Discrete Movement of Micro-Object and the Physical Vacuum.

S. I. Plachinda*
Crimean Astrophysical Observatory, Ukraine

April 17, 2010

Abstract

The scenario of discrete movement of micro-object in the Physical Vacuum is presented. Initial assumptions (axioms) were introduced: physics hierarchy is an inherent property of the nature; the observed world, as a lower hierarchy, is the manifested properties of the Physical Vacuum. The process of movement of micro-object in space is characterized by alternate realization in the absolute frame of two different states - the proper object in the state of rest and the wave process. The time is the function of number of proper micro-object states. If the number of proper object states are constant, then lifetime of short-lived elementary particles depends on a total duration of the wave states. The speed of light is constant in absolute and moving frames because the signal is emitted and detected by an object only at the rest state and our world is the world of only one speed, the speed of light. The result of discrete movement is the wave-particle duality of micro-object and Lorentz equations. The Heisenberg inequality for micro-object with nonzero rest mass is a direct consequence of the alternate realization of the state of proper object and the wave state, and does not need in the probabilistic idea.

1 Introduction

Today, physics is replete with facts that their interpretation needs to include consideration of the properties of the Physical Vacuum (PV) as a matter of which properties manifestation is the observed world. Internally consistent and possessing the necessary and sufficient completeness of the property set of PV is hidden to us, because we are a subset to a set of PV (see Gödel's Incompleteness Theorem [1]). This is true in the case of physics hierarchy of nature and hierarchy, as a consequence, of axiomatic system of mathematics. Therefore, the properties of PV should be laid down in the relevant axiomatic basis. The following is a philosophical concept demonstrating one of the attempts to find some appropriate axioms.

*psi@crao.crimea.ua

The Dirac equation for an electron,

$$i\gamma^{\mu}\partial_{\mu}\Psi = m\Psi,$$

where γ^{μ} is Dirac matrices, Ψ is the wave function, and m is the rest mass of the particle, has two solutions for the velocity in space-time continuum: the magnitude of the projections of the velocity on spatial coordinates are equal to

$$V_x = V_y = V_z = C,$$

or

$$V_x = V_y = V_z = 0.$$

That is, the measured component of the velocity of the electron must be equal to the velocity of light or zero. But according to special relativity (Lorentz equations) the solution of $V_x = V_y = V_z = C$ is impossible for objects with nonzero rest mass because it leads to a solution, which provides the infinite energy of the electron. Moreover, in practice the whole range of measured velocities of such objects is strictly smaller than the speed of light.

These two factors forced the search for acceptable explanation of the obtained solutions. Ultimately, the representation about fluctuating electron the vector of the resultant velocity of which becomes equal to the recorded $\vec{V}$ was born. And to avoid the singular solutions the transition to the momentum space has been made, when integrated velocity recorded in the experiment are used.

The second surprise was the negative kinetic energy solutions (energy of motion) for the electron. This led to the conclusion that there is a new type of particles having a mass of the electron, but opposite in sign of the electric charge. Such particles are called positrons. The problem of the existence of negative kinetic energy had to be solved by introducing the idea that almost all states with negative energy are occupied by electrons distributed with infinite density.

Solutions of the Dirac equation coincide with the results of known experiments with remarkable accuracy. Thus, the initial idea about Physical Vacuum was founded.

We will use the term "Physical Vacuum" extremely enhancing its materialist understanding:

The observed world is the manifested properties of the Physical Vacuum.

By the foregoing, let us to assume that the Planck [2] quanta of the time, length and weight are a reflection of the physical properties of PV. In this case, we can try to get answers to questions: why the speed of light is constant?, why the speed of light is independent of the motion of the emitter and detector?, what is the time?, why the lifetime of particles depends on its velocity?, what matter properties predetermine the existence of Heisenberg uncertainty principle?, what is the nature of the wave-particle duality?, why four-dimensional space of events is preferably to use?, is the world deterministic or stochastic?, and so on.

Below is set out in an extremely schematic form the scenario of separation in time and space the wave and particle properties of micro-objects. Hereafter in the text we assume the existence of a "virtual" observer, which is related with "virtual" absolute reference frame (explanation of this see below), and for which, at least in the abstract, there is a space-time continuum and instantaneous knowledge of the full information on any events at any point in space.

2 Quantized motion

Anticipating the presentation, we need in the definition of what is called by micro-object:

Object, which has both wave and particle properties, is called micro-object.

Let the process of uniform motion of the micro-object is not perturbed in the three-dimensional Euclidean space, and this movement is characterized by alternate states of the implementation of the "*rest*" r-state and "*movement*" m-state. Let the state of *rest* and the state of *movement* are characterized by a finite number of elementary temporal durations - acts. Spatial characteristic of one act of *movement* is a quantum of length, L; a quantum of time, τ, is the duration of single act of *rest* state, τ_r, or the duration of one act of *movement* state, τ_m, such that:

$$\tau = \tau_r = \tau_m,$$

and

$$L/\tau = C, \tag{1}$$

where C - the speed of the fundamental interactions, the speed of light.

The time and space in any moving inertial reference frame (hereinafter - simply "reference frame") are scaled by τ and L, i.e. quanta of time and length are taken as units for time and length. In order to have velocity $0 < V < C$ moving micro-object in any absolute reference frame must be in a state of *rest* $r \geq 1$ individual acts of rest, i.e., $r \geq 1$ quanta of time, where $r = 1, 2, ..., R$ are counting numbers and micro-object must be in a state of movement $m \geq 1$ individual acts of movement, i.e. $m \geq 1$ quanta of time, where $m = 1, 2, ..., M$. By alternating the state of rest and movement, the object is moving with a resultant velocity V in space relative to the absolute frame of reference:

$$V = \sum L_m / (\sum \tau_r + \sum \tau_m) \tag{2}$$

The figure reflects the formal scheme of micro-object moving in space. The condition of the "proper" object (*rest*) has the characteristics m_0c^2 and $\sum \tau_r$. The condition of wave state (*movement*) corresponds to the characteristics $\hbar\upsilon$, $\sum L_m$ and $\sum \tau_m$. Short-lived elementary particle will have the greater life-time the higher its integral velocity. I.e., lifetime depends on a duration of a *movement* state while the number of *rest* states are constant.

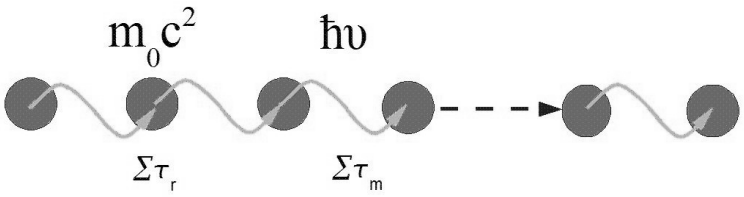

Figure 1: The schema of the separation in time and space the wave ($\hbar\upsilon$; $\sum \tau_m$; $\sum L_m$) and particle (m_0c^2; $\sum \tau_r$) properties of micro-objects.

Next, let in a homogeneous and isotropic three-dimensional Euclidean space there is a fixed reference frame K associated with an absolute observer, and reference frame K' associated with moving micro-object, which is moving relative to K with an integral speed V (2), and showing all the kinematic properties of this object (*rest* and *movement*). In the absolute frame for the absolute observer associated with this reference frame the time flows continuously and uniformly. In the space the process of movement of the frame K' is characterized by by-turn implementation of *rest* states and states of *movement* relatively to a frame of reference K. Signal in the system K' can be emitted by object only at the time of *rest* and detected also only at the time of *rest* state because it is the state of "proper" object. From this follows that the speed of light is constant and independent of the motion of the emitter and detector.

In view of the homogeneity and isotropy of space, as well as the fact that the absolute frame of reference K does not undergo displacement in space, it implies that any spatial location and any spatial orientation system K are full. Therefore, for convenience, we define the bijection of used frames K and K' as follows: 1. X-axis of the absolute reference frame K coincides with the axis X' of K' frame which is moving relative to K with the resultant velocity $V < C$, and Y and Z axes to be parallel Y' and Z'. 2. In the history of the event there is always a moment of time, when zero points of reference frames K and K' coincide.

According to formula (1), since the velocity L/τ is finite and unique, for the correct description of events we must introduce the fourth coordinate axis, which must be scaled in the same units as the other three, and should fix the only real speed of the fundamental interactions C.

In agreement with Poincare's the principle of relativity [3], this procedure of the introduction of the fourth coordinate axis allows to establish a bijective correspondence between the spatial and temporal characteristics of the events described in different frames of reference. This would not be necessary, if $C = \infty$. It is clear that this procedure of the introduction of the fourth coordinate axis is not mandatory, but it greatly simplifies the mathematical language for describe of events.

Thus, the fourth coordinate axis is Ct. In the case of moving observer the fourth axis will be Ct', where t' - time of the event in the frame K'. In the case

of the fourth coordinate axis quantum of length L is a single length scale that is identical with the other three coordinate axes. Since the considered space is three-dimensional then the axis of Ct (Ct') is imaginary. That is, the unit vector corresponding to the axis of Ct (Ct') should be imaginary unit vector.

Accordingly, when we define the space-time relation between the frames K and K' we must use the geometry of four-dimensional pseudo-Euclidean space. In this way we choose the language of description. It is obvious that the choice of language does not change the geometry of real space. Further, at the initial moment of the coincidence of frames K and K' from coordinate origin emitted signal propagates with the speed of light. For this phenomenon in the frame K there is a definite relationship: $X^2 + Y^2 + Z^2 = C^2t^2$. For an observer in the K the period of time between the moment of signal emission and the moment of his arrival at a point (X, Y, Z) can be represented as a sum of *rest* states of K', $\Delta t_r = \sum \tau_r$, and the sum of *movement* states of K', $\Delta t_m = \sum \tau_m$:

$$\Delta t = \Delta t_r + \Delta t_m.$$

Since the observer in K' registers the arrival of the signal only in a state of *object*, then in K'

$$\Delta t' = \Delta t_r \tag{3}$$

For an observer in K the distance which was traveled by the frame K'

$$V\Delta t = C\Delta t_m \tag{4}$$

For the event $V\Delta t = C\Delta t_m$ the square of the interval will be

$$S^2 = C^2\Delta t^2 - C^2\Delta t_m^2 \tag{5}$$

Interval for this event is the distance traveled by the signal during the time Δt_r and equal to $C\Delta t_r$. Hence, for S in (5):

$$C^2\Delta t_r^2 = C^2\Delta t^2 - C^2\Delta t_m^2 \tag{6}$$

Considering (3) and (4) the equation (6) can be rewritten as follows:

$$C^2\Delta t'^2 = C^2\Delta t^2 - V^2\Delta t^2.$$

Then

$$\Delta t' = \Delta t(1 - V^2/C^2)^{1/2}.$$

Because in our model the speed of light is a constant and the principle of relativity is not violated as a result we arrive at the Lorentz equations for space-time transformations. But in our case Lorentz equations describe the space-time relationships between reference frames according to the model of discrete motion of micro-object with nonzero rest mass.

3 Information. Determinism.

Micro-object manifests own properties as an object in a state of *rest*. Wave properties are manifested in a state of *movement*. It is a wave process:

$$\epsilon = \hbar\upsilon$$

The process of movement of a micro-object in space is characterized by alternate realization of two qualitatively different states - the real object (the state of *rest*) and the wave process (the state of *movement*). It is a reflection of wave-particle duality of micro-objects.

In this case, the wave function Ψ which describes the state of micro-object, in addition, should be reflect also the "instantaneous" process in the Physical Vacuum of reproduction of information about "where" "when" and "what" micro-object must be localized in the next state of the "proper" object.

In connection with the above, it is pertinent to recall the Einstein-Podolsky-Rosen paradox [4] and the positive results of the experiments, starting with the Aspect et all. [5], to verify the reality of this phenomenon.

In physics, there are constants that reflect the fundamental properties of Physical Vacuum: $\hbar$ - Planck's constant, C - the speed of the fundamental interactions, the speed of light, and γ - the gravitational constant. It is known that the combination of these constants gives us the units of length, time and mass:

$$L = (2\gamma\hbar/C^3)^{1/2} \approx 10^{-33} cm, \tag{7}$$

$$\tau = L/C \approx 10^{-43} sec,$$

$$m^* = (C\hbar/2\gamma)^{1/2} \approx 10^{-5} g. \tag{8}$$

If the interpretation of the quanta of length and time is obvious, the meaning of the quantum of mass should be established.

In frames of discrete model that we use the relativistic equation for energy

$$E^2 = P^2C^2 + m_0^2C^4 \tag{9}$$

contains the value $m_0^2C^4$, the square of the energy of a micro-object in a state of *rest*, and P^2C^2, the square of energy of a wave process, *movement* state, where P is a momentum.

Therefore, for the wave state $\hbar\upsilon = PC$. Then, for $L = \lambda = C/\upsilon$, where L is the quantum length of smallest possible λ, and use (7) and (8) we obtain

$$P = \hbar\upsilon/C = \hbar/L = \hbar/(2\gamma\hbar/C^3)^{1/2} = (C\hbar/2\gamma)^{1/2}C = m^*C$$

Thus, the quantum of mass characterizes the maximum possible energy of the wave state of a micro-object:

$$\epsilon_{max} = \hbar\upsilon_{max} = m^*C^2.$$

For a single act of the movement state of motion

$$\Delta E\Delta t = \hbar\upsilon(L/C) = \hbar(C/\lambda)(L/C) = \hbar(C/\lambda)(\lambda/C) = \hbar,$$

i.e., for a single act of the state of motion

$$\Delta E\Delta t = \hbar. \tag{10}$$

Thus, the strict equality (10) is present for the case of *movement* state. It is obvious fact because we use the discrete model of a motion, which parameters are determined by equations (1), (7), and (8). Finally, due to (9) and (10) we came to the Heisenberg inequality [6] for micro-objects with nonzero rest mass:

$$\Delta E\Delta t > \hbar.$$

One can see we do not need in the probabilistic idea for the derivation of the Heisenberg inequality since the initial scenario also does not contain them.

The Heisenberg uncertainty principle states that energy and time of micro-object cannot both be known to arbitrary precision due to separated in time and space the wave and particle nature of the object.

The Heisenberg uncertainty principle does not claim that the nature has statistical properties as inherent property.

Because the observed world is a manifestation of properties of Physical Vacuum, magnitude of the quantum of mass allows us to estimate the value of energy in a cubic centimeter of the Physical Vacuum. Since the value of $m^* = 10^{-5}g$ corresponds to the limit value of $L = 10^{-33}cm$, the energy capacity of one cubic centimeter of PV, expressed in units of mass will be $10^{95}g/cm^3$. This is a formal quantity, but it is clear that it is reflects potential capacity of the PV to build observed world. Power potential of a small volume of PV is more than enough to give birth to Gamow Big Bang and to give birth to about 10^{80} elementary particles that make up the substance of the direct observed world.

The speed of light was used to construct a discrete scenario of movement. One can see that under the proposed philosophical concept *our world is the world of only one speed, the speed of light.*

All other speeds are the result of averaging in time separated states of micro-object. For clear understanding, we can draw an analogy with the atom. The atom has ground energy state as well as strictly defined excited energy states. Similarly, the PV has a ground energy state (the absence of any perturbation), with which we associate so-called absolute reference frame, as well as excited energy states, one of which corresponds to the speed of fundamental interaction equal to the speed of light that is our world.

Are there other fundamental velocities in PV similar to the speed of light? That is, are there other worlds parallel to our, an essential feature of which is the presence of fundamental velocities other than the speed of light and from each other? The question is not absurd, since *if there are different selected velocities*

of the fundamental interactions of different worlds, such worlds do not interact with each other, except gravitationally.

Such worlds will not see directly each other. Something similar, only illustrative, we are seeing it at the intersection of two relatively weak beams of light (the space of PV is not perturbed), which do not interact. But these worlds must be seen through their gravitational manifestation. If not only our world was born it becomes clear the origin of the "dark matter".

An important feature of PV is the circuit of matter: $PV \rightarrow matter \rightarrow PV$. In the case of certain physical conditions of the phase transition, we obtain the effect when the matter can return to its original state of substance of the Physical Vacuum. Perhaps, one of the examples is "black holes". The characteristic lifetime of such object, which reached the Schwarzschild radius, is proportional to its size divided by the speed of light. To the outside observer such event would look like as explosion when outer layers of object will not return to its original state of PV. Presumably, astronomers observe similar phenomena in the form of supernova explosions.

The birth of matter is in our time or not? In other words, the birth of substance from Physical Vacuum takes place continuously or it was a one-time process at the time of the Big Bang? Or both events have a place to be? And that is most importantly, is it possible the implementation of the birth of matter in the laboratory with predetermined properties and is possible its transformation or its destruction or not?

4 Summary

We assume that the physics hierarchy is an inherent property of nature, and the observed world, as the lower hierarchy, is only the manifested properties of the Physical Vacuum, and the Planck quanta of the time, length and weight are a reflection of the physical properties of the Physical Vacuum.

The process of movement of a micro-object in space is characterized by alternate realization of two qualitatively different states in absolute frame - the real object (the state of *rest*) and the wave process (the state of *movement*). The result of discrete movement is wave-particle duality of micro-objects. The time is the number of "proper" micro-object states. The speed of light is constant in absolute and moving frames because our world is the world of only one speed, the speed of light, and a signal can be emitted and detected by object only at the time of *rest* when particle state is state of the "proper" object. Lifetime of short-lived micro-objects depends on a total duration of the *movement* state while the number of *rest* states are constant. The Heisenberg inequality for micro-objects with nonzero rest mass is result of the discrete motion, i.e. of the alternate realization of state of object and wave state and does not need in the probabilistic idea. The mathematical language of four-dimension space of events is preferable to use because our world is the world of only one speed, the speed of light. In addition, the discrete movement of the micro-object is accompanied by the "instantaneous" dissemination of the information in the Physical Vacuum

about "where" "when" and "what" micro-object must be localized in the next state of the proper object after wave state.

Comments: Unfortunately, this paper was rejected by arXiv:

– – – – – – – – – – – – – – – – Original Message – – – – – – – – – – – – – – – –
Subject: arXiv:submit/0024790 Removed
From: "Don Beyer [www-admin]" <www-admin@arxiv.org>
Date: Wed, April 21, 2010 4:50 pm
To: "Sergei Plachinda" <psi@crao.crimea.ua>
– –

Your submission has been removed upon a notice from our moderators, who determined it inappropriate for arXiv. Please send to a conventional journal instead for the requisite feedback.

If you disagree with this determination, please do not resubmit the submission to any archive until you first explain the reason to moderation@arxiv.org and receive a positive response.

Please direct all questions and concerns regarding moderation to the moderation@arxiv.org address. More information about our moderation policies can be found at:

http://arxiv.org/help/moderation

– –
arXiv admin

References

[1] Kurt Gödel: *Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme, I.*, Monatshefte für Mathematik und Physik **38**, (1931), 173-98.

[2] Max Plank: *Über irreversible Strahlungsvorgänge*, Sitzungsberichte der Königlich Preußischen Akademie der Wissenschaften zu Berlin, **5**, (1899), 440-480.

[3] Poincaré Henri *L'état actuel et l'avenir de la physique mathématique*, Bulletin des sciences mathématiques, **28**(2), (1904), 302-324.

[4] Einstein, A., Podolsky, B., and Rosen, N. *Can quantum-mechanical description of physical reality be considered complete?*, Phys. Rev. **47**, (1935), 777.

[5] Aspect, A. et al. *Experimental Realization of Einstein-Podolsky-Rosen-Bohm Gedankenexperiment: A New Violation of Bell's Inequalities*, Phys. Rev. Lett. **49**, (1982), 91.

[6] Heisenberg, W. *Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik.*, Zeitschrift für Physik. **43**, (1927), 172-198.