Quantum entanglement

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Abstract : The causes and consequences of the properties of a particle and a wave are presented, during the passage of a quantum of space-matter of an electron, a photon, through one and two slits. Causes and consequences of quantum tunneling through any potential barrier. And the properties of entangled particles are presented as quantum properties of space-matter.

Chapters

1. **Two-slit quantum passage.**
2. **Quantum entanglement.**

There are many interpretations of the passage of a photon and an electron, like quanta, through two slits. In one case, a diffraction pattern is observed on the screen. In another case, when fixing the passage of quanta through the slit, there are two spots on the screen opposite each slit. There are also facts about the birth of entangled particles with amazing properties, on the basis of which the most incredible properties and prospects are built. There are these facts, there is a mathematical description of them, but there are no answers to the questions: WHY is this so? We will present these experimental facts, with answers to the questions WHY, within the framework of the axioms of dynamic space-matter.

1. Double slit quantum passage

Let us consider the experiment of the passage of two slits by a quantumНОЛ$(Y\pm = e)$ electron, similar to НОЛ$(Y\pm = \gamma)$the photon quantum. Based on the properties of the dynamic space-matter quantum of the electron: $(Y\pm = \mathrm{e}^-) = (\boldsymbol{X}+= \nu_e^-)(Y-= \gamma^+)(\boldsymbol{X}+= \nu_e^-)$, we obtain a model of such a quantum, with a virtual photon $(\gamma)$and with certain parameters.

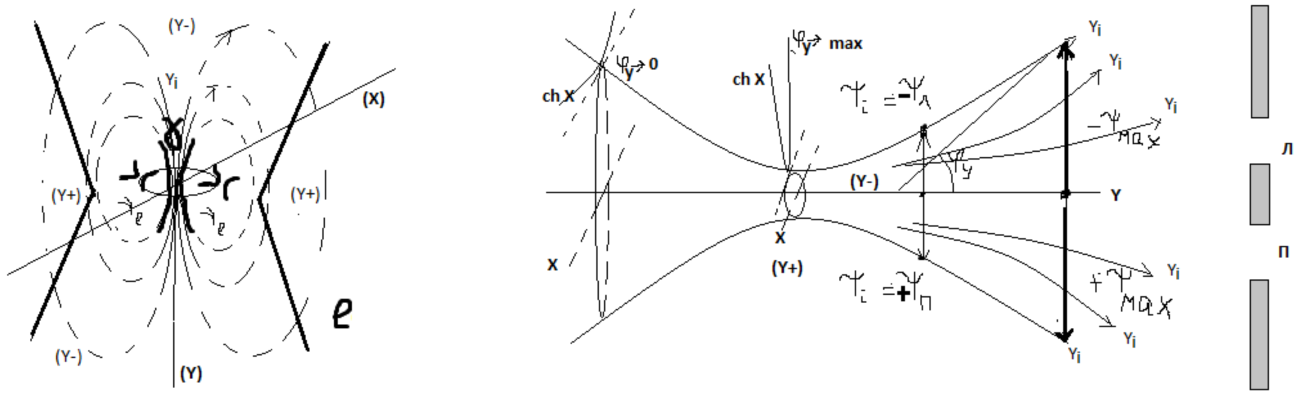


Fig.1. electron (photon) quantum model

Here: $(Y-)$the field is parallel, with a limiting $cos\ \varphi_{Y\ max} = \frac{\mathrm{w_e}}{\mathrm{c}} = \frac{1}{137.036} = \alpha$angle of parallelism, and in each fixed wave function , $(\psi_i)$the "left" or "right" wave function $(+\psi_{п})$is defined $(-\psi_{л})$, with respect to the movement to the left and right slots. When fixing $(-\psi_{л})$the "left" wave function, we talk about its collapse, and at the same time we know exactly the state of the $(+\psi_{п})$"right" wave function without fixing it. For the $(\pm\psi)$ wave ($\psi = YY_0$) function, $i\psi = \sqrt{(+\psi)(-\psi)}$we obtain $i\psi e^{ax} e^{i\omega t} = i\psi e^{ax+i\omega t}$, the function of the Dirac equation and its $\{e^{a(x)} \equiv \mathrm{ch}\left(\frac{\mathrm{X}}{\mathrm{Y_0}}\right)\}$, parameters with constant extremals $(a'(x) = 0)$of the dynamic function $(a(x) \neq const)$, without scalar bosons of gauge fields. The ratio of the cross-sectional $(Y -)$areas $(p = \frac{\pi\psi_i^2}{\pi\psi_{\max}^2})$ of the trajectory of an electron (or photon) is the probability of a quantum state at a fixed point, with the collapse $(\psi_i)$of the wave function. In fact, we are talking about the probability of finding the area of a circle: $(s = \pi\psi_i^2)$, with the limit angle of parallelism, $cos\ \varphi_{Y\ max} = \frac{1}{137.036} = \alpha$, in the allowable maximum section $(s = \pi\psi_{\max}^2)$of the trajectory $(Y -)$. In a dynamic section $(Y -)$of the trajectory, that is, in the plane of a circle of dynamic radius $(\psi_{max} \to \psi_0 \to \psi_{max}) = (\mathrm{K}_Y)$ in quantum relativistic dynamics dynamic $(\frac{\partial a(X)}{\partial x_\mu} \equiv f'(x) = 0)$ function $a(X) \neq const$, the wave function $i\psi e^{i\omega t} \equiv i(cos\ \omega t + i\ sin\ \omega t)$ also performs rotations. We are talking about spin in quantum relativistic dynamics. And with dynamics$(\psi_{max} \to \psi_0 \to \psi_{max})$ wave function, we are talking about the dynamics of the angle of parallelism $(cos\ \varphi_{Y\ max})$ on $(Y -)$ the quantum trajectory $(Y\pm = \mathrm{e}^-)$ electron or photon, as a cloud of probability at its wavelength. At near zero angles of parallelism $cos\ (\varphi_Y \to 0) \to 1$, in quantum relativistic dynamics, the electric field $(Y+ = e)$of an electron disappears on its mass $(Y- = e)$trajectory. At the same time, the quantum of space-matter $i\psi e^{ax} e^{i\omega t} = i\psi e^{ax+i\omega t}$, in the form: $e^{ax} \equiv ch\frac{X}{Y_0}$, and $e^{i\omega t} \equiv cos\ (\varphi_Y)$, Indivisible Area of Localization of the probability cloud, НОЛ $= \left(ch\frac{X}{Y_0\uparrow} \to 1\right)(cos\ (\varphi_Y \to 0) \to 1)$, remains unchanged in quantum relativistic dynamics. And in this, near zero $(Y+) \to 0$, charge state, an electron can pass through any potential barriers. In the Euclidean axiomatics, with a zero $(cos\ (\varphi_Y = 0) = 1)$angle of parallelism, $(Y +)$there is no dynamics of such charge fields and such a representation is impossible.

Now, in such Criteria for the Evolution of the $(Y\pm = e)$electron quantum, let us consider its properties when passing through one or two slits. Note that the wave function characterizes the dynamics of all parameters, including energy and momentum. And it gives the probability of manifestation of certain (with the principle of uncertainty) Evolution Criteria. So, the wave function of the electron, from the Dirac equation, goes first to one gap. It (ψ_i) collapses under any conditions and goes on like $i\psi = \sqrt{((-\psi_л)(+\psi_п)}$ particle-wave, in a "paired" state of "entangled" $(-\psi_л)(+\psi_п)$wave functions. Next quantum$(Y \pm)$ electron (photon) hits the screen along the slot projection axis, at the width of the maximum wave function, with probability $\left(p = \frac{\pi\psi_i^2}{\pi\psi_{max}^2} \neq 0\right)$. Now $(Y\pm = e)$ a quantum, for example, of an electron, approaches two slits with $(-\psi_л)$its "left" $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$and "right" parts$(+\psi_п)$, in any $(\psi_0 \rightarrow \psi_i \rightarrow \psi_{max})$ state, with probability $(p = \frac{\pi\psi_i^2}{\pi\psi_{max}^2} \neq 0)$. The question is, into which slot and how will the electron pass, on $(Y- = e)$ the trajectory. The very trajectory $(Y- = e)$of an electron (as well as a photon) has an uncertainty in space within the limits $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$of the wave function, which is in a superposition $(-\psi_л)(+\psi_п)$of the left and right parts in the direction of the quantum movement on the trajectory $(Y -)$in front of the left and right slits. At the same time, there is no straight Euclidean $(\varphi = 0)$line on $(Y -)$the trajectory and this is the decisive factor. There is any other (Y_l)line with a non-zero $(\varphi \neq 0)$angle of parallelism, within $(Y -)$the trajectory. Therefore, an electron (photon) will always pass either to the left or to the right slot, with the collapse $(\psi_i)$of the wave function. If there is a collapse of the "left" $(-\psi_л)$wave function, the quantum $(Y \pm)$of the electron (photon) goes to the left slot, and the electron goes to the right slot, with the collapse of the "right" $(+\psi_п)$wave function. There is no separation $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$ wave function, indivisible and stable electron (photon) quantum. In both left and right slit cases, it will be a (ψ_i)probability wave passage of the wave function, deflected by one or another $(\varphi \neq 0)$angle of parallelism, forming a dot on the screen. The set of dots on the screen give a plot of the probability density distribution. The angle of parallelism $(\varphi \neq 0)$corresponds to the probability $(\psi_i)$of the wave function. Different (φ_i)angles of parallelism, these are different probabilities $(\psi_i)$of the wave function. And in both cases, a wave with the effect of interference of mechanical waves will come out of each slot. And this is not a physical wave with field oscillations. This is the mathematical wave of wave function collapse. In fact, the interference effect here is due not to the addition of the extremals of the wave crest, as in the case on water, but to the angle of parallelism of the $(\varphi \neq 0)$quantum $(Y -)$trajectory, which in turn determines the probability of $(\psi_i)$the wave function. There are no superimpositions of highs or lows of the wave itself, like superpositions of wave crests on water. There are hits to the point of the screen of single quanta with one or another probability during the collapse $(\psi_i)$of the wave function. Many electrons (photons) pass through a gap with different (ψ_i)wave functions along the wavelength of the space-matter quantum. And on the screen, this is the interference of probability waves, like a collapse (fixation) $(\psi_i)$of the wave function. In this case, the probability of hitting the central axis of the screen from the left and right slits doubles, as it were, when the wave function passes through the left or right slit in an entangled state $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$. At the maximum probability $(\psi_{max})$of the wave function, if the left $(-\psi_л)$part leads $(Y -)$the trajectory of the indivisible energy, the momentum of the quantum to the left slot, then the right part $(+\psi_п)$of the same energy, momentum, appears on the central axis of the screen, and vice versa with the right part, in the right slot. Here we are not answering the question HOW, in mathematical models, but the question WHY, that is, what is the physical meaning, content, cause and effect. Therefore, the central axis is always brighter than the left or right side of the whole picture, with the effect of "probability wave" interference. Displacement $(Y -)$of trajectories to the left or right of the central axis on the screen, due to the angle of parallelism of $(\varphi \neq 0)$the quantum $(Y -)$trajectory, the collapse of only the "left" $(-\psi_л)$or only the "right" $(+\psi_п)$wave function, in the "entangled" $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$, (simultaneous) their state.

If we fix with a sensor the passage of a quantum of space-matter of $(Y\pm = e^-)$an electron or a real (not virtual) $(Y\pm = \gamma)$photon of a light beam, in the left or right slot, the collapse (fixation) of the indivisible energy, momentum, the entire $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$wave function occurs. That is, an electron (photon) is already defined as an indivisible particle, with a subsequent trajectory already as a particle. The subtleties of the question lie in the fact that the wave function is fixed (in collapse) at the same time by both its left and $(-\psi_л)$its $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$right $(+\psi_п)$parts. In this case, $(Y -)$the trajectory is built along the axis of the corresponding slot, and then the quantum of space-matter falls on the screen in the form of a left or right point on the screen. There are no other options here, and this does not contradict the interaction symmetries, as arguments . The most interesting thing is that after fixation in the left or right gap with the subsequent movement of particles to the left or right point on the screen, the electron or photon retains its $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$wave function as a probability wave for the next interactions. And the point is not whether we looked at the particle or not. If "Schrödinger's cat is dead, then he is dead," no options. Such properties do not depend on whether we "look" at the situation or not, and do not depend on the consciousness of the observer. This is a property of the very quantum of space-matter, and with a certain probability of "entangled" states $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$ wave function. Recorded data is saved or erased that this is a particle fixed in a slot, or a wave on the screen. That is, the conditions for the collapse of the wave function change, but the properties of the wave function itself remain unchanged, as a “cloud of probability” of its properties. We are talking about the immutable and indestructible properties of the very quantum of space-matter. They cannot be "erased", and if some properties are written, others do not disappear. Matter cannot disappear. And here the given analogies are impossible, such as: properties or a phenomenon “exists only when we look”, or “virtual reality” and other unfounded fantasies. The properties of a quantum of space-matter always exist. It is matter, and it does not disappear. The question of where, when, how, and with what probability are other questions.

2. quantum entanglement

Wave function $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$in an entangled state, or $i\psi e^{ax+i\omega t}$in the Dirac equation

$$\left[i\gamma_\mu \frac{\partial \overline{\psi}(X)}{\partial x_\mu} - m\overline{\psi}(X)\right] + i\gamma_\mu \frac{\partial a(X)}{\partial x_\mu}\overline{\psi}(X) = 0$$

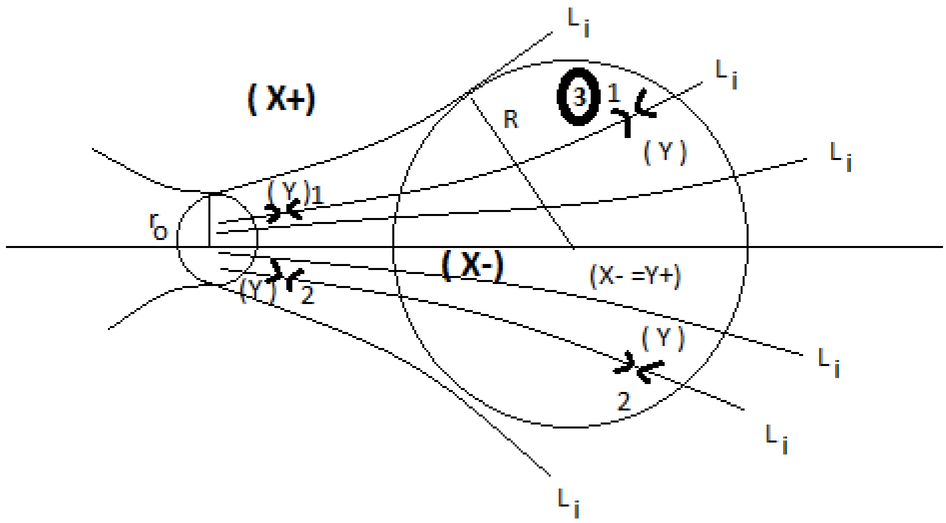
satisfies the wave function $(-\psi_л = e^-)$of an electron and $(-\psi_п = e^+)$a positron simultaneously, in the "Dirac sea". And Dirac was sure of the existence of the positron, as evidenced by his equation. Let's say more, if the wave function $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$ describes a proton, then there is an antiproton, and so on. Moreover, in the "Dirac Sea", an electron-positron pair exists, or is born, as they say today, in an "entangled", simultaneous state. It is important to understand here that entangled particles are born in one quantum field, according to the conditions of admissible symmetries.

A) Hidden options.

We will talk about the properties of the electron and proton as indivisible quanta of space-matter in their models. Electron: $(Y\pm = e^-) = (\boldsymbol{X}\pm = \nu_e^-)(Y\mp = \gamma^+)(\boldsymbol{X}\pm = \nu_e^-)$, and proton: $(X\pm = p^+) = (\boldsymbol{Y}\pm = \gamma_0^+)(\boldsymbol{X}\mp = \nu_e^-)(\boldsymbol{Y}\pm = \gamma_0^+)$. Their wave functions, 2 $(\boldsymbol{X}\pm = \nu_e^-)$neutrinos for an electron and 2 $(\boldsymbol{Y}\pm = \gamma_0^+)$" dark photons" for a proton, rotate $rot_Y G(X+= \nu_e^-)$or $rot_X E(Y+= \gamma_0^+)$around the axis $(Y-)$and$(X-)$ quantum trajectories, respectively. This is like the spin of the entire quantum of an electron or a proton in this case. It is important that two quanta, 2 $(\boldsymbol{X}\pm = \nu_e^-)$neutrinos for an electron or 2 $(\boldsymbol{Y}\pm = \gamma_0^+)$" dark photons" for a proton, are "two sides" of $(-\psi_л)(+\psi_п)$"entangled" wave functions, in the form of $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$a full wave function of an electron or a proton. Each of the entangled wave functions $(-\psi_л)(+\psi_п)$, has its own probability of manifestation of properties on$(Y-)$ or $(X-)$ quantum trajectories, respectively. In the section circle $i\psi(e^{i\omega t} \equiv \cos i\omega t + i\sin i\omega t)$of these trajectories, in Bell's experiments, manifestations of the properties of the general wave function of an electron or proton are fixed or not $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$. And fix these properties, with the probability of "entangled" $(-\psi_л)(+\psi_п)$wave functions. And this probability will be different, in different angles of rotation of the sensors in the experiment. These are, as it were, "hidden parameters" about which we know nothing in advance. These are entangled wave functions. We cannot say that at the point of fixation, or collapse of entangled wave functions, the quantum $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$of the Dirac equation, $(-\psi_л)$)either $(+\psi_п)$the wave function will come, in a state known in advance. We do not know this, and we cannot know in principle. These options are hidden, but not because they aren't there. They are always there (Einstein is right, "the moon is always there"). These are the properties of a quantum of space-matter. They don't disappear. But we cannot say for sure that these parameters are predetermined at the moment of the collapse of the general $(i\psi)$wave function. And we don't know anything definitely, the position $(-\psi_л)$or $(+\psi_п)$in space-time, on$(Y-)$ or $(X-)$ trajectories of quantum, electron and proton respectively, in this case. It can be any other quantum of space-matter, with $i\psi = \sqrt{(-\psi_л)(+\psi_п)}$a wave function.

B) Entangled particles.

Much has been said and written about HOW it "works". We will answer the question WHY it "works" the way it does. We talked about "entangled" $(-\psi_л)(+\psi_п)$wave functions. If we say that each of them corresponds to a particle, then we are talking about entangled particles. And here are the key conditions for the birth and evolution of entangled particles. The first condition is that entangled particles are born in one single quantum field. The second is the criteria of their dynamics, which are opposite in admissible symmetries. This is the main thing. Consider, for example, an analogue of the proton quantum $(X-)$ field, with entangled $(Y\pm)$ dark photons or electrons in a single $(X- = Y+)$ space-matter. For example, we will talk about two $(Y\pm)$ quanta in the ones born in the same $(X-)$quantum field at points 1 and 2, in the sphere.



Rice. 2. Model of entangled particles.

Let $(\mathrm{Y}\pm)$ quanta of space-matter be born in the same quantum $(\mathrm{X}-)$field with the Euclidean isotropy of parallel (L_i)straight lines in the sphere $(r_0 \leftrightarrow R)$of non-stationary Euclidean space-matter, with a dynamic $(\varphi \neq const)$angle of parallelism. These $(\mathrm{Y}\pm)$ quanta, in $(\mathrm{X}-)$the field of, for example, a photon or an electron in this case, are born in a certain acceptable symmetry of the general state. Knowing the state (for example, spin) of one quantum, knowing their admissible symmetry, we know exactly and speak about the state of another quantum. It is said that when one $(-\psi_1)$wave function collapses, "information is instantly transferred" to another entangled quantum, which learns that it needs to collapse into a $(+\psi_2)$wave function state, both modulo probability and "direction" in admissible symmetry. Moreover, it "recognizes" instantly at "monstrous $(R \to \infty)$distances" in a dynamic sphere with Euclidean isotropy. This is what is observed and recorded in experiments. The key point is that entangled particles do not transmit any information to each other. This is inherent in their properties, we see or whether we fix them in space-time or not.It must be said that in Euclidean space we do not see anything from the properties of dynamic space-matter, except for the "cloud of probability".

And here we answer the question WHY it works like this. The classical scheme says that if we act on a particle (1) with a certain particle (3), which changes its properties, then "this information is instantly transmitted" to an entangled particle (2), which is already synchronous, that is, instantly, also reverses its properties. Let's say right away that these are facts of reality and properties of dynamic space-matter. They are. Moreover, if each entangled particle has its own trajectory (L_i), then there will be many such entangled particles in the quantum $(\mathrm{X}-)$field. But there is no transfer of information between entangled particles. It really works if the particle (3) changes the properties of the particle (1) by changing the common and unified $(\mathrm{X}-)$field in which the entangled particles (1) and (2) are born, then the properties and particles (2) change to the opposite (in symmetries) . Roughly speaking, it's like if we pull a tablecloth on the table with a certain object (3), moving the cup (1) towards us, let's say this: we change the state of the cup (1). In this case, the cup (2) on the same table will also change its state. The cup(1) does not transmit any information to the cup(2), and there is no effect of the object (3) on the cup(2). In other words, by influencing the particle (3) through the quantum $(\mathrm{X}-)$field on the particle (1), changing its properties, for example, changing its potential (acceleration over length). Then the quantum $(\mathrm{X}-)$field itself also changes the properties of the particle (2). It is impossible to change the properties of the quantum $(\mathrm{X}-)$field, only in the location of the particle (1). This is a quantum field, it is not divisible. In the axioms of dynamic space-matter, we are talking about the Indivisible Area of Localization of a quantum of space-matter. This is a non-local for particles (1) and (2) change of their properties, by means of the entire $(\mathrm{X}-)$field. That's WHY "this is how it works." Any interpretations in the "Euclidean" space-time about teleportations, transfers of superluminal information, contacts, and so on, to put it mildly, are not correct, and have no arguments. We considered the properties of the space-matter of the Universe. We considered the properties of a multilevel physical vacuum, and according to the formulas of Einstein's theory and quantum relativistic dynamics (it's fashionable to talk about the quantum theory of relativity), so in these theories superluminal speeds are allowed in a multilevel physical vacuum. And these are the realities that we do not yet see. But there are consistent theories, and there are calculation formulas.

Let's consider what practically, at light speeds of information transfer, or impact, can be done with entangled particles. What conditions are needed to create such entangled particles and influence entangled particles. These are codes, ciphers, quantum computers, how it works and how real it all is. As already noted, entangled particles must be born in one quantum of space-matter. In addition to stable photons, electrons, protons, the nucleus of a stable atom, like the atom itself, is also a quantum of space-matter. The second moment, the background of the state and the impact on entangled particles. For example, the orbital electrons of the same atoms, in the same orbits, have the same energy levels. By irradiating a group of atoms with coherent photons (a laser) and achieving certain properties of one orbital electron, we know exactly the states of the orbital electrons of the entire group of atoms. Such a state of the orbital electrons of a group of atoms can be programmed by laser irradiation. Many other groups of atoms, this is a lot of other programs for their irradiation. We can record and record such information, and we are talking about quantum computers, in physically admissible properties.