Article

Human Consciousness & Bohm's Pilot Wave

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Abstract

One of the fundamental property of human consciousness is human memory. In Bohm's interpretation of quantum mechanics, the pilot wave guides the particles including those in human brain. In this paper, we develope a modified Schrodinger equation (MSE) which contained a consciousness term, solve the MSE and obtain a formula for pilot wave in human neuron.

Keywords: Modified Schrodinger equation, pilot wave, Planck mass, neuron mass.

In this paper, we study Bohm's quantum equation and its relation to consciousness (e.g., memory). We show that the Bohm's equation (modified Schrodinger equation) is the result of the memory of quantum system.

When Planck made the first quantum discovery, he noted an interesting fact [1]. The speed of light, Newton's gravity constant and Planck's constant clearly reflect fundamental properties of the world. From them it is possible to derive the characteristic mass M_P, length L_P and time T_P with approximate values:

$$L_P = 10^{-35}\ \mathrm{m}$$
$$T_P = 10^{-43}\ \mathrm{s}$$
$$M_P = 10^{-5}\ \mathrm{g}$$

Nowadays much of cosmology is concerned with "interface" of gravity and quantum mechanics.

After the *Alpha* moment – the spark in eternity [1] - the space and time were created by "Intelligent Design" [2] at $t = T_P$. The enormous efforts of the physicists, mathematicians and philosophers investigate the *Alpha* moment. Scholars seriously discuss the Alpha moment – by all possible means: theological and physico-mathematical with growing complexity of theories. The most important result of these investigation is the anthropic principle and Intelligent Design theory (ID).

The thermal history of the system (heated gas container, semiconductor or Universe) can be described by the generalized Fourier equation [3]-[5]

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$$q(t) = -\int_{-\infty}^{t} \underbrace{K(t-t')}_{\text{thermal history}} \underbrace{\nabla T(t')dt'}_{\text{diffusion}}. \tag{1}$$

In Eq. (1) $q(t)$ is the density of the energy flux, T is the temperature of the system and $K(t-t')$ is the thermal memory of the system

$$K(t-t') = \frac{K}{\tau}\exp\left[-\frac{(t-t')}{\tau}\right], \tag{2}$$

where K is constant, and τ denotes the relaxation time.

As was shown in [3]-[5]

$$K(t-t') = \begin{cases} K\delta(t-t') & \text{diffusion} \\ K = \text{constant} & \text{wave} \\ \dfrac{K}{\tau}\exp\left[-\dfrac{(t-t')}{\tau}\right] & \text{damped waveor hyperbolic diffusion.} \end{cases}$$

The damped wave or hyperbolic diffusion equation can be written as:

$$\frac{\partial^2 T}{\partial t^2} + \frac{1}{\tau}\frac{\partial T}{\partial t} = \frac{D_T}{\tau}\nabla^2 T. \tag{3}$$

For $\tau \to 0$, Eq. (3) is the Fourier thermal equation

$$\frac{\partial T}{\partial t} = D_T \nabla^2 T \tag{4}$$

and D_T is the thermal diffusion coefficient. The systems with very short relaxation time have very short memory. On the other hand for $\tau \to \infty$ Eq. (3.3) has the form of the thermal wave (undamped) equation, or *ballistic* thermal equation. In the solid state physics the *ballistic* phonons or electrons are those for which $\tau \to \infty$. The experiments with *ballistic* phonons or electrons demonstrate the existence of the *wave motion* on the lattice scale or on the electron gas scale

$$\frac{\partial^2 T}{\partial t^2} = \frac{D_T}{\tau}\nabla^2 T. \tag{5}$$

For the systems with very long memory Eq. (3) is time symmetric equation with no arrow of time, for the Eq. (5) does not change the shape when $t \to -t$.

In Eq. (3) we define:

$$\upsilon = \left(\frac{D_T}{\tau}\right), \tag{6}$$

velocity of thermal wave propagation and

$$\lambda = \upsilon\tau, \tag{7}$$

where λ is the mean free path of the heat carriers. With formula (3.6) equation (3.3) can be written as

$$\frac{1}{\upsilon^2}\frac{\partial^2 T}{\partial t^2} + \frac{1}{\tau\upsilon^2}\frac{\partial T}{\partial t} = \nabla^2 T. \tag{8}$$

From the mathematical point of view equation:

$$\frac{1}{\upsilon^2}\frac{\partial^2 T}{\partial t^2} + \frac{1}{D}\frac{\partial T}{\partial t} = \nabla^2 T$$

is the hyperbolic partial differential equation (PDE). On the other hand Fourier equation

$$\frac{1}{D}\frac{\partial T}{\partial t} = \nabla^2 T \tag{9}$$

and Schrödinger equation

$$i\eta\frac{\partial \Psi}{\partial t} = -\frac{\eta^2}{2m}\nabla^2\Psi \tag{10}$$

are the parabolic equations. Formally with substitutions

$$t \leftrightarrow it,\ \Psi \leftrightarrow T \tag{11}$$

Fourier equation (9) can be written as

$$i\eta\frac{\partial \Psi}{\partial t} = -D\eta\nabla^2\Psi \tag{12}$$

and by comparison with Schrödinger equation one obtains

$$D_T\eta = \frac{\eta^2}{2m} \tag{13}$$

and

$$D_T = \frac{\eta}{2m}. \tag{14}$$

Considering that $D_T = \tau \upsilon^2$ (3.6) we obtain from (3.14)

$$\tau = \frac{\eta}{2m\upsilon_h^2}. \tag{15}$$

Formula (15) describes the relaxation time for quantum thermal processes.

Starting with Schrödinger equation for particle with mass m in potential V:

$$i\eta \frac{\partial \Psi}{\partial t} = -\frac{\eta^2}{2m}\nabla^2\Psi + V\Psi \tag{16}$$

and performing the substitution (11) one obtains

$$\eta \frac{\partial T}{\partial t} = \frac{\eta^2}{2m}\nabla^2 T - VT \tag{17}$$

$$\frac{\partial T}{\partial t} = \frac{\eta}{2m}\nabla^2 T - \frac{V}{\eta}T. \tag{18}$$

Equation (18) is Fourier equation (parabolic PDE) for $\tau = 0$. For $\tau \neq 0$ we obtain

$$\tau \frac{\partial^2 T}{\partial t^2} + \frac{\partial T}{\partial t} + \frac{V}{\eta}T = \frac{\eta}{2m}\nabla^2 T, \tag{19}$$

$$\tau = \frac{\eta}{2m\upsilon^2} \tag{20}$$

or

$$\frac{1}{\upsilon^2}\frac{\partial^2 T}{\partial t^2} + \frac{2m}{\eta}\frac{\partial T}{\partial t} + \frac{2Vm}{\eta^2}T = \nabla^2 T.$$

With the substitution (3.11) equation (3.19) can be written as

$$i\eta \frac{\partial \Psi}{\partial t} = V\Psi - \frac{\eta^2}{2m}\nabla^2\Psi - \tau\eta \frac{\partial^2 \Psi}{\partial t^2}. \tag{21}$$

The new term, relaxation term

$$\tau\eta\frac{\partial^2\Psi}{\partial t^2} \tag{22}$$

describes the interaction of the particle with mass *m* with space-time. The relaxation time τ can be calculated as:

$$\tau^{-1} = \left(\tau_{e-p}^{-1} + \ldots + \tau_{Planck}^{-1}\right), \tag{23}$$

where, for example τ_{e-p} denotes the scattering of the particle m on the electron-positron pair ($\tau_{e-p} \sim 10^{-17}$s) and the shortest relaxation time τ_{Planck} is the Planck time ($\tau_{Planck} \sim 10^{-43}$s).

From equation (23) we conclude that $\tau \approx \tau_{Planck}$ and equation (21) can be written as

$$i\eta\frac{\partial\Psi}{\partial t} = V\Psi - \frac{\eta^2}{2m}\nabla^2\Psi - \tau_{Planck}\eta\frac{\partial^2\Psi}{\partial t^2}, \tag{24}$$

where

$$\tau_{Planck} = \frac{1}{2}\left(\frac{\eta G}{c^5}\right)^{\frac{1}{2}} = \frac{\eta}{2M_p c^2}. \tag{25}$$

In formula (25) M_p is the mass Planck. Considering Eq. (25), Eq. (24) can be written as

$$i\mathrm{h}\frac{\partial\Psi}{\partial t} = -\frac{\mathrm{h}^2}{2m}\nabla^2\Psi + V\Psi - \frac{\mathrm{h}^2}{2M_p}\nabla^2\Psi + \frac{\mathrm{h}^2}{2M_p}(\nabla^2\Psi - \frac{1}{c^2}\frac{\partial^2\Psi}{\partial t^2}). \tag{26}$$

The last two terms in Eq. (26) can be defined as the *Bohmian* pilot wave

$$\frac{\eta^2}{2M_p}\nabla^2\Psi - \frac{\eta^2}{2M_p c^2}\frac{\partial^2\Psi}{\partial t^2} = 0, \tag{27}$$

i.e.

$$\nabla^2\Psi - \frac{1}{c^2}\frac{\partial^2\Psi}{\partial t^2} = 0. \tag{28}$$

Equations (27) and (28) constitute Bohm-type quantum equation, Modified Schrodinger Equation (MSE). It is interesting to observe that pilot wave Ψ does not depend on the mass of the particle.
With postulate (28) we obtain from equation (26)

$$i\eta\frac{\partial\Psi}{\partial t}=-\frac{\eta^2}{2m}\nabla^2\Psi+V\Psi-\frac{\eta^2}{2M_p}\nabla^2\Psi \tag{29}$$

and simultaneously

$$\frac{\eta^2}{2M_p}\nabla^2\Psi-\frac{\eta^2}{2M_pc^2}\frac{\partial^2\Psi}{\partial t^2}=0. \tag{30}$$

In the operator form Eq. (21) can be written as

$$\hat{E}=\frac{\hat{p}^2}{2m}+\frac{1}{2M_pc^2}\hat{E}^2, \tag{31}$$

where $\hat{E}$ and $\hat{p}$ denote the operators for energy and momentum of the particle with mass m. Equation (31) is the new dispersion relation for quantum particle with mass m. From Eq. (21) one can concludes that Schrödinger quantum mechanics is valid for particles with mass $m \ll M_P$. But pilot wave exists independent of the mass of the particles.

For particles with mass $m \ll M_P$ Eq. (29) has the form

$$i\eta\frac{\partial\Psi}{\partial t}=-\frac{\eta^2}{2m}\nabla^2\Psi+V\Psi. \tag{32}$$

In the case when $m \approx M_p$ Eq. (29) can be written as

$$i\eta\frac{\partial\Psi}{\partial t}=-\frac{\eta^2}{2M_p}\nabla^2\Psi+V\Psi, \tag{33}$$

but considering Eq. (30) one obtains

$$i\eta\frac{\partial\Psi}{\partial t}=-\frac{\eta^2}{2M_pc^2}\frac{\partial^2\Psi}{\partial t^2}+V\Psi \tag{34}$$

or

$$\frac{\eta^2}{2M_pc^2}\frac{\partial^2\Psi}{\partial t^2}+i\eta\frac{\partial\Psi}{\partial t}-V\Psi=0. \tag{35}$$

We look for the solution of Eq. (35) in the form

$$\Psi(x,t)=e^{i\omega t}u(x). \tag{36}$$

After substitution formula (36) to Eq. (35) we obtain

$$\frac{\eta^2}{2M_p c^2}\omega^2 + \omega\eta + V(x) = 0 \tag{37}$$

with the solution

$$\begin{aligned} \omega_1 &= \frac{-M_p c^2 + M_p c^2 \sqrt{1 - \frac{2V}{M_p c^2}}}{\eta} \\ \omega_2 &= \frac{-M_p c^2 - M_p c^2 \sqrt{1 - \frac{2V}{M_p c^2}}}{\eta} \end{aligned} \tag{38}$$

for $\frac{M_p c^2}{2} > V$ and

Considering that M_p equals the mass of human neuron (10^{-5}g)

$$\begin{aligned} \omega_1 &= \frac{-M_p c^2 + iM_p c^2 \sqrt{\frac{2V}{M_p c^2} - 1}}{\eta} \\ \omega_2 &= \frac{-M_p c^2 - iM_p c^2 \sqrt{\frac{2V}{M_p c^2} - 1}}{\eta} \end{aligned} \tag{39}$$

for $\frac{M_p c^2}{2} < V$.

Both formulae (38) and (39) describe the string oscillation, formula (27) damped oscillation and formula (28) over damped string oscillation. Considering that M_p equals the mass of human neuron (10^{-5}g) both equation describe the human neuron oscillations – emission of brain waves.

References

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