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Theory of Time as the basis of Quantum Mechanics

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ABSTRACT

The proposed work presents the derivation of the wave function and the Schrödinger equation based on the dual tangential equation of time with an imaginary rate. The derivation uses de Broglie formulas. The wave and complex-conjugate functions are considered, which participate in the probabilistic description of the position of a particle in a potential field. Another interpretation of the product of these functions is presented. Based on it, the classical structure of the electron is derived. The derivation determines the quantum value of the imaginary incident vector. When deriving wave functions, simple solutions immediately arise for energies corresponding to radiation emitted by portions and a microscopic harmonic oscillator. In quantum mechanics, the first solution was used by Planck as a hypothesis when deriving his famous formula for describing equilibrium thermal radiation. The second energy solution was obtained from the Schrödinger equation by cumbersome calculations.

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Introduction

Many scientists believe that modern physics is in deep crisis. The reason for such pessimism is that it does not give a general picture of the physical World. Knowledge about it is fragmented. On the one hand, we have space filled with stellar matter. On the other hand, we have a micro world represented by particles - waves and radiation. The infinitely large must consist of the infinitely small. This is a logical conclusion. It is precisely this barrier that separates one World from another. The reason for the division is the difference in the mathematical apparatus in the description of cosmic and micro processes.

It is believed that space is controlled by gravity. The general theory of relativity developed by A. Einstein in 1915 is a successful theory that has been used to describe gravitational phenomena for over a hundred years. It is based on determinism. This means that space-time is considered a continuous fabric subject to curvature due to the masses of matter in it. The resulting curvature is the cause of gravity. The theory is based on Einstein's tensor equation, which relates curvature and energy-momentum.

The phenomena of the micro world are described by quantum mechanics. It is based on the idea of quantization or discreteness of processes associated with the movements of elementary particles. The main equation of this science is the Schrödinger equation. It is not derived from any general principle. Schrödinger established it based on the optical-mechanical analogy. The meaning of the analogy is in the similarity of the equations describing the course of light rays and the equations determining the trajectories of particles in classical mechanics.

Its solution is the wave function. Its probabilistic interpretation was given in 1926 by Max Born. Since then, all particle-wave movements in potential fields have been described using statistical methods.

As we can see, both theories have a solid period of application. Each of them individually perfectly describes phenomena on its own scales of space and time. But they cannot be combined because of the different approaches to their description. There is no common equation that would allow deriving the Einstein and Schrödinger equations from it.

In this article, the author attempted to fill the gap in both theories, using the theory of time he developed. The foundations of the theory were presented in articles [1-3]. Article [1] shows the derivation of the Friedman equation based on the dual sinusoidal equation of tempo. The dual equation consists of two parts. The right part is the pseudo-Euclidean interval of STR, and the left part is the wave part, which includes the function of the real tempo. The equation is a modified Einstein equation and connects the theory of time with GTR.

In the proposed article, the derivation of the wave function and the Schrödinger equation is given based on the dual tangential equation of tempo. The right part in it is the Euclidean interval of space-time. The left part is the wave part, which includes the imaginary tempo.

Derivation of the Wave Function

In the work [1] a tangential dual equation was obtained, which has the form:

$$\pm\widehat{t} = \sqrt{\widehat{\tau}^2 + \psi^2} = \widehat{\tau} + \psi\dot{\psi} \qquad (1)$$

Where $\dot{\psi} = d\psi / d\hat{t}$ there is a tempo of time.

$\hat{\tau} = \hat{t}\cos\varphi$ - own time; $\psi = \hat{t}\sin\varphi$ - proper time of space.

The plus sign denotes the direction of the forward flow of time $\hat{t}$; the minus sign denotes the reverse flow. When deriving the equation, a unit derivative was introduced $d\hat{\tau} / d\hat{t} = 1$.

The joint solution of the equation leads to a relationship between the forward and reverse tempo:

$$\dot{\psi}_{np} + \dot{\psi}_{o\delta p} = -2ctg\varphi = -2\frac{\hat{\tau}}{\psi} \text{ и } \dot{\psi}_{np} \cdot \dot{\psi}_{o\delta p} = -1 \qquad (2)$$

From the second dependence, it follows that if the direct and reverse rates are equal, then they are imaginary:

$$\dot{\psi}_{np} \cdot \dot{\psi}_{o\delta p} = \dot{\psi}^2 = -1 = i^2 \text{ или } \dot{\psi} = \pm\sqrt{-1} = \pm i \qquad (3)$$

From this condition follows the wave function describing the behavior of a particle in a direct flow at a positive imaginary velocity: $\dot{\psi} = i$ .The original equation is the dual equation for the direct flow (1), in which all time coordinates are multiplied by the speed of light:

$$c\hat{t} = \sqrt{\hat{s}^2 + l^2} = \hat{s} + \dot{\psi}_{np} l = \hat{s} + i \cdot l \qquad (4a)$$

Where $\dot{\psi}_{np} = d\psi / d\hat{t} = i$ there is a direct imaginary tempo of time.

The equation consists of two parts. The first is the module of the falling time vector in Euclidean space. The second has a wave nature, inherent to this vector. To derive the wave function, we will use only the wave part of the equation.

$$c\hat{t} = \sqrt{\hat{s}^2 + l^2} = \hat{s} + \dot{\psi}_{np} l = \hat{s} + i \qquad (4b)$$

We divide by $c\hat{t}$ and we arrive at the Euler equation [5]:

$$1 = \frac{\hat{s}}{c\hat{t}} + i \cdot \frac{l}{c\hat{t}} = \cos\varphi + i \cdot \sin\varphi = e^{i\varphi} = e^{2\pi n i} \qquad (5)$$

From the obtained dependence, it follows:

$$\varphi = 2\pi n = \frac{2\pi}{T_0} T_0 n = \omega_0 n T_0 = \frac{E_0}{\hbar} n T_0 = \frac{E_n}{\hbar} T_0 \qquad (6)$$

Where $E_0 = \hbar\omega_0$ there is a formula for the initial energy of de Broglie;

$E_n = E_0 n = \hbar\frac{2\pi n}{T_0} = \hbar\omega_0 n = \hbar\frac{\varphi}{T_0}$ there is quantum energy of direct flow.

The resulting energy describes the radiation emitted in portions and is used to derive Planck's formula.

Because. $1 = d\hat{\tau} / d\hat{t} = dc\hat{t} / d\hat{s}$, then, substituting into (5), we obtain the differential equation:

$$dc\hat{t} = e^{i\varphi} d\hat{s} = \frac{ce^{i\varphi}}{\Delta\omega} d(\Delta\omega\hat{\tau}) = \frac{ce^{i\varphi} d(i\varphi)}{i\Delta\omega} \qquad (7a)$$

To find the integral, we express φ through $\hat{\tau}$ according to the formula:

$$\varphi = \Delta\omega \cdot \hat{\tau}$$

Where $\Delta\omega = \omega_0 - \omega_{01}$ there is a difference in circular frequencies.

Expressing frequency ω_0 via de Broglie's formula:

$$\omega_0 = \frac{E}{\hbar}$$

We introduce the following notation for ω_{01}:

$$\omega_{01} = k\frac{l}{\hat{\tau}} = ku$$

Where $u = l / \hat{\tau}$ - speed of particle movement.

We find *K*:

$$k = \frac{\omega_{01}}{u} = \frac{2\pi}{T}\frac{1}{u} = \frac{2\pi}{\lambda} = \frac{p}{\hbar} \qquad (7b)$$

The resulting coefficient K s called the wave number, in which the wavelength is expressed by the de Broglie formula through the momentum $p = mv$

Then

$$\omega_{01} = k\frac{l}{\hat{t}} = \frac{p}{\hbar} \cdot \frac{l}{\hat{\tau}}$$

We define the function of an angle φ according to the formula above:

$$\varphi = \Delta\omega \cdot \hat{\tau} = \omega_0\hat{\tau} - \omega_{01}\hat{\tau} = \frac{E}{\hbar}\hat{\tau} - \frac{p}{\hbar} \cdot l = \frac{E\hat{\tau} - pl}{\hbar} \qquad (8)$$

Integrating (7a) under the initial conditions $c\hat{t}(0) = c\hat{t}_0$ и $\varphi(0) = 0$, we get:

$$c\hat{t} - c\hat{t}_0 = \frac{c}{i\Delta\omega} e^{i\varphi} - \frac{c}{i\Delta\omega}$$

Where does it follow from

$$c\hat{t} = \frac{c}{i\Delta\omega} e^{i\varphi} - \frac{c}{i\Delta\omega} + c\hat{t}_0 = \frac{c}{i\Delta\omega} e^{i\varphi}$$

Where we accept that $c\hat{t}_0 = \dfrac{c}{i\Delta\omega}$

We transform the equation to the imaginary value of the falling vector

$$ic\hat{t} = \frac{c}{\Delta\omega} e^{i\varphi} = \frac{c}{\Delta\omega} e^{i\frac{E\hat{\tau} - pl}{\hbar}}$$

Because $d\psi = id\hat{t}$, then $\psi = i \cdot \hat{t}$ and the resulting solution can be written as a wave function for the direct flow:

$$\Psi^* = l = ic\hat{t} = \frac{c}{\Delta\omega} e^{i\frac{E\hat{\tau} - pl}{\hbar}} = Ae^{i\frac{E\hat{\tau} - pl}{\hbar}} \qquad (9)$$

Where $A = c / \Delta\omega$ is the amplitude of the wave function.

As we can see, the spatial coordinate of the imaginary falling vector acts as a wave function.

We will perform similar transformations for the reverse flow of time, applying the wave part of the tangential dual equation to it:

$$-c\hat{t} = \hat{s} + l\dot{\psi}_{o\delta p} = \hat{s} - i \cdot l \qquad (10)$$

Where $\dot{\psi}_{o\delta p} = d\psi / d\hat{t} = -i$ there is an imaginary rate for the reverse flow·

$$-1 = \frac{\hat{s}}{c\hat{t}} - i \cdot \frac{l}{c\hat{t}} = \cos\varphi - i \cdot \sin\varphi = e^{-i\varphi} = e^{i(2n+1)\pi} \qquad (11)$$

We divide by and arrive at Euler's equation [5]:

From the obtained dependence it follows:

$$-\varphi = (2n+1)\pi = 2\pi(n+\frac{1}{2}) = \frac{2\pi}{T_0}(n+\frac{1}{2})T_0 = \omega_0(n+\frac{1}{2})T_0 = \frac{E_0}{\hbar}(n+\frac{1}{2})T_0 = \frac{E_0}{\hbar}T_0$$

Where $E_0 = \hbar\omega_0$ there is a formula for the initial de Broglie energy.

$$E_n = E_0(n+\frac{1}{2}) = \hbar\omega_0(n+\frac{1}{2}) = -\frac{\hbar\varphi}{T_0} \qquad (12)$$

There is quantum energy of the reverse flow.

The resulting formula E_n is a solution to the Schrödinger equation for a microscopic harmonic oscillator.

Because $-1 = d\hat{\tau}/d\hat{t} = dc\hat{t}/d\hat{s}$,then, substituting into (11), we obtain the differential equation:

$$dc\hat{t} = e^{-i\varphi}d\hat{s} = \frac{ce^{-i\varphi}}{\Delta\omega}d(\Delta\omega\hat{\tau}) = -\frac{ce^{-i\varphi}d(-i\varphi)}{i\Delta\omega} \qquad (13)$$

To find the integral, we express φ it through $\hat{\tau}$ the formula

$$-\varphi = -\Delta\omega\cdot\hat{\tau}$$

Applying formula (8), we obtain.

$$-\varphi = -\frac{E\hat{\tau} - pl}{\hbar} = \frac{pl - E\hat{\tau}}{\hbar} \qquad (14)$$

Integrating (13) under a negative initial condition $c\hat{t}(0) = -c\hat{t}_0$ и $\varphi(0) = 0$, andwe obtain:

$$-c\hat{t} + c\hat{t}_0 = -\frac{c}{i\Delta\omega}e^{-i\varphi} + \frac{c}{i\Delta\omega}e^0$$

Whence it follows that at $c\hat{t}_0 = c/i\Delta\omega$:

$$-c\hat{t} + c\hat{t}_0 = -\frac{c}{i\Delta\omega}e^{-i\varphi} + \frac{c}{i\Delta\omega}e^0$$

We transform the equation to the imaginary value of the falling vector:

$$ic\hat{t} = \frac{c}{\Delta\omega}e^{-i\varphi} = \frac{c}{\Delta\omega}e^{i\frac{pl-E\hat{\tau}}{\hbar}}$$

Since $d\psi = -id\hat{t}$ then $\int_0^{\psi} d\psi = \psi = -i\int_0^{-\hat{t}} d\hat{t} = -i(-\hat{t}) = i\cdot\hat{t}$ the obtained solution can be written in the form of a wave function for the reverse flow:

$$\Psi = l = ic\hat{t} = \frac{c}{\Delta\omega}e^{-i\varphi} = Ae^{i\frac{pl-E\hat{\tau}}{\hbar}} \qquad (15)$$

It is this function that is considered a wave function in quantum mechanics, since it is a solution to the Schrödinger equation. Then the function obtained above for the direct flow is complex conjugate.

To describe the motion of a particle in quantum mechanics, a probabilistic interpretation of the wave function is used. To justify it, we write the product of wave functions as:

$$\Psi\cdot\Psi^* = (ic\hat{t})^2 = \left|-c\hat{t}\right|^2 = \left|\Psi\right|^2 = A^2$$

Let's take their relationship:

$$\frac{\Psi\cdot\Psi^*}{A^2} = \frac{\left|-c\hat{t}\right|^2}{A^2} = 1 = \frac{dV}{dP}\cdot\frac{dP}{dV}$$

where V is the volume in which the particle is located; P is the probability of its being in this volume.

Then we can write the equality:

$$\frac{A^2 dV}{dP} = \frac{\left|c\hat{t}\right|^2 dV}{dP} = \frac{\Psi\cdot\Psi^* dV}{dP} = 1$$

It implies the probability that the particle is located at one of the points in the space of the time volume. It is officially called the normalization condition

$$\int_{-\infty}^{\infty}\left|-c\hat{t}\right|^2 dV = \int_{-\infty}^{\infty}\Psi\cdot\Psi^* dV = \int_0^1 dP = 1 \qquad (17a)$$

In relation to the obtained meaning for the wave function, as a function of the location of the particle in space-time described by the falling vector, the normalization condition takes on a different form:

$$\frac{\left|-c\hat{t}\right|^2}{A^2} = 1 = \frac{d\hat{s}}{dc\hat{t}} = \frac{d\hat{s}}{dP}\cdot\frac{dP}{dc\hat{t}}$$

Where $\dfrac{\left|-c\hat{t}\right|^2 dc\hat{t}}{dP} = \dfrac{A^2 d\hat{s}}{dP} = 1$

Or $dP = A^2 d\hat{s} = \left|-c\hat{t}\right|^2 dc\hat{t}$

Integration leads to a normalization condition in the form:

$$\int_0^1 dP = 1 = \int A^2 d\hat{s} = \int\left|-c\hat{t}\right|^2 dc\hat{t} = \int\Psi\cdot\Psi^* dc\hat{t} \qquad (17b)$$

In quantum mechanics, with a probabilistic approach, it is believed that the behavior of a microparticle is described by a plane de Broglie wave, but only the square of the amplitude of this wave, equal to the square of the modulus of the complex function, has a physical meaning.

Such an interpretation, in the author's opinion, leads not only to a probabilistic description of the location of one particle, but also allows one to move on to the gravitational interaction of the particle and antiparticle as a single whole.

To substantiate this point of view, let us consider the following picture. Based on the wave functions, we can say that the imaginary falling time vector bifurcates in its proper time. Its first part goes into the region of the direct direction of its proper time, and the second - into the reverse direction. The causal relationship is broken. The ends of the vectors can be expressed through the same masses, since they are identical and have a finite maximum size. A particle and an antiparticle can be associated with these masses. The first particle is in the region with the direct direction of its proper time. The second antiparticle is in the region with the reverse direction of its proper time. Since both particles have the same mass, then they interact gravitationally with each other.

Let's consider this interaction. Let the amplitude of the wave function be equal to the gravitational radius of the particle multiplied by the dimensionless scale.

$$\grave{A} = l_m \xi \qquad (18a)$$

Where $l_m = mG / c^2$ there is a gravitational radius.

Then you can write:

$$\grave{A} = l_m \xi = \frac{mG}{c^2}\xi = \frac{mG}{v_m^2 \frac{c^2}{v_m^2}}\xi = \frac{mG}{v_m^2}\cdot\frac{\xi}{\frac{c^2}{v_m^2}} = \frac{mG}{v_m^2} \qquad (18b)$$

Where $\xi = \frac{c^2}{v_m^2}$ there is a dimensionless scale; v_m^2 - square of the first gravitational velocity of the particle

Since imaginary value $ic\hat{t}$ s are wave functions, they can be written in terms of the introduced amplitudes:

$$\Psi^* = l = ic\hat{t} = Ae^{i\varphi}$$

$$\Psi = ic\hat{t} = Ae^{-i\varphi}$$

The product of these functions can be considered as the square of the amplitude, which has physical meaning:

$$\Psi \cdot \Psi^* = A^2 = \frac{mG}{c^2}\xi \cdot \frac{m^* G}{c^2}\xi = \frac{m \cdot m^* G^2}{c^4}\xi^2$$

The physical meaning can be interpreted as the gravitational interaction of the masses of the particle and antiparticle m:

$$\Psi \cdot \Psi^* = \grave{A}^2 = \frac{mG}{c^2}\xi \cdot \frac{m^* G}{c^2}\xi = \frac{m \cdot m^* G^2}{c^4}\xi^2 \qquad (19a)$$

We write (19a) through the Planck force: $F_0 = c^4 / G = m_0 c^2 / \ell_0 = m_0^2 G / \ell_0^2$

$$\frac{F_0}{\xi^2} = \frac{c^4}{\xi^2 G} = \frac{m \cdot m^* G}{\Psi \cdot \Psi^*} = \frac{m \cdot m^* G}{-(c\hat{t})^2} = -\frac{m \cdot m^* G}{(c\hat{t})^2} = \frac{m \cdot m^* G}{A^2} \qquad (19b)$$

Thus, we obtained the Planck force with a minus sign, which indicates the gravitational attraction of the masses of the particle and antiparticle, and with a plus sign, which indicates the appearance of a centrifugal force.

In quantum mechanics, the gravitational interaction between a particle and an antiparticle is not taken into account. Instead of Planck's gravitational force, its notation is used as a centrifugal force from one particle:

$$\frac{F_0}{\xi^2} = \frac{c^4}{\xi^2 G} = \frac{m \cdot m^* G}{A^2} = \frac{m^* c^2 \cdot mG}{A^2 \quad c^2} = \frac{m^* c^2}{A^2} l_m = \frac{m^* c^2}{\xi^2 l_m} = \frac{m^* c^2}{r} \qquad (19c)$$

Here $\xi^2 l_m = r$ - the size of the particle radius taking into account the scale.

From the resulting record, it is clear that the mass of the antiparticle is converted into the gravitational radius, which on the appropriate scale becomes the radius of the circle for the particle. Then we can write the equation in terms of the square of the amplitude of the wave function:

$$\frac{F_0}{\xi^2} = \frac{m^* c^2}{r} = \frac{m^* c^2}{r^2} r = \frac{m^* c^2}{A^2} l_m = \frac{m^* c^2}{(\frac{c}{\Delta\omega})^2} l_m = m^* (\Delta\omega)^2 \cdot l_m \qquad (19d)$$

Here: $r = \xi^2 l_m = (\frac{c}{\Delta\omega})^2 \frac{1}{l_m}$ is the radius of the circle. :

For further calculations, we take the electron mass as a particle $m^* = m_e$ and the positron mass, equal to the electron mass, as an antiparticle $m = m_e^+$

Let us show that the resulting formula leads to the equality of forces arising in the electron on some scale. To do this, we transform the Planck force, writing it in the form following from (19c):

$$F_0 = \frac{m_e c^2}{l_m}$$

Let's multiply both parts by the electromagnetic constant α_e :

$$\alpha_e F_0 = \frac{m_e c^2 \alpha_e}{l_m} = \frac{m_e c^2 \alpha_e^2}{\alpha_e l_m}$$

We get for the left side: $\alpha_e F_0 = \frac{e^2}{m_0^2 G}\frac{m_0^2 G}{\ell_0^2} = \frac{e^2}{\ell_0^2}$

For the right side: $\frac{m_e c^2 \alpha_e^2}{\alpha_e l_m} = \frac{m_e v_e^2}{\alpha_e \frac{m_e^+ G}{c^2}} = \frac{m_e v_e^2}{\alpha_e l_m}$

Where $v_e = c\alpha_e$ is the linear velocity of the electron.

By equating both parts, we obtain the equation of forces:

$$\alpha_e F_0 = \frac{e^2}{\ell_0^2} = \frac{m_e v_e^2}{\alpha_e l_m}$$

Multiply both parts by the number $1 / \alpha_e^2 n_e^2$

$$\frac{\alpha_e F_0}{\alpha_e^2 n_e^2} = \frac{e^2}{\ell_0^2 \alpha_e^2 n_e^2} = \frac{e^2}{r_e^2} = \frac{m_e {v_e}^2}{\alpha_e l_m \alpha_e^2 n_e^2} = \frac{m_e {v_e}^2}{\alpha_e \dfrac{m_e^+ G}{c^2} \alpha_e^2 n_e^2} = \frac{m_e c^2 {\alpha_e}^2}{\alpha_e \dfrac{m_e n_e G}{c^2} \alpha_e^2 n_e} = \frac{m_e c^2}{\alpha_e \dfrac{m_0 G}{c^2} n_e} = \frac{m_e c^2}{\alpha_e \ell_0 n_e} = \frac{m_e c^2}{r_e}$$

Where $n_e = m_0 / m_e$ is the number of electrons in the Planck mass.

Finally, taking into account (19b):

$$\frac{F_0}{\xi^2} = \frac{\alpha_e F_0}{\alpha_e^2 n_e^2} = \frac{e^2}{r_e^2} = \frac{m_e c^2}{r_e} = \frac{m_e c^2 \alpha_e}{l_m \alpha_e^2 n_e^2} = \frac{m_e c^2}{l_m \alpha_e n_e^2} = \frac{m^* c^2}{r} \qquad (20a)$$

Where $r = r_e = \alpha_e \ell_0 n_e$ is the classical radius of the electron.

The resulting equality describes the equilibrium of forces in an electron with a classical radius. Determining the scale ξ^2

$$\xi^2 = \frac{\alpha_e^2 n_e^2}{\alpha_e} = \alpha_e n_e^2 = (\frac{c^2}{v_m^2})^2 \qquad (20b)$$

Where

$$v_m = \sqrt[4]{\frac{c^4}{\alpha_e n_e^2}} = \frac{c}{\sqrt[4]{\alpha_e n_e^2}} \qquad (20c)$$

is the gravitational velocity of the electron.

We find l_m (see (20a)):

$$r_e = r = l_m \xi^2 = l_m \alpha_e n_e^2 = \frac{m_e^+ G}{c^2} \alpha_e n_e^2 = \frac{m_e^+ n_e G}{c^2} \alpha_e n_e = \frac{m_0 G}{c^2} \alpha_e n_e = \ell_0 \alpha_e n_e$$

Where

$$l_m = \frac{\ell_0 \alpha_e n_e}{\alpha_e n_e^2} = \frac{\ell_0}{n_e} \qquad (20d)$$

On an enlarged scale l_m, we find the electron rotation frequency from (19d), writing it in the form:

$$\frac{F_0}{\xi^2} = \frac{e^2}{r_e^2} = \frac{m_e c^2}{r_e} = \frac{m_e c^2}{r_e^2} r_e = m_e \Delta\omega^2 l_m$$

We find $\Delta\omega$

$$\Delta\omega = \frac{c}{r_e} = \frac{c}{l_m \xi^2} = \frac{c}{l_m \alpha_e n_e^2} = \frac{c}{\dfrac{\ell_0}{n_e}} \cdot \frac{1}{\alpha_e n_e^2} = \Delta\omega_0 \cdot \frac{1}{\alpha_e n_e^2} = \frac{\Delta\omega_0}{\xi^2} \qquad (20e)$$

Where: $\Delta\omega_0 = \dfrac{c}{l_m} = \dfrac{c^3}{m_e G} = \dfrac{c^3}{\dfrac{m_0}{n_e} G} = \dfrac{c}{\dfrac{\ell_0}{n_e}}$ - initial frequency of rotation of the electron.

We find the magnitude of the amplitude of the wave function based on the found circular frequency:

$$A = \frac{c}{\Delta\omega} = \frac{c}{\dfrac{c}{r_e}} = r_e = l_m \xi \qquad (20f)$$

The results obtained are obtained from an approach based on the centrifugal force that occurs when an electron moves along a circle of radius . This force prevents the collapse of an electron, which has a negative electric charge, which interacts with the charge located in the center of the circle. As can be seen from the study, such a charge, but only of a positive sign, is possessed by the positron, which turns into the space of the circle for the electron, keeping its charge in the center. The positive charge of the positron and the negative charge of the electron are attracted to each other. If it were not for the centrifugal force that arose, they would be attracted to each other and annihilate, turning into photons.

Let us now consider the gravitational interaction of a particle and antiparticle, leading to the determination of the magnitude of the falling vector. It has the form (19b):

$$\frac{F_0}{\xi^2} = \frac{e^2}{r_e^2} = -\frac{m_e \cdot m_e^+ G}{(c\hat{t})^2} \qquad (21a)$$

Here: m_e^+ - mass of the antiparticle - positron; m_e - mass of the particle - electron.

We find the initial length of the imaginary falling vector $(c\hat{t})^2$

$$(c\hat{t})^2 = -\frac{m_e \cdot m_e^+ G}{e^2} r_e^2 = -\frac{m_e \cdot m_e^+ G}{m_e M_e G} r_e^2 = -\frac{m_e^+}{M_e} r_e^2 = -\frac{m_e^+ r_e}{M_e} r_e = -\frac{m_e^+ r_e}{M_e} \frac{M_e G}{c^2} = -\frac{m_e^+ G r_e}{c^2} = -l_m r_e = -\frac{\ell_0}{n_e} \alpha_e n_e \ell_0 = -\alpha_e \ell_0^2$$

Or

$$ic\hat{t} = \sqrt{\alpha_e \ell_0^2} = \ell_0 \sqrt{\alpha_e} \qquad (21b)$$

Here: $e^2 = m_e M_e G = m_e c^2 r_e$ there is a gravitational expression for the square of the charge

As can be seen from the obtained result, for the time vector to be a real value, the positron mass must be negative. But the positron mass is positive. Therefore, the falling vector is an imaginary value. This imaginary value provides gravitational attraction in space-time, which forms the falling vector.

Let us carry out a further transformation of the previous formula:

$$(c\hat{t})^2 = -\frac{m_e^+ G}{c^2} r_e = -\frac{m_e^+ G}{c^2} \cdot \frac{M_e G}{c^2} = -m_e^+ \cdot M_e G \cdot \frac{G}{c^4} = -\frac{e^2}{F_0} \qquad (21c)$$

We find F_0

$$F_0 = -\frac{e^2}{(c\hat{t})^2} = \frac{e^2}{\alpha_e \ell_0^2} = \frac{e^2 m_0^2 G}{e^2 \ell_0^2} = \frac{m_0^2 G}{\ell_0^2}$$

As we can see, the Planck force can be both negative and positive.

Derivation of the Schrödinger Equation

Let us show that both parts of the tangential dual equation (10), describing the reverse flow of time, serve as the basis for deriving the Schrödinger equation. This is how the derivation differs from the derivation of the wave function, in which only the wave part is involved.

Let us write it in the form

$$-c\hat{t} = \sqrt{\hat{s}^2 + l^2} = \hat{s} + l\dot{\psi}_{обр} = \hat{s} + \frac{dl}{cd\hat{t}} \cdot l \qquad (22a)$$

Where $\dot{\psi}_{обр} = dl / cd\hat{t} = -i$ is the inverse imaginary tempo of time; $d\hat{s} / cd\hat{t} = cd\hat{t} / d\hat{s} = 1$ is the condition of homogeneity of time. $\hat{s} = c\hat{t}\cos\varphi = (c\cos\varphi)\hat{t} = u\hat{t}$ is the metric coordinate of proper time;

$l = c\hat{t}\sin\varphi = (c\sin\varphi)\hat{t} = v_1\hat{t}$ is the metric coordinate of proper time of space.

Here: $u = c\cos\varphi$ is a constant velocity directed along the axis of proper time of the falling vector; $v_1 = c\sin\varphi$ is a constant velocity directed along the axis of proper time of space.

Taking into account the introduced notations, we transform the derivative of the spatial tempo:

$$\frac{dl}{cd\hat{t}} = \frac{dl}{d\hat{s}} = \frac{v_1 d\hat{t}}{cd\hat{\tau}} = \sin\varphi \text{ since } \frac{d\hat{t}}{d\hat{\tau}} = 1$$

Substituting the found value into the dual equation, we obtain:

$$-c\hat{t} = \sqrt{\hat{s}^2 + l^2} = \hat{s} + \frac{dl}{cd\hat{t}} \cdot l = \hat{s} + l\sin\varphi \qquad (22b)$$

We transform by squaring both sides:

$$l^2 = 2l\hat{s}\sin\varphi + l^2\sin^2\varphi$$

From the obtained expression it follows

$$\frac{l}{2\hat{s}} = \frac{\sin\varphi}{\cos^2\varphi} \qquad (22c)$$

Let us derive the Schrödinger equation based on (22c). For this, we will consider the ratio as a function of speed, representing it in the form:

$$v = u\frac{l}{2\hat{s}} = u\frac{\sin\varphi}{\cos^2\varphi} \qquad (22d)$$

Where $u = c\cos\varphi$

The resulting formula for speed will be expressed in terms of time $\hat{t}$:

$$v = u\frac{l}{2\hat{s}} = u\frac{l}{2u\hat{t}} = \frac{l}{2\hat{t}} = c\cos\varphi \cdot \frac{\sin\varphi}{\cos^2\varphi} = c \cdot tg\varphi \qquad (22e)$$

Since $l / \hat{t} = -i$ by definition of tempo, the resulting speed function is imaginary.

But for now, we will not pay attention to this and take the derivative of the obtained speed function: Transform to acceleration in time $\hat{t}$:

$$\frac{dv}{d\hat{t}} = \frac{1}{2}\left(\frac{d\bar{l}}{\hat{t}d\hat{t}} - \frac{\bar{l}}{\hat{t}^2}\right)$$

Let's write it in the form:

$$\frac{dv}{d\hat{t}} + \frac{1}{2}\frac{l}{\hat{t}^2} = \frac{1}{2}\frac{dl}{\hat{t}d\hat{t}} = \frac{1}{2}\frac{v}{\hat{t}} \qquad (23a)$$

Here: $v = c\dot{\psi}_{обр} = -ic = \frac{dl}{d\hat{t}}$ is the imaginary velocity expressed through the time derivative $\hat{t}$.

Let's transform the second term:

$$\frac{1}{2}\frac{l}{\hat{t}^2} = \frac{1}{\hat{t}}\left(\frac{l}{2\hat{t}}\right) = \frac{v}{\hat{t}} = \frac{v}{l}2v = \frac{2v^2}{l}$$

Here the permutation $\hat{t} = l / 2v$ following from (22e) is applied.

The right-hand side member is transformed in a similar way:

$$\frac{1}{2}\cdot\frac{v}{\hat{t}} = \frac{1}{2}\frac{v}{l}2v = \frac{v^2}{l}$$

We substitute the terms into equation (23a)

$$\frac{dv}{d\hat{t}} + \frac{2v^2}{l} = \frac{v^2}{l}$$

We transform it into the form:

$$-l\frac{dv}{d\hat{t}} + v^2 = 2v^2 \qquad (23b)$$

If we bring the solution to the end, we get:

$$-l\frac{dv}{d\hat{t}} = v^2 \qquad (23c)$$

Let us transform the acceleration formula taking into account that $v = dl / d\hat{t}$ и $dv / d\hat{t} = vdv / dl$ Then equation (23c) can be written as:

$$-l\frac{vdv}{d\bar{l}} = v^2$$

Or

$$\frac{dv}{v} = -\frac{dl}{l}$$

We integrate under the initial conditions $v(0) = v_0,\ l(0) = l_0$

$$\int_{v_0}^{v}\frac{dv}{v} = -\int_{l_0}^{l}\frac{dl}{l}$$

Or

$$\ln\frac{v}{v_0} = -\ln\frac{l}{l_0} = \ln\frac{l_0}{l}$$

As a result, we arrive at the speed formula in the form:

$$v = v_0\frac{l_0}{l} = v_0\frac{l_0}{l^2}l = \omega l \qquad (24)$$

Where $\omega = v_0\frac{l_0}{l^2}$ there is a variable speed.

Based on (24), equation (23b) can be written as:

$$-l\frac{dv}{d\hat{t}} + \omega^2 l^2 = 2\omega^2 l^2$$

Reducing by l, we get:

$$-\frac{dv}{d\hat{t}}+\omega^2 l=2\omega^2 l \qquad (25a)$$

Let us apply the quantum energy formula according to de Broglie to the obtained equation (см. (6)):

$$E_0=\hbar\omega_0$$

Where ω_0 is the constant circular frequency of the particle

On the other hand, we express the variable frequency through a constant, considering that the speed v_0 is the linear speed of the particle's movement along a circle.

$$v_0=\omega_0 l_0$$

In this case, the second term in (25a) can be written as:

$$\omega^2 l=(\omega_0\frac{l_0^2}{l^2})^2 l=(\frac{E_ч}{\hbar}\frac{l_0^2}{l^2})^2 l=(\frac{E}{\hbar})^2 l \qquad (25b)$$

Where $E=E_ч\frac{l_0^2}{l^2}=\hbar\omega_0\frac{l_0^2}{l^2}$ is a function of the total energy of the particle.

Then equation (25a) will take the form:

$$-\frac{1}{2}\frac{dv}{d\hat{t}}+\frac{E^2}{2\hbar^2}l=\frac{E^2}{\hbar^2}l \qquad (25c)$$

We divide both parts by $1/m_ч$:

$$-\frac{\hbar^2}{2m_ч}\frac{d^2 l}{\frac{E}{m_ч}d\hat{t}^2}+\frac{E}{2}l=El \qquad (25d)$$

We introduce the notation of potential energy:

$$- \qquad (26a)$$

As we can see, it is two times less than the total energy.
We believe that in quantum processes the total energy can be expressed through the velocity and mass of the particle:

$$E=m_ч v^2 \qquad (26b)$$

Since it represents the sum of potential and kinetic energies, it can be written as:

$$E=m_ч v^2=K+U=K+\frac{E}{2}$$

Where do we find kinetic energy

$$K=E-U=E-\frac{E}{2}=\frac{E}{2}=\frac{m_ч v^2}{2}=\frac{m_ч^2 v^2}{2m_ч}=\frac{p^2}{2m_ч} \qquad (26c)$$

Thus we have:

$$E=\frac{p^2}{2m_ч}+U=m_ч v^2 \qquad (26d)$$

It follows from this that

$$\frac{E}{m_ч}=v^2 \qquad (26e)$$

Then the differential equation (25c) will take the form:

$$-\frac{\hbar^2}{2m_ч}\frac{d^2 l}{v^2 d\hat{t}^2}+Ul=El \qquad (27)$$

Here: $v^2 d\hat{t}^2=dl^2$ according to (23a).

In the resulting equation, the metric coordinate of spatial time is a function that depends on three spatial coordinates $l=l(x,y,z)$, i.e. it is the radius of 3-dimensional space.

Then we can replace the second derivative with the Laplace operator:

$$\frac{d^2 l}{dl^2}=\nabla^2\bar{l}=\frac{\partial^2 l}{\partial x^2}+\frac{\partial^2 l}{\partial y^2}+\frac{\partial^2 l}{\partial z^2} \qquad (28)$$

Finally, let us recall the imaginary velocity (see (23a)). Let us apply it to the study of the right-hand member in (27). Let us consider the particle energy formula (25b). Let us transform it to the form:

$$E=E_ч\frac{l_0^2}{l^2}=\hbar\omega_0\frac{l_0^2}{l^2}=\hbar\omega_0\frac{l_0}{l}\cdot\frac{l_0}{l}=\hbar\omega_0\frac{l_0}{-ic\hat{t}}\cdot\frac{l_0}{l}=i\hbar\omega_0\frac{l_0}{-i^2 c\hat{t}}\cdot\frac{l_0}{l}=i\hbar\omega_0\frac{l_0}{c\hat{t}}\cdot\frac{l_0}{l}$$

Let us write it as the rate of change of part of the wave function over time: $\hat{\tau}$:

$$l\frac{E}{i\hbar}=-il\frac{E}{\hbar}=\frac{\omega_0 l_0}{c\hat{t}}l_0=\frac{v_0}{c}\cdot\frac{l_0}{\hat{t}}=\tilde{v} \qquad (29a)$$

By part of the wave function, we will understand the quantity , which depends only on time. We find the total differential of it.

$$dl=d\Psi(\tau)=\frac{\partial\Psi}{\partial\hat{\tau}}d\hat{\tau}=\frac{\partial\Psi}{\partial\hat{\tau}}d\hat{t}$$

Let's write it as the rate of change of the wave function:

$$\tilde{v}=\frac{dl}{d\hat{t}}=\frac{\partial\Psi}{\partial\hat{\tau}}$$

Equating the obtained expression (29a), we obtain the equation:

$$-il\frac{E}{\hbar}=-i\Psi\frac{E}{\hbar}=\frac{v_0}{c}\frac{l_0}{\hat{t}}=\tilde{v}=\frac{dl}{d\hat{t}}=\frac{\partial l}{\partial\hat{\tau}}=\frac{\partial\Psi}{\partial\hat{\tau}} \qquad (29b)$$

From it we find E :

$$E=-\frac{\hbar\partial\Psi}{i\Psi\partial\hat{\tau}}=\frac{i\hbar\partial\Psi}{-i^2\Psi\partial\hat{\tau}}=\frac{i\hbar\partial\Psi}{\Psi\partial\hat{\tau}} \qquad (29c)$$

Substituting (29c) into equation (27) and replacing in it $l=\Psi$, we obtain the Schrödinger equation:

$$-\frac{\hbar^2}{2m_ч}\nabla^2\Psi+U\Psi=E\Psi=i\hbar\frac{\partial\Psi}{\partial\hat{\tau}} \qquad (30)$$

Consider equation (29b). It has two solutions. The first occurs when separating variables:

$$\frac{d\hat{t}}{\hat{t}}=\frac{c}{v_0}\frac{dl}{l_0}=\frac{dl}{l_0}=\frac{p}{\hbar}dl$$

Here: $c=v_0=\omega_0 l_0$

Then $k=\frac{1}{l_0}=\frac{\omega_0}{c}=\frac{2\pi}{cT}=\frac{2\pi}{\lambda}=\frac{p}{\hbar}$ - is the wave number (see (7b))

We integrate for the initial conditions of the inverse time vector and the imaginary initial condition $l(0) = il_0$

$$\int_{\hat{t}_1}^{-\hat{t}} \frac{d\hat{t}}{\hat{t}} = \frac{p}{\hbar} \int_{il_0}^{il} dl$$

We obtain a solution in the form:

$$\ln \frac{|-\hat{t}|}{\hat{t}_1} = \frac{p}{\hbar} i(l - l_0)$$

Where

$$-\hat{t} = \hat{t}_1 e^{\frac{p}{\hbar} i(l - l_0)} \qquad (31a)$$

The second solution occurs after separation of variables

$$\frac{\partial l}{l} = -i \frac{E}{\hbar} \partial \hat{\tau}$$

We integrate for the initial conditions $l(0) = l_0$ и $\hat{\tau}(0) = \hat{\tau}_0$

$$\int_{l_0}^{l} \frac{\partial l}{l} = -i \frac{E}{\hbar} \int_{\hat{\tau}_0}^{\hat{\tau}} \partial \hat{\tau}$$

We obtain a solution in the form:

$$\ln \frac{l}{l_0} = -i \frac{E}{\hbar} (\hat{\tau} - \hat{\tau}_0)$$

Where

$$l = l_0 e^{-i \frac{E}{\hbar} (\hat{\tau} - \hat{\tau}_0)} \qquad (31b)$$

We combine both solutions by taking their product:

$$(-\hat{t}) l = \hat{t}_1 \cdot l_0 e^{i(\frac{p}{\hbar} l - \frac{E}{\hbar} \hat{\tau}) - \frac{p}{\hbar} i l_0 + \frac{E}{\hbar} i \hat{\tau}_0} = \hat{t}_1 \cdot l_0 e^{i \frac{pl - E\hat{\tau}}{\hbar}}$$

Where $-\frac{p}{\hbar} i l_0 + \frac{E}{\hbar} i \hat{\tau}_0 = 0$ при $E = p \frac{l_0}{\hat{\tau}_0}$

Let's transform it into the form:

$$\frac{(-\hat{t}) l}{\hat{t}_1} = ict = l_0 e^{i \frac{pl - E\hat{\tau}}{\hbar}} \qquad (31c)$$

Here: $-\frac{\hat{t} \cdot l}{\hat{t}_1} = -\frac{\hat{t} \cdot (-ict_1)}{\hat{t}_1} = ict$ where is expressed through the end of the process time at the moment $-i\hat{t}_1$

The resulting function is a wave function that coincides with (9) at.

$$l_0 = c / \Delta\omega = A$$

Thus, the derivation of the Schrödinger equation is complete. It is the fundamental equation of quantum mechanics, describing the behavior of a particle in a potential field. But as quantum physicists themselves admit [4], "the Schrödinger equation does not have a rigorous derivation. It is not deduced, but established, and its correctness is confirmed by agreement with experience of the results obtained with its help"

That's why his conclusion is so important. The underlying dual equation for the reverse flow of time with an imaginary rate should become a basic principle for quantum physics. Knowing what the wave function actually describes, one can draw far-reaching conclusions about the nature of time.

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