A classic interpretation of the wave function and of the quantum potential

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Abstract: In the paper, by the known Bohm's equations and by the interpretation of the squared amplitude of the wave function, R(Ψ) as the probability to find a volumic particle in a point different from its center, is deduced a value of the Bohm's quantum potential equal with the m-particle's kinetic energy $\frac{1}{2}mv^2$, which- for a classic electron composed by 'naked' photons rotated by the relativist etherono-quantonic vortex $\Gamma_r = 2\pi rv$ or/and the vortex Γ_μ of its magnetic moment, given by etherono-quantonic winds, is explained by the de Broglie's relation of quantum equilibrium between the particle's action and its associated entropy as being a centrifugal potential Q_{cf} of spinorial rotation explained by an attractive total potential $Q_a = - Q_{cf}$ given by the sum of the potentials of vortex -field which maintain all the naked photons of the electron rotated with the v-speed ($v \le c$) around the electron's superdense centroid.

The interpretation explains also the intrinsic energy: $E = mc^2$ of the electron, of the photon and of other particles.

Keywords: Bohm equation; quantum potential; electron' energy; vector photon; self-potential

1. Introduction

It is known that in the base of the wave –particle dualism, inserting ψ in polar form into the Schrodinger' equation, written –for simplicity, for a single particle:

$$i\hbar\frac{\partial\Psi}{\partial t} = -\frac{\hbar^2}{2m}\nabla^2\Psi + V\Psi \;; \qquad (1)$$

(V -classical potential), writing $\psi = R\cdot e^{iS/\hbar}$, where R and S are real-valued functions of space and time and separating the real and imaginary terms, D. Bohm obtained two equations [1]:

$$\frac{\partial S}{\partial t} + \frac{(\nabla S)^2}{2m} + V - \frac{\hbar^2}{2m}\frac{\nabla^2 R}{R} = 0 \;; \qquad -\frac{\hbar^2}{2m}\frac{\nabla^2 R}{R} = \mathrm{Q} \quad . \qquad (2)$$

$$\frac{\partial R^2}{\partial t} + \nabla\cdot\left(R^2\frac{\nabla S}{m}\right) = 0 \qquad (3)$$

the eqn. (2) representing the quantum Hamilton-Jacobi equation because in the classical limit, is deduced that the width of the wave packet is much greater than the wave length and the term $\mathrm{Q} = -\hbar^2\nabla R^2/2mR$ is much smaller than the term $(\nabla S)^2/2m$ and neglecting this small term the eqn. (2) is reduced to:

$$\partial S_c/\partial t + (\nabla S_c)^2/2m + V = 0 \qquad (4)$$

where S_c refers to the classical generating function S which occurs in the classical Hamilton-Jacobi equation for a single particle moving with momentum $\mathbf{p} = \nabla S_c$.

Because (3) is the continuity equation, Bohm interpreted the value $\rho = \psi^*\psi$ as a probability distribution of particles following trajectories given by $\mathbf{p} = \nabla S$, interpretation which represents the connection with the formalism of the classical mechanics for particles moving along continuous trajectories. It is considered that the potential Q generates an additional quantum force $F = -\nabla Q$, of particle's interaction with a sub-quantum fluid of the quantum vacuum .

According to the de Broglie-Bohm' causal interpretation of quantum mechanics, $R^2(\mathbf{x},t)d\mathbf{x}$ represents the probability that a particle lies between $\mathbf{x}$ and $\mathbf{x} + d\mathbf{x}$, the path of the particle being deterministic [2]. It was shown also that the uncertainty principle is not strictly necessary for this interpretation because it refers to what we can measure, not to what exists .

One possible interpretation of the quantum potential was given considering the quantum vortex model for the kinetic structure of the electron, (P. Constantinescu, [2, p.137]), with a relativist speed of the quantum fluid, with exponential decreasing, ($\sim r^{-3}$) and using the relations specific to quantum equilibrium, obtained by de Broglie [3]: $\varepsilon/k_b = S_0/\hbar$ (ε -the associated entropy; S_0 –the physical action; k_b –the Boltzmann's constant; the rationalized Planck constant) and: $\varepsilon = - k_b \ln R^2$, (i.e. $R = e^{-\varepsilon/2k}$), resulted by the Boltzmann's relation ($\varepsilon = k_b.\ln W$) .

In concordance with a classical vortexial model of electron, obtained by a Cold genesis theory (CGT, [4-6]) of the author, based on the Galilean relativity [7], the electron is composed of a superdense kernel ('centroid') with a possible spiral form and a quantum volume of pseudoscalar and vector photons with inertial mass m_w which gives the electron's inertial mass and which are considered in a revised Munera' model of pseudo-scalar photon, i.e. formed by two vector photons vortexially generated and with antiparallel spins. According to CGT's model [4-6] and in concordance with a previous vortex model [8], these vector photons are composed of 'quantons' of mass $m_h = h/c^2 = 7.37\text{x}10^{-51}$ kg and are rotated around the electron's kernel with the light speed c by an etherono-quantonic vortex of circulation $\Gamma_\mu = 2\pi rc$ of the electron's magnetic moment, composed by an etheronic part Γ_A , formed by 'heavy' etherons ('sinergons'- in CGT, with mass $m_s \approx 10^{-60}$ kg) which gives the physical nature of the magnetic potential A and a 'quantonic' part Γ_c formed by quantons which generates quantonic vortex-tubes $\boldsymbol{\xi}_\mathbf{B}$ corresponding to the magnetic B-field's lines.

The E-field is generated- according to the model, by a quasi-spherically distributed flux ϕ_E of light vector photons ('vectons' –in CGT) escaped from the internal photonic vortex of the electron's e-charge, induced by the etherono-quantonic vortex Γ_μ which is maintained by the quantum vacuum's negentropy, given to the electron by etherono-quantonic winds considered in the model as having a mean speed c. In this way the resulted model of CGT is concordant with the 'hidden thermodynamics' of the particle [3] and with the oppinions of Vigier [9].

It was considered by some authors [2] that the quantum potential Q can explain also the stability of a fermionic particle like the electron.

In the paper we re-analyze this possibility with a relative new interpretation of the quantum potential Q.

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2. A reinterpretation of the Bohm's quantum potential

2.1. A classic interpretation of the presence probability for a volumic particle

Starting from the Bohm's interpretation of the density $\rho = \psi^*\psi$, as a probability distribution of particles following trajectories given by $\mathbf{p} = \nabla S$ and considering classic models of photon and of electrons, with sub-structure of 'quantons' of mass $m_h = h/c^2$ in the case of a photon and of heavy photons ('vexons'- in CGT {xx])- in the case of an electron, if the center of the particle is in the point x and the particle's density is maximal in its center, decreasing with r, we can re-interpret classically, deterministic, the probability of the presence of a structured particle in a point x' = x + δx as:

$$R^2 = \rho(\delta x)/\rho^0 = \rho(r)/\rho^0(0). \qquad (6)$$

According to this interpretation, a particle with its mass contained in a volume $\vartheta_p(r_p)$ of decreasing density $\rho(r)$ is present in a point x' = x + δx , ($\delta x \le r_p$) in the proportion (with the probability): $\rho(\delta x)/\rho^0(0)$. If the classically calculated trajectory of the particle pass through the point x, we can consider classically that the particle will pass also through the point x' but with the probability $R^2 = \rho(\delta x)/\rho^0 = \rho(r)/\rho^0(0)$.

This interpretation is based on the fact that –according to a classical point of view, the certitude of the m-particle's positioning in the x-point of space exists (with 100% probability) when its center of mass is positioned in the x-point, the null probability being in the case in which the x-point is in the outside of the m-particle's volume, (where can exists photonic quanta of its E-field but weakly linked to its inertial m-mass, i.e. which do not contribute to its inertial mass).

Also, the given interpretation is compatible with the probabilistic character of the Boltzmann' statistic, for example, that gives the relative probability that a subsystem of a physical system has a certain energy, a certain state *i* , probability that is equal to the number of particles in state *i* divided by the total number of particles in the system, that is the fraction of particles that occupy state *i*: $P_i = N_i/N$, and it not exclude the Bohm-de Broglie's interpretation.

For example, if $\rho_0 = m_0 N_0$ is the density of air molecules at the Earth's surface, in a point $h_0 = x_0$, because the concentration of air molecules at the level: h' = ($x_0 + \delta x$) is: $N_i(h') = N_0 \cdot e^{-mgh'/kT}$, the probability to find the mass of air contained in the volume $\vartheta(h_0) = (2\delta x)^3$ with the mass center in h_0 also in the position h' is :

$P' = N_i(h')/N_0 = \rho_i(h')/\rho_0 = e^{-mgh'/kT}$, i.e. – equal with the relative probability to find the air molecules in the energetic state E(h') = mgh', according to the previous interpretation.

The continuity equation (3) results in this case rewritten in the form:

$$\frac{\partial \rho(r)}{\partial t} + \nabla \cdot \left(\rho(r) \cdot \mathrm{v_p}\right) = 0 \qquad (7)$$

in which, because for a non-rotated particle we can consider that all its parts have the particle's speed, $v_p = \nabla S/m$, the product $\rho(r)v$ represent the impulse density p(r) of the sub-particles which compose the m-particle (photons- for example, of m_f –mass).

Also, if the m-particle has an e-charge which emits a flux of quanta $\phi_E = \rho_c c^2$ of an homogenous E-field, the intensity $E_\perp$ of this field orthogonal to the m-particle's impulse p_m = mv, which is obtained in CGT according to the relation: $E = k_1 \rho_c c^2$,in vacuum, ($p_E = \rho_c c$ being the impulse of the vector photons which gives the E-field), then this quanta have also an impulse density: $P_H = \rho_c v_p$, (parallel with the m-particle's impulse), which- according to CGT , generates a H-field with the induction given by: $B = k_1 \rho_c v_p = (1/c^2)E \cdot v_p$ (in accordance with the known basic relations of the electromagnetism), k_1 being a proportionality constant whose value is given by the equality between the electrostatic energy and the kinetic energy of E-field's quanta at the electron's surface: $k_1 = 4\pi a^2/e = 1.56 \times 10^{-10}$ [m^2/C], (a – 1.41 fm- classic electron' radius corresponding to the e- charge in the electron's surface).

The continuity equation (7) can be used also in this case, with $\rho(r) = \rho_c(r)$, resulting the known basic relation of the electromagnetism:

$$\frac{1}{c^2}\frac{k_1\partial\rho_c(r)c^2}{\partial t}+\nabla\cdot\left(k_1\rho_c(r)\cdot \mathrm{v_p}\right)=0; \quad \Rightarrow \quad \frac{1}{c^2}\frac{\partial E}{\partial t}=-\nabla\cdot B \tag{8}$$

$v_p = v_v$ being in this case the speed of the vector photons of the E-field in report with the quantons of the quantum vacuum, in which they induce quantonic vortex-tubes which 'materializes' the magnetic field's lines of the B-field.

This conclusion is in concordance with the explanation given to the known Faraday paradox which indicated that the B-field 'lines' are formed from the energy of the quantum vacuum [4,5]. In the case of a stationary m-particle with e-charge and μ_p magnetic moment given –according to CGT, by a quantonic vortex, of circulation:

$$\Gamma_\mu = 2\pi r\cdot v_h; \quad \text{with: } v_h = c \quad \text{if} \quad r \le r_\mu = \hbar/mc \ \text{ and } \ v_h = c\cdot(r_\mu/r) \text{ for } r > r_\mu \tag{9}$$

and by a density $\rho_h(r)$, the induced B-field have the value: $B = k_1\rho_h v_v$, ($v_v = -v_h$). Because v_h is in the same time the quantons' speed related to the vector photons ('vectons') of the E-field, the equations (7), (8) can be applied also in this case, with $\rho(r) = \rho_h(r)$ and $v = v_v = -v_h$.

2.2. <u>A re-interpretation of the quantum potential' nature for a classic model of particle</u>

-Regarding the equation (5) , if we take V = 0, we have:

$$\partial S/\partial t = -(\nabla S)^2/2m - Q. \tag{10}$$

If in the Schrodinger equation we take: $\Psi(x,t) = \Psi_0(x)\cdot e^{-E\cdot t/\hbar}$ with Ψ_0 –solution with eigenvalue E_0, S will be in the form: $S(x,t) = S_0(x) - E_0\cdot t$, and it results that:

$$E_0 = (\nabla S_0)^2/2m + Q = p^2/2m + Q; \qquad (S_0 = mv\cdot x) \tag{11}$$

The energy E_0 in this case will not contain the rest energy mc^2 because- by the de Broglie's relation specific to quantum equilibrium: $\varepsilon/k_b = S_0/\hbar$ [3], and with $R = e^{-\varepsilon/2k}$, (ε -the entropy associated to the m-particle) both terms of the right part are speed-depending and null for p = 0. So, as in the photon's case, we must take for E_0 an expression characteristic to the wave-particle properties.

Considering also the de Broglie relation: $E = \hbar\cdot\omega$, with : $\omega = 2\pi/T = 2\pi v/\lambda$, (i.e. taking $\lambda = v\cdot T$, v being in this case the group speed of the associated wave, identical with the m-particle's speed), because $\lambda = h/m.v$, for $E = E_0$ we have: $E_0 = m\cdot v^2 = p^2/m$, resulting –in this case, that $Q = p^2/2m$, i.e. equal with the kinetic energy of the particle, E_k .

For the interpretation of this result in the base of a Galilean relativity, we will consider the existence of the zero-point energy of the quantum vacuum in the form of a 4rownian etherono-quantonic energy.

If the m- particle is a fermionic lepton, i.e. a vector photon or an electron which has a spiral-like super-dense kernel, ('centroid' with spiral form –in CGT, analog to a short 'string' [4, 5]), its displacing through this medium with the symmetry axis of its centroid rectangular to its impulse will generate a relativist etherono-quantonic vortex, according to the fluids mechanics laws considered also for this etherono-quantonic medium, of circulation:

$\Gamma_r = 2\pi r\cdot v_h$ for $r \le r_\lambda = \hbar/mv$, (by similitude with the electron's magnetic moment generating).

This etherono-quantonic vortex can explain the quantum potential Q of leptons by the conclusion that it induces the rotation with the same v- speed of the particle's components considered as being 'quantons' with mass $m_h = h/c^2$ or 'vectons' (light photons which mediates the electrostatic interaction- in CGT)- in the case of a vector photon [4, 5] and by 'naked' photons m_f – in the case of the electron, ($m_e \approx \Sigma m_f$ – neglecting the centroid's mass), which will obtain a total centrifugal potential:

$$E_C = ½\Sigma m_f \cdot v^2 = ½\, m_e \cdot v^2 = |Q| \qquad (12)$$

The considered components of the leptonic m-particle are maintained to a quasi-stable circular orbital around the particle's centroid because the centrifugal potential $E_c = ½ m_f \cdot v^2$ of the particle's component is equilibrated by an attractive potential which is the real quantum potential Q and which is given- according to the considered model (specific to CGT [4, 5]), by the vortex potential V_Γ induced by the etherono-quantonic medium which in CGT explains the particle's stability.

In the Bohm-Vigier theory, is defined the 'quantum impulse', given by the physical impulse and the gradient of the entropy ε(x) associated to the kinetic particle, considered according to the equation:

$$p^* = \nabla\left(S_0 + i\frac{\hbar}{k_b}\varepsilon\right) \quad ; \quad \varepsilon(x) = -k_b \ln \rho_p = -k_b \ln \rho_p; \quad \rho_p = R^2 = |\Psi|^2 \qquad (13)$$

in which: k_b is the Boltzmann constant and ρ_p – the equivalent of the thermodynamic probability of the Boltzmann's relation ($\varepsilon = k_b \ln W$) , resulting that: $R = e^{-\varepsilon/2k}$.

It was argued [3] that at quantum equilibrium, when $\rho_p = R^2$, the entropy ε(x) is proportional with the particle's action according to the relation: $\varepsilon/k_b = S_0/\hbar$ found by de Broglie by the condition $p^* = 0$, but generalized by P. Constantinescu [2] in the form: $\varepsilon/k_b = \gamma\cdot(S_0/\hbar)$, (γ- arbitrary proportionality constant), in accordance with the Rosen's equation for the impulse of the informational field of the associated wave, π^* [10]:

$$\frac{\varepsilon(x)}{k_b} = \gamma\frac{S_0(x)}{\hbar}; \qquad \pi^* = \hbar\frac{\nabla R}{R} = -\frac{\hbar}{k_b}\nabla\varepsilon = -\gamma\cdot p; \quad (p = mv) \qquad (14)$$

(the particle's entropy being associated with its undulatory property).

For the obtained case: $|Q| = E_C = ½\, m_e \cdot v^2$, using this generalized relation in the expression of the quantum potential Q, we obtain:

$$Q = -\frac{\hbar^2}{2m}\frac{\nabla^2 R}{R} = E_C\ ; \quad R^2 = e^{-\frac{\varepsilon(x)}{k_b}}\ ; \quad \frac{\varepsilon(x)}{k_b} = \gamma\frac{S_0(x)}{\hbar}; \quad \Rightarrow \quad Q = -\frac{\hbar^2}{2m}\frac{(ip\cdot\gamma/2)^2}{\hbar^2} = \frac{p^2}{2m}\frac{\gamma^2}{4} \qquad (15)$$

resulting – for $Q = E_C$, that: $\gamma = 2$ in this case, (of constant value). This indicates that –if we ignore the existence of the etherono-quantonic winds, the quantum potential depends on the m-particle's impulse, in accordance with our explanation of its generating. The double value in report with the case $\varepsilon/k_b = S_0/\hbar$ found by de Broglie, indicates that in the equation (13) we must take: $S'(x) = 2S_0(x)$ instead of $S_0(x)$, which gives an impulse $p' = \nabla S' = 2p$ – value which corresponds to a kinetic energy $E_C' = p'^2/2m = 2E_C$ – i.e.- the total kinetic energy of the m-particle (translational and rotational).

The equation (13) must be re-written in this case, in the form:

$$p^* = \nabla\left((S_0 + S_\omega) + i\frac{\hbar}{k_b}\varepsilon\right) \quad ; \quad \varepsilon(x) = -k_b \ln \rho_p; \quad \rho_p = R^2 = |\Psi|^2 \tag{16}$$

in which S_ω represents the total rotational action associated to the m-particle, which gives its rotational impulse $p_\omega = \nabla S_\omega$,which corresponds to its spinorial rotation and which increases the impulse $\pi^* = \nabla\varepsilon$ of the informational field (and the informational flux).

The quantum potential Q results in this case as centrifugal potential of the particle's rotation, Q_{cf} which –logically, can appears only if it is equilibrated by an equal attractive potential, Q_a , of vortexial nature.

The previous explanation is concordant with the result of some authors [11] which obtained a potential of Bohm type resulted as enthalpy (thermodynamic potential for adiabatic systems at constant pressure) of turbulences in the quantum vacuum generated as particle-like eddies of m-mass and a mean size $l = \hbar/mc$.

Also, the resulted explanation is concordant with the interpretation given by Giovanni S., Erasmo R. and co-workers (1998, [12, 13]) to the Bohm's quantum potential [1]: $Q = (\hbar^2/2m)(\Delta\sqrt{\rho}/\sqrt{\rho})$ identified with the kinetic energy of the internal motion ("zitterbewegung") associated with the spin S of a spin-½ particle,

$$(\rho = R^2 = \Psi\Psi^*; \; \Psi = R\cdot e^{-iS/\hbar}; \; S = m_\mu c\cdot x; \; x \perp r),$$

in accordance with the Schrodinger's equation, written in the form:

$$-\frac{2s^2}{m}\Delta\Psi = E\Psi; \qquad \Psi = R\cdot e^{-S/\hbar}; \qquad s = \frac{\hbar}{2} \tag{17}$$

For the particular case: v = c, i.e. for a 'vecton' or a 'vexon'with mass m_w of a pseudoscalar photon with mass $m_f = 2m_w$, it results that:

$$m_f v_f^2 = 2m_w v_f^2 = 2(p_w^2/2m_w + Q_w(v_f)) = h\nu; \quad (p_w = m_w v_f\,;\, v_f \le c) \Rightarrow \; p_w^2/2m_w = Q_w(v_f) \tag{18}$$

When $v_f = c$, $\Rightarrow m_f v_f^2 = m_f c^2 = h\nu$ and when $v_f = 0$, $\Rightarrow m_f v_f^2 = 0$, this result being in concordance with the conclusions of Quantum mechanics and apparently sustains the QM's conclusion of null rest mass for photons.

The CGT's generalization for the case of the vector photons [4-6] is in accordance with the Esposito's generalization of the Giovanni's interpretation of the Bohm's potential from matter particles to gauge particles, particularly- to photons, [14].

If m_0 is the rest-mass and m_v is the relativist mass of the vector photon ('vecton' or 'vexon' –in CGT [4, 5]) of a pseudo-scalar photon considered in a 6rownian relativity and in accordance to a revised Munera' photon model [6], the equations (11) and (13) show that the photon's energy: $E_v = h\nu = m_v c^2$ is explained by two terms: its kinetic energy, $E_k = ½\cdot m_v\cdot c^2$ and a vortex energy- equal with its quantum potential: $E_\omega = Q_v$.

Because for a photon with c-speed the generated E- and B- fields are in the relation: $E = c\cdot B$, which gives equal energy densities: $\in_{(r)} = ½\cdot\varepsilon_0 E^2 = ½\cdot\mu_0 H^2$, it results that the kinetic energy of the vector photon determines the induced E-field and the vortex energy $E_\omega = Q_v$ generates its magnetic moment and the induced magnetic B-field [4, 5].

The similitude with the electron's case is given in the next way: by the fact that –similarly to the Munera's model of pseudo-scalar photon, formed by two vector photons coupled magnetically, the hard gamma-quantum, of 1 MeV, which in the nuclear splits into a pair negatron-positron can be considered as formed by a pair of degenerate electrons (with opposed and diminished charges) magnetically coupled [6].

3. The vortexial nature of the quantum potential

3.1. The vortexial nature of the vector photon

Of relativistic point of view, the previous considered case is equivalent with the case of a stationary m_0- particle with the considered form, 'washed' by etherono-quantonic winds having the mean speed $\overline{v}_c = c$ and with approximately the same density as the previously considered 7rownian etherono-quantonic medium, and this case can explain the electron's magnetic moment as etherono-quantonic vortex which induces vortex-tubes by the gradient of the impulse density of the vortexed quantons and which- in CGT, explains also the electron's mass as being given by a number of 'naked' photons (virtually reduced to their inertial, rest mass m_0^f) attracted and retained in the vortexial field of the electron's magnetic moment μ_e and whose value results as saturation value $n_f = m_e/ m_0^f$ given by the equality between the magnetic (vortexial) energy of the volume of Compton radius, $r_\mu = \hbar/m_e c$, and the rest energy $E_e = m_e c^2$:

$$m_e c^2 = \int_v(½\cdot\mu_0 H^2)dV = e^2/8\pi\varepsilon_0 a, \quad \text{with } a = 1.41\text{fm}, \quad \text{(e-charge in surface)} \qquad (19)$$

According to CGT, the rest energy $E_e = m_e c^2$ is given by the kinetic energy of the 'naked' photons m_0^f which compose the electron's mass m_e and the kinetic energy of a spinorial mass $m_s \approx m_e$ of photons vortexed around its inertial mass m_e by the etherono-quantonic vortex Γ_μ of the electron's magnetic moment in the volume of Compton radius r_μ , photons which- because they are relative weakly linked to the inertial mass m_0 (being maintained around it only by the attractive force type generated by the vortexial field V_Γ) , they do not contribute to the electron's inertial mass.

However, because the realistic situation, evidenced also by the conclusion that the 'dark energy' has a field-like nature, according also to some astrophysical observations [15] and in accordance with the de Broglie's "hidden" thermodynamics of particle [3], is those which indicates the existence of both forms of etherono-quantonic energy:7brownian (pseudo-stationary) and in form of etherono-quantonic winds the mean speed $\overline{v}_c = c$, so the vortex energy $E_\omega = Q_v = ½\cdot m_v c^2$ of the vector photon (vecton, vexon) is given by both considered mechanisms, suggesting the equality between the density of the Brownian etherono-quantonic energy and the mean energy of the etherono-quantonic winds, i.e.:

$$\rho_b^0 \approx \rho_v^0.$$

In this case, because in the case of a vector photon, similarly to the electron's case, the energy of the etherono-quantonic vortex Γ_c is the cause of its total inertial mass, $m_v = E_v/c^2$ it results – in the case of the vector photon m_v ('vexon' or 'vecton') of a pseudo-scalar photon m_f , that its rest mass $m_v^0 = m_v(0)$ must be – classically (in a Galilean relativity), half of its relativist mass $m_v(r) = 2\, m_v^0$, so the relativist quantum potential Q_r^v results- for $\rho_b^0 \approx \rho_v^0$, equal with the vortexial potential V_w^0 of the vecton's rest mass m_v^0, the total centrifugal potential which explains the vector photon's energy $m_v c^2$ resulting of value:

$$Q_v(r) = E_\omega = ½\cdot m_v c^2 = 2Q_v^0 , \qquad (Q_v^0 = Q_v(0)) \qquad (20)$$

It is deduced from the eqns. (11), (13), (18), that:

$$Q_v^0 = (^1/_4)\cdot m_v c^2 = ½\cdot m_v^0 c^2 \qquad (21)$$

Considering the ‚vecton' as being a cylindrical vortex of quantons with mass m_h , radius r_c and a small etheronic vortex of high $l_c = 2r_c$ induced around it with the circulation $\Gamma_c(r_c) = 2\pi r_c c$ by the etheronic medium with a density ρ_s , the dynamic equilibrium for the vortexed quantons or/and clusters of quantons inside the Compton radius: $r_\lambda = \lambda_0/2\pi$ of a vector photon (‚vecton' or ‚vexon') is given by a magneto-gravitic force of Magnus type generated by the etheronic vortex $\mathbf{\Gamma}_A$ (‚sinergonic' –in CGT, generating a magnetic potential A [4, 5]) over the quantons rotated with the speed $v = v_f = c$ to the vortex line $l_r = 2\pi r$ inside a pseudo-stationary (brownian) etheronic medium increased around the vecton's centroid with radius r_w and having a linear variation of its density: $\rho_s(r) \sim r^{-1}$ [6], i.e. :

$$F_{sl} = 2r_c\cdot\Gamma_c(r_c)\cdot\rho_s(r)\cdot c = 4\pi r_c^2 \cdot c^2\cdot\rho_s^0\cdot(r_w/r) = m_h c^2/r\,; \quad r \le r_\lambda\,; \quad (\rho_s(r) = \rho_s^0\cdot(r_w/r)); \qquad (22)$$

by the resulted condition: $4\pi r_c^2 \cdot\rho_s^0\cdot r_w = m_h = h/c^2$, with: m_h –the quanton' mass; r_c –the quanton's radius; ρ_s^0- the density of sinergons at the surface of the vecton's centroid, of radius r_w ; $\Gamma_c(r_c)$- the circulation of sinergons at the quanton's surface. It results that: $\rho_s^0\cdot r_w = \rho_s(r)\cdot r = K$ (i.e. constant for all vectons), resulting that $\rho_s(r)$ *is* quasi-equal with the mean density $\overline{\rho_s}$ of the brownian subquantum medium at the limit: $r = r_\lambda = \lambda_0/2\pi = \hbar/m_v c$, ($m_v$ – the vecton's mass).
Similarly may be explained the stability of the heavy vector photon (‚vexon') formed by ‚vectons' vortexed with the mean speed considered equal with the light's speed, c, (CGT [5, 6]).
This possibility suggests that also in the electron's case must exists a similar attractive force acting over the electron's ‚naked' photons, which can explain the centrifugal quantum potential $Q = Q_{cf}$ as attractive quantum potential Q_a .

3.2. The vortexial field of the classic electron

We will consider the case of a classic (Lorentzian) electron considered as confined electromagnetic energy, i.e. –as confined photons, which- in a Galilean relativity, have rest mass m_f^0 of its inertial part ('naked' photon [5, 7]), the sum of their inertial mass giving approximately the electron's inertial mass, i.e.: $m_e = \Sigma\, m_f^0$.

For a stationary particle like the electron, for example, which has an etherono-quantonic vortex $\Gamma_\mu = 2\pi r\cdot c$ of its magnetic moment- according to CGT [4, 5], this Γ_μ -vortex will induce the rotation of the naked photons with almost the same speed c ,

In CGT is deduced as logical a classical radius $r_e = a = 1.41$ fm for the electron's volume , corresponding to the e-charge contained in its surface, and the same density variation for the Γ_μ -vortex as those of the electron's mass m_e, corresponding to an exponential variation of the density of m_f^0 –photons : $\rho_\mu(r) = \rho_e(r) = \rho_e^0\cdot e^{-r/\eta}$. By the value of the electron mass and the condition of equality between the electron's density and the E-field quanta' density at the electron's surface: $\rho_e(a) = \rho_E(a) = \mu_0/k_1^2$, it results that: $\rho_e^0 = 22.24\times10^{13}$ kg/m^3 and $\eta_e = 0.965$ fm.

To the m_f^0 –photon's rotation around the electron's centroid with an angle $\delta\theta$ we can associate a wave-function:

$$\Psi = R\cdot e^{-iS'/\hbar}\,, \quad \text{with } S' = m_f^0 c\cdot x\ , \ dS' = m_f^0 c\cdot dx = m_h c\cdot(r\cdot d\theta),\ (x \perp r) \qquad (23)$$

Because the m_f^0 is formed by a number of n_h quantons with the mass $m_h = h/c^2$, we can use the equation of quantum equilibrium for quanton, in accordance with the relation (23): $\varepsilon_h/k_b = \gamma\cdot S_h/\hbar$, ($\varepsilon_h(r)$ being the entropy per quanton found at the distance r from the electron's center).

By eqn. (23) , the action S_{vl} of an m_f^0–photon on a vortex line $l = 2\pi r$ is:

$$S_h(r) = \oint m_h c\cdot dx = 2\pi r\cdot m_h c; \qquad r\cdot d\theta = dx \perp r \tag{24}$$

Using the equations (6), (13), (14) and (24), it results that:

$$\varepsilon_h(r) = -k_b \ln R^2 = -k_b \ln\left(\frac{\rho_e(r)}{\rho_e^0}\right) = \gamma^1\cdot(k_b/\hbar)S_h(r)\ ; \qquad (R^2 = |\Psi|^2\ ;\ \Psi = R\cdot e^{-i\frac{S_h}{\hbar}}) \tag{25}$$

It results that:

$$\rho_e(r) = \rho_e^0\cdot e^{-\gamma^1\frac{S_h}{\hbar}} = \rho_e^0\cdot e^{-\gamma^1\frac{2\pi\cdot m_h c}{\hbar}r} = \rho_e^0\cdot e^{-\frac{r}{\eta}}\ ; \qquad \Rightarrow \qquad \eta_e = \frac{\hbar}{\gamma^1\cdot 2\pi m_h c} \tag{26}$$

resulting that: $\gamma^1 = c/4\pi^2\eta_e$, (constant –also in this case, but dependent of η_e).

The fact that the entropy per quanton $\varepsilon_h(r)$ is null in the particle's center (where the Γ_μ -vortex has maximal density) and increases with r indicates that it is generated by the entropy of the subquantum (etheronic) medium, by the Brownian component $\rho_b(r) \to \rho_b^0$, associated to the static etheronic pressure $P_s(r) = \rho_s(r)c^2$, (to the sub-quantum medium entropy), which decreases with r as consequence of the increasing of the dynamic pressure $P_d(r) = ½\cdot\rho_v(r)c^2$ of the heavy etherons ('sinergons' –in CGT [4, 5]) of the etherono-quantonic vortex Γ_μ , (associated with the medium's negentropy), which generates the magnetic potential A of the electron's magnetic field, in accordance with the Bernoulli's law in the simplest form:

$$P_s(r) + P_d(r) = \text{constant}. \tag{27}$$

In consequence, using the eqn. (6), the de Broglie relation of quantum equilibrium allows the conclusion that the amplitude R of the wave- function $\Psi(r)$ associated to the electron's structure characterizes the variation of the quantum density $\rho_e(r)$ of the m_e-particle's mass and the intrinsic entropy, $\varepsilon_e(r)$, generated by the Brownian component of the subquantum medium and the imaginary part: $I = e^{iS/\hbar}$ characterizes the variation of the impulse density $p_v(r) = \rho_e(r)c$ of the electron's sub-components ('naked' photons- according to the model) and of the magnetic moment's quantum vortex Γ_μ, for which $S_\mu \sim p_\mu(r) = \rho_\mu(r)\cdot c = p_v(r)$, with: $\delta S_\mu = (\delta m_e)_r\cdot c\cdot\delta x_r$; $(\delta m_e)_r = (\delta\upsilon_e)\cdot\rho_e(r)$, (identical variation for $p_\mu(r)$ and $p_v(r)$, conform to CGT [4, 5])

3.3. The vortexial quantum potential of the classic electron

For $p_\mu(r) = \rho_\mu(r)\cdot c = p_v(r)$ [xx] , by the eqs. (6) and (26), we have:

$$\begin{gathered}\rho_\mu(r) = \rho_e(r) = \rho_e(0)\cdot R^2 = \rho_e^o \cdot e^{-\frac{\varepsilon_h}{k_b}} = \rho_c^o \cdot e^{-\gamma\frac{\mathrm{S_h}}{\hbar}} = \rho_e^o \cdot e^{-\frac{r}{\eta_e}}; \qquad \mathrm{S_h} = \oint m_h c\cdot dx_r = 2\pi\,\mathrm{r}\cdot \mathrm{m_h} c \\ \mathrm{R}^2 = |\Psi|^2; \quad \Psi = R\cdot \mathrm{e}^{\mathrm{i}\frac{-S_\mu}{\hbar}}; \quad \mathrm{S}_\mu = (\delta\,\mathrm{m}_{\mathrm{e}})_{\mathrm{r}}\mathrm{c}\cdot\delta\,\mathrm{x_r} = S_e(r) = n_h\cdot S_h(r); \quad n_h = \frac{(\delta\,\mathrm{m}_{\mathrm{e}})_{\mathrm{r}}}{m_h}\end{gathered} \tag{28}$$

in which $(\delta m_e)_r$ is the mass of a volume $\delta\upsilon_e$ with the density $\rho_e(r)$ contained by the electron's volume $\upsilon_e(a)$. The exponential variation of the electron's density corresponds- according to the model, to a mixture of bosons and fermions, with Brownian statistic distribution, i.e. to a mixture of pseudo-scalar and vector 'naked' photons.

It is understood that the total intrinsic energy of the electron is given by the impulse of its 'naked' photons contained by the entire electron and giving its inertial mass m_e, bound by their magnetic moments μ_w (given by the evanescent part of the vexons) and by the quantons m_h of the etherono-quantonic vortex Γ_μ , with the same impulse density variation, i.e.:

$$E_e^i = E_k^i + E_k^\mu = ½\int\rho_e c^2 d\upsilon + ½\int\rho_\mu c^2 d\upsilon = 2E_k^i = m_e^0 c^2 \tag{29}$$

the considered electron model explaining- in consequence, the known intrinsic rest energy: $E = mc^2$ of the particle's rest mass, known as Einstein's relation.

It results that the quantum intrinsic energy of electron, which is liberated at electron-positron annihilation, is given as in the case of the vector photon, whose intrinsic vortexial energy results by its kinetic energy and its rotational (spinorial) energy given by vortexed quantons and quantonic clusters with mass m_c, which explains also its magnetic moment:

$$E_w = ½m_w c^2 + ½\sum_\mu m_c(\omega\cdot r)^2 = m_w c^2 \quad ; \quad ((\omega\cdot r) = c) \tag{30}$$

The stability of the electron quantum volume is explained by the attraction force generated by the Γ_μ - vortex which generates the electron magnetic moment, $\boldsymbol{\mu}_e$, in the next way:

-In accordance also with other soliton models of electron [16], the stability equation of the Γ_e – vortex of m_f^0- photons composing the electron's mass may be expressed by the Schrödinger nonlinear equation (NLS) with soliton-like solutions, identifying in this equation the term: $k_n\cdot|\Psi|^2$, (k_n- the nonlinearity constant), with the strong self-potential $V_p(r)$ of the particle, generated by its Γ_μ-vortex and acting over a quantum volume $\delta\upsilon_e$ which particularly may contain a single naked photon. If this potential results equal with the centrifugal potential $V_{cf} = ½(\delta m_e)_r \cdot c^2$, it can explain the electron's stability according to the equation:

$$(31a) \qquad i\hbar\frac{\partial\Psi}{\partial t}+\frac{\hbar^2}{2m}\frac{\partial^2\Psi}{\partial x^2}-k_n\cdot|\Psi|^2\Psi=0; \quad \Psi=\mathrm{R}\cdot \mathrm{e}^{-\mathrm{i}\frac{S_\mu}{\hbar}}; \quad k_n\cdot|\Psi|^2=k_n\cdot[\rho_\mu(r)/\rho_e^0]=V_p(r) \qquad (31b)$$

In the eqn. (31a) written for a volume $\delta\upsilon_e = (\delta m_e/\rho_e)_r$ corresponding to at least a naked photon vortexed to the vortex line: $l_r = 2\pi r$, $(\delta x_r \perp r)$, the action is: $\delta S_e = \delta S_\mu = (\delta m_e)_r \cdot c \cdot x_r$.

In conditions of quantum equilibrium, with $\delta x_r/\delta t = c$ and without vortex expansion or contraction, the potential $V_p(r)$ may correspond to the quantum potential $Q_a = -Q_{cf}$, resulting that:

$$-i\hbar\frac{\partial\Psi}{\partial t}=\hat{H}\,\Psi=(\hat{E}_{cf}+V_P)\cdot\Psi=-\frac{\hbar^2}{2\delta\, m_e}\;\frac{\partial^2\Psi}{\partial x^2}+k_n\cdot|\Psi|^2\Psi=0; \qquad \Psi=R\cdot\mathrm{e}^{\mathrm{i}\frac{S_\mu}{\hbar}}$$

$$\Rightarrow\; V_P(r)=-\frac{1}{2}\delta m_e(r)\cdot c^2=-\frac{1}{2}\delta\upsilon_e\cdot\rho_\mu(r)\cdot c^2=-k_n\frac{\rho_\mu(r)}{\rho_e^0};\;\; \mathrm{S}_\mu=(\delta m_e)_r\, c\cdot x \qquad (32)$$

which gives: $k_n = V_P^0(o) = ½\delta\upsilon_e\rho_\mu^0 c^2$ and express the equality between the values of the centrifugal potential $E_{cf}(r)$ and the self-potential, E_{cf} :

$$E_{cf} = ½(\delta m)_r c^2 = |V_p(r)|\,; \qquad V_p(r) = -½\delta\upsilon_e\rho_\mu(r)c^2 = -V_p^0\cdot|\psi|^2 = -V_p^0\cdot e^{-r/\eta} \qquad (33)$$

which –in this case, corresponds to the quantum potential at the limit: $\delta m = m_e = \upsilon_e\,\overline{\rho}_e$, i.e. if $\delta\upsilon_e = \upsilon_e$ and $\rho(r)$ is equal with the mean density of the electron, $\overline{\rho}_e$.

This case corresponds to the attraction of all naked photons of the electron.

Supposing a mass $(m_f)_r = (\upsilon_w \cdot \overline{\rho}_w)_r$ for the naked photon, its maintaining to the vortex line l_r imply a value of the potential $V_p(r)$ equal with the centrifugal potential:

$V_p(m_f) = E_{cw}(m_f) = ½\, m_f c^2$, so if the electron's mass is given by a number n of naked photons we will have:

$$\Sigma_n(E_{cw}) = -\Sigma_n(V_p(m_f)) = ½ m_e c^2 = Q_e(m_e) \qquad (34)$$

Conform to mechanics of ideal fluids, the form (32) of the fermion strong self-potential corresponds to an Eulerian attractive force of quantum static pressure gradient $F \sim \nabla_r P_s(r)$, $(P_s(r) = \rho_c(r)c^2)$:

$$F_p(r) = -\nabla_r V_p(r) = -\delta\upsilon_e\cdot\nabla_r P_s(r) = \delta\upsilon_e\cdot\nabla_r P_d(r)\,; \qquad (35)$$

$$(V_p(r) = \delta\upsilon_e\cdot P_d(r)\;;\quad P_d(r) = \tfrac{1}{2}\rho_\mu v_c^2 = P_s^0 - P_s(r)\;;\quad v_c \le c)$$

generated by a pseudo-stationary quantonic medium accumulated by the etheronic (sinergonic) part Γ_A- vortex of the magnetic moment's vortex Γ_μ, having the density variation $\rho_c(r)$ in accordance with the Bernoulli's law in the simplest form, in which the attracted mass $(\delta m_e)_r$ has a relativistic c-speed .

The relations (34), (35) corresponds also to the quantum potential induced by the particle's passing with the speed v through a Brownian sub-quantum (and quantum) medium whose density ρ_c induces a relativist etherono-quantonic vortex Γ_r around the superdense electronic centroid, which determines the spinorial energy E_ω of the leptonic particle, according to the presented classic model, energy which explains the value of the quantum potential obtained by the eqn. (15).

The same (35)- expression has also the self-potential generated by the Γ_μ-vortex having the same relative impulse density, acting upon a (pseudo)stationary mass having the impenetrable quantum volume, i.e:

$$\delta\upsilon_e = \upsilon_I\;;\quad V_P(r) = \tfrac{1}{2}\,\upsilon_i\cdot\rho_\mu(r)c^2. \qquad (36)$$

The potential equation (36) results from the Euler equation: $\omega = \rho_c^{-1}\cdot P_s$ (ω- the thermodynamic work per unit mass; ρ_c- the fluid's density; P_s –the static pressure of the fluid) by the Bernoulli's law considered in the simplest form (35), ($P_s(r) + P_d(r) = P_s^0(r;c)$ = constant), in the form:

$$F_p = -\nabla V_p = -\nabla(\omega\cdot\rho_c\cdot\upsilon_k) = -\nabla L_f = -\nabla(\upsilon_k\cdot P_s) = -\upsilon_k\cdot\nabla P_s\;;$$

$$\nabla P_s = -\nabla P_d\;;\;\Rightarrow\; V_p = \upsilon_k\cdot P_d = \tfrac{1}{2}\upsilon_k\rho_c v^2 \quad (v \le c) \qquad (37)$$

4. Conclusions

In the paper, by the known Bohm's equations and by the interpretation of the squared amplitude of the wave function, $R(\Psi)$ as the probability to find a volumic particle in a point different from its center, is deduced a value of the Bohm's quantum potential equal with the m-particle's kinetic energy $\frac{1}{2}mv^2$, which- for a classic electron composed by 'naked' photons rotated by the relativist etherono-quantonic vortex $\Gamma_r = 2\pi rv$ or/and the vortex Γ_μ of its magnetic moment, given by etherono-quantonic winds, is explained by the de Broglie's relation of quantum equilibrium between the particle's action and its associated entropy as being a centrifugal potential Q_{cf} of spinorial rotation explained by an attractive total potential $Q_a = -Q_{cf}$ given by the sum of the potentials of vortex -field which maintain all the naked photons of the electron rotated with the v-speed ($v \le c$) around the electron's superdense centroid.

The interpretation explains also the intrinsic energy: $E = mc^2$ of the electron, of the photon and of other particles. The paper argues that this intrinsic rest energy of the electron is given vortexially, by a vortex of electronic 'naked' photons Γ_e and an etherono-quantonic vortex Γ_μ of the electron's magnetic moment, μ_e, contrary to some opinions that the electron's mass is contained by a volume with a radius of $\sim 10^{-18}$ m, indicated by some experiments [19] but which in CGT represents the radius of an electronic super-dense kernel, of possible spiral form.
This conclusion is important because it is possible to bring arguments for a preonic model of quark resulted as cluster of degenerate electrons $((e^{-}e^{+})^{*}$-pairs) with diminished mass, charge and magnetic moment [19], an important argument in this sense being the experimentally evidenced possibility to obtain quark-antiquark pairs from relativistic jets of electrons and positrons [20].

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