A NEW PARADIGM FOR QUANTUM MECHANICS

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ABSTRACT

This paper introduces a new theoretical paradigm for elementary particles, specifically the electron, proposing an internal structure composed of entangled mass elements. The model extends Bohm's quantum potential theory ,redefining the quantum potential as an emergent property of intra-particle entanglement, rather than as a purely mathematical non-local function. This framework offers a novel resolution to the problems of wave function collapse and non-locality, while ensuring compatibility with special relativity. Additionally, the model incorporates concentric "s"-type orbitals to describe the spatial arrangement of mass elements, providing a framework that aligns with the principles of quantum mechanics while allowing for a stationary and symmetric configuration of the electron. Though detailed electrostatic and relativistic derivations are beyond the scope of this work, this paradigm suggests a unified and physically grounded interpretation of quantum phenomena that bridges the gap between quantum mechanics and classical physics. Further developments and mathematical formalism will be discussed in subsequent works.

1) INTRODUCTION

A longstanding paradigm in quantum mechanics, particularly in the context of elementary particle physics, assumes that such particles lack internal structure and are dimensionless, being treated as material points. This perspective has persisted due to the unsuccessful attempts by various researchers to establish any internal structure, notably in the case of the electron.[1]

The present work aims to consider a structure of the elementary particles, in particular of the electron, consisting of entangled mass elements of which a possible and particular arrangement will be provided, even if the latter is not strictly necessary for the purposes of the proposed work.

To the mass elements, the sum of whose masses equals, within the experimental limits, the mass of the electron, the quantum potential is applied in accordance with Bohm's theory, which in this case takes the form of an entangled potential, that is, which contains all the information relating to the quantum states of the afore mentioned mass elements, of which it constitutes the total wave function which turns out to be the wave function of the electron.

2) COMPOSITE PARTICLE

Without delving into the specifics of its derivation, I propose the following expression, which formally subdivides the electron's mass into a series of smaller mass elements.

I only mention, to remain on the focus of the document, that the expression derives from taking into consideration, the work done by the electrostatic field of a charge that from infinite is brought to λ_e (reduced Compton wavelength).

From this expression a development in a particular series of powers is subsequently determined, the rearrangement and unification of the constants of which leads to the given expression .

1) $m_e = \hbar c D \sum_{i=1}^{n} K_i$

Where : m_e = electron mass [Kg_{mass}] , $\hbar$ = reduced PlancK constant [$Joule \cdot sec$] ,

c = speed of light [$metri/sec$] , D = unit constant [$sec^2/metri^3$]

the Ki are function of α (fine structure constant) and are determined as follows :

$K_1 = \alpha^2/2$; $K_2 = \alpha^{2,5}/2,5$; $K_3 = \alpha^3(\frac{1}{2}+\frac{1}{3})$; $K_4 = \alpha^{3,5}(\frac{1}{2}+\frac{1}{2,5}+\frac{1}{3,5})$; $K_5 = \alpha^4(\frac{1}{2}+\frac{1}{2,5}+\frac{1}{3}+\frac{1}{4})$;

$K_6 = \alpha^{4,5}(\frac{1}{2}+\frac{1}{2,5}+\frac{1}{3}+\frac{1}{2,5}+\frac{1}{4,5})$; $K_7 = \alpha^5(\frac{1}{2}+\frac{1}{2,5}+\frac{1}{3}+\frac{1}{3,5}+\frac{1}{4}+\frac{1}{5})$; ....

I'm rewriting in another way to make the construction of Ki clearer :

$\alpha^2/2 + \alpha^{2,5}/2,5 + \alpha^3/3 + \alpha^{3,5}/3,5 + \alpha^4/4 + \alpha^{4,5}/4,5 + \alpha^5/5 + \ldots\ldots \alpha^n/n$

$\uparrow K_1$ $\alpha^3/2 + \alpha^{3,5}/2,5 + \alpha^4/3 + \alpha^{4,5}/3,5 + \alpha^5/4 + \ldots\ldots \alpha^n/n-1$

$\uparrow K_2$ $\alpha^{3,5}/2 + \alpha^4/2,5 + \alpha^{4,5}/3 + \alpha^5/3,5 + \ldots\ldots \alpha^n/n-2,5$

$\uparrow K_3$ $\alpha^4/2 + \alpha^{4,5}/2,5 + \alpha^5/3 + \ldots\ldots \alpha^n/n-2$

$\uparrow K_4$ $\alpha^{4,5}/2 + \alpha^5/2,5 + \ldots\ldots \alpha^n/n-2,5$

$\uparrow K_5$ $\alpha^5/2 + \ldots\ldots \alpha^n/n-3$

$\uparrow K_6$ .....

$\uparrow K_7$

Ki can be constructed by this method for any n and therefore the expression of the mass of the electron, which for simplicity I will call the expression Z, or simply Z, can be written with

a sufficient number of terms to be able to compare its value with that of the mass of the electron detected experimentally

A straightforward calculation shows that for $K10$, we obtain :

2) $K_{Tot} \simeq \sum_{i=1}^{10} K_i \simeq 2,8813127934 \cdot 10^{-5}$ and the theoretical mass of the electron :

3) $m_e = \hbar c \sum_{i=1}^{10} K_i \simeq 9,109347539 4 \cdot 10^{-31}$ Kg_{massa}

You can see how increasing the order of Ki' (K11 , K12 , K13 , ...) the experimental mass is never reached, since there is a small mass defect that can be corrected by adding to Z terms of the type $\hbar c K_i^2 / 2\pi$ derived from relativistic considerations associated with the individual massive elements of each s-orbital and taking into account the magnetic field that is generated by the associated charge in motion . The sum of these contributions up to K6 (the contribution for i > 6 can be calculated, but it is irrelevant as in the previous case), is:

4) $\Delta m_e = \frac{\hbar c}{2\pi} \sum_{i=1}^{6} K_i^2 \simeq 3,5843200431 \cdot 10^{-36}$ Kg_{massa}

the theoretical value of the electron mass is therefore :

5) $m^{th} = m_e + \Delta m_e \simeq 9,1093833826 \cdot 10^{-31}$ Kg_{massa}

this value can be compared with the experimental value :

6) $m_e^{SP} \simeq 9,1093837139 \cdot 10^{-31}$ Kg_{massa} were : $m^{th} \simeq 0,9999999631 \cdot m_e^{SP}$

obtaining value with relative error :

7) $err = \frac{m_e^{SP} - m^{th}}{m_e^{SP}} \simeq 3,6362590667 \cdot 10^{-8}$

the value of d , $\hbar$, c , m_e^{SP} were obtained from CODATA 2022 [2].

(5) can also be written as :

8) $m^{th} = \hbar c \sum_{i=1}^{10} K_i (1 + K_i / 2\pi)$ which i also call Z correct or ZC for short

For the purposes of the document, it is not necessary to illustrate the method used for the determination of the expression Z and its corrected version, which will be the subject of a specific document.

The ZC can be seen as the sum of n massive elements expressed by the generic term:

9) $m_i = \hbar c K_i (1 + K_i / 2\pi)$

Wanting to express a form of entanglement between the massive elements, I need to implement further information that can be derived from how these elements can be structured to form the electron.

Taking into account the spherical symmetry of the latter and its stationarity (at rest and without any external field) I propose a simple model that presents characteristics of symmetry, stationarity, energy stability, coherence with quantum models and ease of defining its entanglement relative to the mass elements themselves.

I therefore consider each mass element distributed on a spherical orbital of type s .
The various concentric orbitals are arranged, with radii inversely proportional to the mass distributed on the orbital considered.

The s-orbital configuration is maintained by a central attractive potential balanced by a repulsive potential.[a] The stationarity of the entire system (electron) does not imply that all orbitals must be stationary even if this is a possible configuration and is taken as an implicit reference.

For a low-speed electron, not subject to external fields, I can write its wave function:

10) $\psi(x,t) = A \cdot e^{-iEt/\hbar}$ with $v \to 0$ it has : $E \to mc^2$ and the (10) becomes :

11) $\psi(x,t) = A\, e^{-ic^3 \sum_{i=1}^{n} K_i (1+K_i/2\pi)\cdot t}$

While in relativistic condition the Dirac[4] equation is used , which in compact form is :

12) $(i\gamma^\mu \partial_\mu - m)\,\psi = 0$ which becomes :

13) $\left(i\gamma^\mu \partial_\mu - \hbar c \sum_{i=1}^{n} K_i (1+K_i/2\pi)\right)\psi = 0$

In both cases, since they collectively reconstruct the mass of the electron and are part of the same wave function, they are to be considered entangled.

In fact, this last condition can also occur with different or even random distributions, for this reason I have not deepened the proposed model, only worrying about respecting, in a plausible way, conditions of symmetry and stationarity.

In order to ensure energy stability to the proposed model, I also assume that for each orbital s the relationship that links the mi to the λ_i^c in an inversely proportional way is valid :

14) $\lambda_i^c = \frac{\hbar}{m_i c}$ with λ_i^c radius relative to i-th orbital .[b] So you have :

15) $m_e = \sum_{i=1}^{n} m_i = \frac{\hbar}{c} \sum_{i=1}^{n} \frac{1}{\lambda_i^c}$ with : $\left(\sum_{i=1}^{n} \frac{1}{\lambda_i^c} \right)^{-1} = \lambda_T^c$

so what : $\lambda_c < \lambda_T^c$ and : $\lambda_c < \lambda_i^c \ (i = 1 \dots n)$

Considering that the wave function of a generic orbital si depends on its distance from the center and that it depends on all the other rays through λ_T^c and this is verifiable for every $\psi_i(r, \lambda_i^c)$, therefore these wave functions are entangled .

For this reason the orbital si and the relative masses mi distribuited within them are entangled .

a) I do not indulge in the further specification of the afore mentioned potentials and the relative Hamiltonian, which is possible through an articulated analysis carried out with new elements and assumptions, nor in the role of the spin and magnetic moment of the electron, since the model, as already mentioned, is proactive but not necessary to the assumption that considers the electron as composed of entangled mass elements configured in a way compatible with their entanglement.

b) I have generalized $\lambda_c = \frac{\hbar}{m^{sf} \cdot c}$ by considering the λ_i^c approximating to partial Compton rays :

16) $\lambda_i^c = \frac{\hbar}{m^{th} \cdot c} = \frac{1}{c^2 \cdot K_i (1 + K_i/2R)} \simeq \frac{1}{c^2 \cdot K_i}$

λ_c delimits the region below which the classical approach is no longer valid, but the quantum approach must be used .

since : $\lambda_T > \lambda_c$ we are in the region where we have : $m \cdot v = \hbar / \lambda_i$ $(m_i \cdot v_i = \hbar / \lambda_i)$

the masses m_i can be associated with the respective de Broglie waves and therefore with their orbital distributions .

In this case consider S-type orbitals , is correct .

S-type orbitals very closely surround each Compton region , that can identify as "Compton spheres" .

3) BOHOMIAN MECHANICS

One can suitably manipulate the Scroedinger equation , inserting the wave function in polar coordinates and resort to Euler's expression for complex numbers :

17) $\psi = R\, e^{iS/\hbar}$ = wave function , R = wave amplitude , S = action

Replacing (17) in the non-relativistic Scroedinger equation and zeroing out the imaginary part once and the real part once gives two equations. In one of the two:

18) $$\frac{\partial S}{\partial t} + U + \frac{1}{2m}(\nabla S)^2 = \frac{\hbar^2}{2m} \cdot \frac{\nabla^2 R}{R}$$

A term appears on the first member which, when equaled to zero, reproduces the Jacobi equation of classical mechanics, while on the second member a term that is assimilated by analogy to a potential, similar to U and which is called quantum potential:

19) $$Q_q = -\frac{\hbar^2}{2m}\frac{\nabla^2 R}{R}$$

Following Bohm's treatment we can determine the guide formula and the quantum force .

I do not go on with the discussion, which can be found in various original writings by Bohm.[3]

Notably, while de Broglie proposed a similar approach for individual particles, Bohm extended the concept of the quantum potential to multiple particles, treating them consistently as material points.

The quantum potential is introduced as a mathematical function, not a local one, which drives particles in an instantaneous and deterministic manner and which can influence them independently of their distance, by virtue of their dependence on the overall wave function.

This, while being consistent with the phenomenon of entanglement, raises questions of compatibility with the R.R. which does not allow superluminary speeds.

Despite this, Bohm's approach, unlike the Copenhagen interpretation, allows to overcome the problem of the collapse of the wave function and brings quantum physics closer to traditional physics.

4) NEW PARADIGM

By considering individual particles, such as electrons, not as material points but as complex systems with entangled mass elements, and applying Bohm's quantum potential to these elements, the quantum potential can be reinterpreted as an emergent effect of the entanglement between the masses constituting the particle.

This implies that the quantum potential is not a simple non-local mathematical function, but is directly related to the physical correlations between the entangled components of the particle system. In this case entanglement itself is the source of the quantum potential.

This explanation offers a more "physical" view than Bohm's abstract one.

According to this paradigm, non-locality emerges as a consequence of the entanglement between the masses that make up the particle.

However, since the quantum potential is directly related to entanglement, one can reinterpret nonlocality in order to make it compatible with R.R. This can be done by considering the nonlocal correlations mediated by entanglement, rather than considering them as instantaneous actions at a distance, typical of Bohm's theory.

The new paradigm would therefore solve the problem of the collapse of the wave function (not solved in the Copenhagen interpretation) and of compatibility with the R.R. (not solved in the Bohm interpretation). Formally, it is sufficient to rewrite the quantum potential of (19) taking into account (8) :

20) $$Q_q = -\frac{\hbar}{2c\sum_{i=1}^{n} K_i(1+K_i/2\pi)} \cdot \frac{\nabla^2 R}{R}$$

5) CASE OF MULTIPLE PARTICLES

In the case of multiple particles, two main scenarios can be distinguished: the intraparticle situation and the interparticle situation.

In the intraparticle scenario, the internal mass elements of each particle are entangled and thus share a common quantum potential specific to that particle. In this context, the quantum potential is not merely a mathematical function but an emergent property of the entanglement between the different mass elements that compose the particle.

This potential governs the deterministic behavior of the entangled elements within the particle.

In the interparticle scenario, when two or more particles become entangled, a collective wave function emerges that describes the entire system of entangled particles, subsequently influencing the total quantum potential.

As a result, the group of entangled particles shares a single quantum potential that governs their collective behavior .

If the particles are not entangled with each other, each particle retains its independent quantum potential. In this scenario, the mass elements within each particle remain entangled internally, but there is no connection between different particles.

This ensures that no non-local effects occur, thus maintaining compatibility with special relativity.

There can also be mixed cases, where groups of particles are entangled, while other particles remain unentangled. In such situations, the entangled group will have a combined wave function and a shared quantum potential, while each non-entangled particle will retain its specific quantum potential and associated wave function.

6) CONCLUSION

The main idea is an structure of electron formed by mass elements distributed on orbitals of type s , concentric and with a radius inversely proportional to the mass distributed on the orbital itself.

This configuration suggests an entanglement relationship of the orbitals and therefore of the masses themselves of which a quantification is given for each orbital.

The resulting entanglement emerges as a defining characteristic of the quantum potential.

The variant made to Bohomian mechanics, which I call together with the electron subdivided : new paradigm, makes this mechanics compatible with R.R.

To this end, it was not necessary to go into further details on the electron model and on the genesis of the expression ZC, details that are however in an advanced phase of refinement.

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