C. About Wheeler-Feynman absorber theory and The Transactional Interpretation of Quantum Mechanics

Wheeler and Feynman (1945, 1949) showed there exist another solution of Maxwell's equations that is

$$\left.\begin{array}{c} \vec{E} = g(\vec{k}\cdot\vec{r} + wt) \\ \vec{B} = g(\vec{k}\cdot\vec{r} + wt) \end{array}\right\}. \tag{50}$$

Which is a wave traveling to the past. And if we proceed in the same way like in the previous point, we have

$$\left.\begin{array}{c} E = g(w\frac{x}{c} + wt) = g(wt^{+}) \\ B = g(wt^{+}) \end{array}\right\}. \tag{51}$$

The 'Transactional Interpretation of Quantum Mechanics' (TIQM) (Cramer, 1986) calls Eq. (14) as 'retarded wave' that is a wave that travels into the future, and the new one Eq.

(50) as ‘advanced wave’ that is a wave that travels to the past. TIQM describes quantum interactions like an agreement that occurs when the absorber accepts an interaction. The absorber communicates this acceptation to the emitter by an confirmation wave that is an ‘advanced wave’ from the absorber to the emitter. The interaction is offered by the emitter with an offered wave that is an ‘retarded wave’ from the emitter to the absorber.

These trips into the future and to the past can be eliminated by assuming our change of coordinates that return Eqs. (15) and (51). Thus far now the old retarder and advanced waves are in a proper line for the emitter and for the absorber. So there do not exist travels to the future or to the past because this process is ‘proper instantaneous’.

VI. QUANTUM MECHANICAL PART

In the following points we shall see that our theory explains, in a simple way and keeping what previously we have deducted, the quantum effects that come from the quantum entanglement phenomenon which seems to be against local theories.

A. Entanglement, Schrödinger’s cat and Einstein-Podolsky-Rosen paradox

The concept of entangled states is considered the hardest concept to understand of Quantum Mechanics. It says that if, for example, there is a bit of radioactive substance, so small that perhaps in half an hour, any electron of it decays, or, with equal probability, perhaps it does not, the only thing we can ensure is that it is in a ‘decayed - non decayed’ superposition until we observe its state.

Schrödinger made his famous thought experiment (Schrödinger, 1935) by joining the bit of radioactive substance with a trigger that killed a cat in case of decay. He placed everything into a closed box in such a way that, until the moment in which the observer looks into the box, the cat was in the superposed state ‘death cat - alive cat’.

The real problem is that if during a particular ‘horizontal’ time t there is a decay, the cat is considered under the mentioned combination of states till the moment in which the observer receives the information that this decay has occurred, (observation concept explained in the paragraph II.B). That is a time $t + r/c$, where r is the space that separates us from the decay. It is supposed that is our measurement that makes the state collapses in one of the two possible values. This effect is difficult to understand by using the quantum physics, but it has a very simple explanation taking into account the new concept of proper present, because the decay happens at the moment we observe it (observation, paragraph II.B). This moment is $t^+ = t + \frac{r}{c}$ (both events will be 'proper instantaneous') and there will never be linear combination of states, neither 'decayed - non decayed' combination, nor 'alive cat - dead cat' linear combination.

The quantum explanation for the following case of entanglement is also difficult. Let's suppose that two entangled photons are emitted in a 'horizontal' time t towards two points A and B separated between each other. According quantum physics, both photons travel through the space to their respective destinations with the properties of each photon entangled with the same property of the other photon, i.e. what affects one of them, also affects the other one. If we measure in A one of the photons, that measurement will have direct influence on the other photon no matter how far it is. Thus it would receive information immediately, that is, the information will go through a big amount of space instantly, what it contradicts Special Relativity Theory by violating the maximum speed limit (non - locality). This fact is the origin of the famous Einstein–Podolsky–Rosen paradox (Einstein *et al.*, 1935) and it is one of the main obstacles in physics nowadays. As in Schrödinger's cat experiment (Schrödinger, 1935), this effect can easily be explained by introducing the new concept of proper presents. We shall see how it works:

The emission, from the origin of the photon till its arriving to A (measuring), is made in a proper present line $[t^-, t^{+\prime}]$. Thus that process is instantaneous for the receptor A being a proper instantaneous exchange. That is, the A machines are directly measuring in the origin forcing the photon to collapse in either of the two states. Then that measurement will affect the other photon, that will be forced to take the other state, as is in the same point (origin) and, at the same proper time, this other photon is joined to B through another $[t^-, t^{+\prime}]$ line. The problem lies in thinking about photons travel through the space.

So we resolve Einstein–Podolsky–Rosen paradox (Einstein *et al.*, 1935), since, as we have seen, the exchanges of photons are proper instantaneous for receptors, but not for the rest of points out of that line $[t^-, t^{+\prime}]$.

Entanglement: We see now that before measuring, for the one who is measuring, the photon is not in an intermediate space between the emitter and the receptor, the photon has not being emitted yet. Therefore the entanglement represents the probability that each possible state has to be the one who will takes the photon when is emitted-measured. This is the correct entanglement effect observed by quantum. But, if we do not take the new concept of proper present, the entanglement seems to travel with each photon. Let's see graphically in Fig. 8.

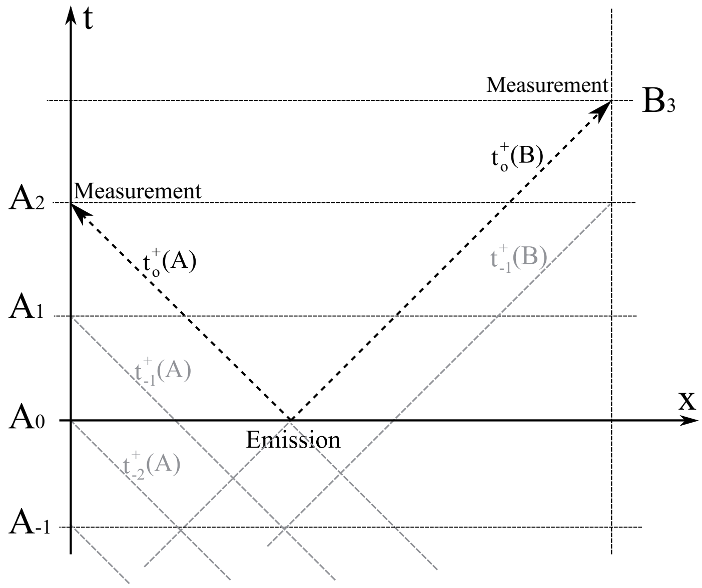

FIG. 8 A-B Experiment.

We can see that in the 'horizontal' scenario of presents the emission occurs in A_0. In this same scenario at A_1 the photons are traveling through the space at an intermediate point between the emission and the reception (with entangled properties), and is finally measured at A_2 were it collapses and the entanglement disappears. But if we consider the new scope of presents (inclined dotted lines), for the observer A at A_0 and at A_1 the emission has not happened yet. And at A_2 the emission and measurement occurs, at the same time, for this observer (because the emission and measurement are in the same line $t_0^+(A)$ for the observer A).

B. Double-slit experiment

Let us consider the famous Young's double-slit experiment (Young, 1804). We have two slits separated by a distance and a screen placed a distance from the slits. A light source generates photons that arrive to the screen through the slits.

The electric field in a point p of the screen is caused by the superposition of the photons wave functions owing to each slit and it is proportional to the real part of

$$\psi_{tot} = \psi_1 + \psi_2 = A\left[e^{i(kr_1 - wt)} + e^{i(kr_2 - wt)}\right],$$

where

$$\psi_1 = Ae^{kr_1 - wt} \qquad \text{and} \qquad \psi_2 = Ae^{kr_2 - wt}.$$

They are wave functions of photons due to each slit and A is the amplitude of both waves. Because $k = \frac{w}{c}$ and making our change of coordinates Eq. (2) we have

$$\psi_{tot} = \psi_1 + \psi_2 = A\left(e^{-iwt_1^-} + e^{-iwt_2^-}\right).$$

We see that there will be two different values of t^-, t_1^- and t_2^- in every instant for each point p on the screen, which define two emitted lines for the source.

The total electromagnetic energy that reaches the screen in the point p is proportional to the square of ψ_{tot}:

$$\begin{aligned} P(y) \alpha Re\left(\psi_{tot} \cdot \psi_{tot}^*\right) &= A^2 \cdot 2 \cdot Re\left[1 + e^{-iw(t_2^- - t_1^-)}\right] \\ &= A^2 \cdot 2 \cdot Re\left[1 + \cos(w\Delta t^-) + i\sin(w\Delta t^-)\right] \\ &= A^2 \cdot 2\left[1 + \cos(w\Delta t^-)\right] \\ &= A^2 \cdot 4\cos^2(c\pi\tilde{v}\Delta t^-), \end{aligned} \qquad (52)$$

where $w = 2c\pi\tilde{v}$ ($\tilde{v}$ is the wave number).

Then the maximums will appear when

$$\Delta t^- = \frac{n}{c\tilde{v}} \qquad (n = 0, 1, 2, \ldots)$$

and the minimums

$$\Delta t^- = \frac{n}{2c\tilde{v}} \qquad (n = 1, 3, 5, \ldots).$$

We see the famous Young's interference pattern (Young, 1804). Quantum mechanics explains that pattern will appear even though we emit an only photon. It means that photon will interfere with itself like if it passed trough both slits. This effect has to do with the quantum entanglement of states again, because the state of that photon, before arriving to the screen, is considered as the linear combination of the corresponding states to the photon going trough both slits. That interference pattern disappears if we block one of the slits. But how does the photon know that a slit has been blocked? Quantum has no answer for this question; however it can be answered in a simple way using the new theory. Photon knows which paths are available because the probability of reaching p, Eq. (52), depends only on its own wave number and the time lines t_1^- and t_2^-, being two instantaneous proper lines. That is, the photon is just, in the emission moment, in direct contact (proper instantaneity) with p through the available paths (either t_1^-, t_2^- or both)

VII. REGARDING BELL'S THEOREM

With the new change of concept we have a theory that, as we have proved, satisfies the local reality. It also agrees with the experimental evidence described by the quantum mechanics and that it is not contradictory to Bell's theorem (Bell, 1964) because hidden variables have not been used.

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