Analysis of second quantization of Schrödinger and its effects on the path of a particle

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Abstract

The whole portion will concentrate on enhanced performance in the procedure by trying to address a number of practical uses in the initial part, and on having to introduce the essential features of second quantization in the second portion. There has been a number of worthwhile attempts over the course of the past 10 years to expand Bohmian quantum mechanics to a quantum field theory. An additional term is introduced into the Klein-Gordon equations as a result of the effect of Bohmian mechanics to a quantum field theory. The very first illustration comes from the research of the physics of linked electron systems as well as the control of electron orbitals formation and destroying operations. The second instance is an analysis of classical magnetism performed in the context of electron development and destruction processes. A dynamic model is represented by its dynamical system (x1, xn, t) in the system and makes R 3n at all-time t, which solves the non-relativistic Schrodinger formula. A functional approach to quantum field theory also known as the second quantization is one way to arrive at this new level of detail so that it can be examined. The study also determined modified Hamilton-Jacobi equation by the second quantization, by comparing this identity with the Hamilton-Jacobi equation of the classical field. Researchers believe that all of the determines the optimal of the quantum theory can be seen in this extended dynamic perspective as a result of the fact that the experimental sets are built for the detection of electrons. This new invention can describe concepts such as the conception and total destruction of the particulate, as well as the lack of environmental protection of chances at the level of components, despite the fact that the chance of the whole being preserved. The first equation, with two additional terms, has the same structure as the standard Hamilton-Jacobi equation. In the Bohmian statistical many particle QM, the phrase R 2 can be regarded as a particle density distribution (or probability distribution of the particle's position). In the conventional QM, the term R 2 is interpreted as the probability of the particle detection, following observation. As long as the wave magnitude is not zero, the effect of quantum potential is still applicable. There is no pilot wave or active information when R decreases to zero as a result of Equation. It has been demonstrated that the modified Schrödinger equation has two consequences on the evolution of the particle. One way is through the modified Bohmian potential. It affects the nonlinearity of the modified Schrödinger equation and provides a foundation for creating a mechanism of converting active information to inactive information in the Bohmian interpretation and its relationship to the mental effect on matter, we suggest that this dissipative extra term may be considered as a solution for the measurement problem in standard QM.

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takes into account higher levels [5]. Through the introduction basic perspective, increased concentrations have the ability to have an impact on this molecular scale.

Aims of the study

1- The study intends to find out quantum potential at the level of the Schrödinger equation.

2- The intends to obtain a continuity equation for explaining several phenomena

Questions of the study

1- How Schrödinger equation can be used in quantum field theory?

2- What is the quantum potential in Bohmian mechanics?

Significance of the study

The modified Schrödinger equation was quantized in this study for obtaining the quantum potential at the level of the Schrödinger equation. A modified Schrödinger equation can be used for generating new quantum potential in the Hamilton-Jacobi equation. This equation can influence the path of the particles. Also, this modified Schrödinger equation can explain phenomena like the creation and annihilation of the particles, and the lack of conservation of probability at the level of parts, preserving the total probability.

Introduction

The description of several situations can be done using simple and effective language provided by second quantization [1]. As an outcome of this, one could obtain an exhaustive explanation of the notion all throughout the body of published work. The whole portion will concentrate on enhanced performance in the procedure by trying to address a number of practical uses in the initial part, and on having to introduce the essential features of second quantization in the second portion. That the very first part of this portion will be focused on the demonstration of the essential features of second quantisation [2].

There has been a number of worthwhile attempts over the course of the past 10 years to expand Bohmian quantum mechanics to a quantum field theory [3]. In particular, this has been achieved for the scenario involving bos+onic particles that obey the Klein–Gordon equation [2, 3]. An additional term is introduced into the Klein-Gordon equations as a result of the effect of Bohmian mechanics to a quantum field theory [4]. Quantum opportunity is the term given to this unique notion. The initial reduction results in the appearance of a qualitative perspective that is capable of exerting all of the fundamental level's impacts on the traditional level as well as the direction that electrons take. Bohm also

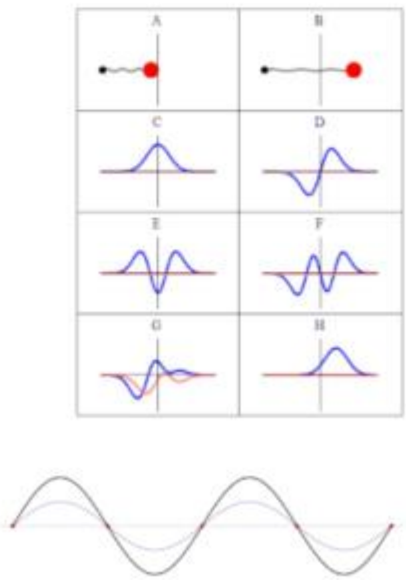

Figure X: Schrödinger equation dependent on time particles could be traveling in different directions but they would have to continue following the same path over and over again [6-8]. The outcome will be ultimately observable but if we were to study it at an indeterminate number of iterations, it will give us a harder time detecting our observation due to the large number of possible outcomes that would result from our calculations. This can make our observations extremely sensitive to variations in this one calculation and it may very well lead us astray from finding what we are actually looking for [7]. This is where the second quantization comes into play. This process models the motion of a particle with a simple set of rules that are able to be easily tracked. In this case, we will not have to worry about variations in our calculations since we are using more basic and definite rules for our particles to follow [8]. The second quantization provides steps for how a particle's path can be predicted based on its initial condition and the external force acting on it. These steps will allow us to follow the path of a particle by solving the Schrödinger equation at each point in the path, in other words, by calculating the wave function at each distance along its trajectory [9].

Methodology

While the second quantization is only a symbol and not a resolution within itself, its use frequently results in a significant decrease in complexity during the process of evaluating many-particle problems. It can be looked at as a few varieties of applications in order to stress home this concept and obtain some hands-on experience with second quantized functions [6]. The very first illustration comes from the research of the physics of linked electron systems as well as the control of electron orbitals formation and destroying operations. The second instance is an analysis of classical magnetism performed in the context of electron development and destruction processes. However, before we start discussing these aspects, allow us first to

Literature review

Second quantization is required for a causal interpretation of the quantum universe in order to account for events like the production and destruction of particles, which gives rise to quantum field theory [5,6]. A new quantum potential can be used to explain the causal implications of the second quantization. The second quantization of Schrodinger and its consequences on a particle's path has been discussed in this article. With the use of a new component in the continuity equation and a modified quantum potential, this generalization results in a modified Schrodinger that influences the particle. We have demonstrated how these effects can offer a framework for the understanding of particle formation and destruction phenomena as well as other effects of quantum field theory [6].

The Schrödinger Equation (SE) is one such case where we are able to use quantum theory to analyze how particles behave mathematically. The equation will describe the many different outcomes an event has and predict which outcome will happen if certain conditions are met. One event that would be described by the SE is the path taken by a particle in a sea of Schrödinger particles. A sea of Schrödinger particles will fully describe a particle's path. Each particle in this sea is given an initial condition and based on these states, their movement can be predicted [7,8]. This calculation of how a particle moves depends on many factors including but not limited to: force acceleration, inertia, friction, external forces (such as gravity), and other objects in the path of the particle. These factors can be modeled for a large indefinite number of iterations which would end up making our actual observations more difficult to detect so it is very important that we limit our calculation to fewer iterations [7].

The path of a particle must repeat in order to be observable. This is of particular importance when we are looking at the path taken by a single entity, which is the case here. The

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dynamic model is represented by its dynamical system (x1, xn, t) in the system and makes R 3n at all-time t, which solves the non-relativistic Schrodinger formula. A functional approach to quantum field theory also known as the second quantization is one way to arrive at this new level of detail so that it can be examined.

go away" and revisit the research of diffraction patterns inside the quantum chain. This will lay the foundation for the remainder of the discussion. When having to move on to the overall foundation for creating the pilot-wave models, researchers discuss the de Broglie and Bohm proposed trial analysis for non-relativistic quantum theory [1-3]. A

If *m = h = 1*, we can use the following Lagrangian density to get the Schrödinger equation for the conventional QM:

$$\mathcal{L} = i[\psi\psi * - \psi * \psi] + 2\psi * U\psi + \nabla\psi\nabla\psi * \qquad \text{(Eq.1)}$$

where the classical potential is *U = U(x,t)*. The action principle is used to derive the Euler-Lagrange equation:

$$\delta\mathcal{L}/\delta\psi * - \partial/\partial x\ \mu\ \delta\mathcal{L}/\delta\psi, \mu * = 0 \qquad \text{(Eq.2)}$$

$$\delta\mathcal{L}/\delta\psi - \partial/\partial x\ \mu\ \ \delta\mathcal{L}/\delta\psi, \mu = 0$$

Hence, the Schrödinger equation.

$$-i\psi + U\psi - \nabla\ 2\psi/2 = 0 \qquad \text{(Eq.3)}$$

The equivalent (conjugate) momenta of ψ∗ and ψ are, respectively:

$$\Pi = \delta\mathcal{L}/\delta\psi * = i\psi \qquad \text{(Eq.4)}$$

$$\Pi * = \delta\mathcal{L}/\delta\psi = -i\psi * \qquad \text{(Eq.5)}$$

We can now determine the density of the Hamiltonian:

$$\mathcal{H} = \Pi\psi * + \Pi * \psi - \mathcal{L} = -2\psi * U\psi - \nabla\psi\nabla\psi * \qquad \text{(Eq.6)}$$

$$H = \int d\ 3x\mathcal{H} = \int d\ 3x(-2\psi * U\psi - \nabla\psi\nabla\psi *) \qquad \text{(Eq.7)}$$

$$i\hbar\frac{\partial}{\partial t}|\psi(t)\rangle = \hat{H}|\psi(t)\rangle$$

Schrödinger's equation dependent on time

$$i\hbar\frac{\partial}{\partial t}\Psi(\mathbf{r},t) = \frac{-\hbar^2}{2m}\nabla^2\Psi(\mathbf{r},t) + V(\mathbf{r},t)\Psi(\mathbf{r},t)$$

Figure X: Hamilton's equation

$$\mathcal{H}(t,\mathbf{q},\mathbf{p}) = \sqrt{m^2\,c^4 + \mathbf{p}^2\,c^2}\,.$$

Figure X: Hamilton's equation for the free body (including the effects of Allenstein's special relativity theory)

Then utilize relations (4) and (5) and to determine the Hamilton-Jacobi equation using the identity H + S = 0:

$$S - \int d\ 3x(2\Pi * U\Pi + \nabla\psi\nabla\psi *) = 0 \qquad \text{(Eq.8)}$$

Using the identities, let's now:

$$\delta S/\delta\psi * \equiv \Pi , \delta S/\delta\psi \equiv \Pi * \quad \text{(Eq.9)}$$

We arrive at the Hamilton-Jacobi equation by

$$S - \int d\,3x\,(2\,\delta S/\delta\psi\, U\, \delta S/\delta\psi * + \nabla\psi\nabla\psi\, *) = 0 \quad \text{(Eq.10)}$$

Everything has been traditional up until now. We can now derive the temporal evolution of the functional field using the canonical second quantization approach [10]. The time evolution principle and the transition of momenta to the field's differential operators are two components of the canonical method:

$$i\,\partial/\partial t\,\Psi = H\Psi\,;\ \Pi \rightarrow i/\hbar\ \delta/\delta\psi * , \Pi * \rightarrow i/\hbar\ \delta/\delta\psi \quad \text{(Eq.11)}$$

Using equation (7) for the Hamiltonian, we have the following:

$$H = \int d\,3x(-2\Pi * U\Pi - \nabla\psi\nabla\psi\, *) = \int d\,3x\,(2\,\delta/\delta\psi\, U\, \delta/\delta\psi * - \nabla\psi\nabla\psi\, *) \quad \text{(Eq.12)}$$

In light of connection (11), the following is how long a functional field has existed:

$$i\,\partial/\partial t\,\Psi = [\int d\,3x\,(2\,\delta/\delta\psi\, U\, \delta/\delta\psi * - \nabla\psi\nabla\psi\, *)]\Psi \quad \text{(Eq.13)}$$

We may now define the wave functional ψin the polar form in terms of two real functional fields, just like in the Bohmian approach. Next, we obtain the following equations by dividing the real and imaginary components of the equation (Eq.13).

$$\Psi(\psi,t) = \mathcal{R}(\psi,t)e\ i\mathcal{S}(\psi,t) \quad \text{(Eq.14)}$$

$$-\mathcal{S} = \int d\,3x\,(-\nabla\psi\nabla\psi\, * - 2\,\delta\mathcal{S}/\delta\psi\, U\, \delta\mathcal{S}/\delta\psi * + 2\,\mathcal{R}\,\delta/\delta\psi\, U\, \delta/\delta\psi *\ \mathcal{R}) \quad \text{(Eq.15)}$$

$$\mathcal{R}\,\mathcal{R} = \int d\,3x\,[\,2U\,\mathcal{R}\,(\,\delta\mathcal{S}/\delta\psi\,\delta\mathcal{R}/\delta\psi * + \delta\mathcal{R}/\delta\psi\,\delta\mathcal{S}/\delta\psi *) + 2\,\delta/\delta\psi\, U\, \delta/\delta\psi *\ \mathcal{S}] \quad \text{(Eq.16)}$$

Using the following names as aliases:

$$\Pi \equiv \delta\mathcal{S}/\delta\psi * , \Pi * \equiv \delta\mathcal{S}/\delta\psi \quad \text{(Eq.17)}$$

And when we add them to Eq. (Eq.15), we obtain

$$-\mathcal{S} = \int d\,3x\,(-\nabla\psi\nabla\psi\, * - 2\Pi * U\Pi + 2\,\mathcal{R}\,\delta/\delta\psi\, U\, \delta/\delta\psi *\ \mathcal{R}) \quad \text{(Eq.18)}$$

Now, by the second quantization, a modified Hamilton-Jacobi equation is produced by comparing this identity with the Hamilton-Jacobi equation of the classical field, Eq. (Eq.8): 173

$$\mathcal{S} = \int d\,3x(2\Pi * U\Pi + \nabla\psi\nabla\psi\, * - 2\mathcal{Q}) \quad \text{(Eq.19)}$$

$$\mathcal{Q} = [\,\delta/\delta\psi\, U\, \delta/\delta\psi *\ \mathcal{R}(\psi,t)]\,/\mathcal{R} \quad \text{(Eq.20)}$$

The modified Hamiltonian is then obtained by using the identity H + S = 0 :

$$H = \int d\,3x(-2\Pi * U\Pi - \nabla\psi\nabla\psi\, * + 2\mathcal{Q}) \quad \text{(Eq.21)}$$

$$\mathcal{H} = -2\Pi * U\Pi - \nabla\psi\nabla\psi\, * + 2\,\mathcal{R}\,[\,\delta/\delta\psi\, U\, \delta/\delta\psi *\ \mathcal{R}(\psi,t)] \quad \text{(Eq.22)}$$

As a result, by applying the Hamiltonian-Lagrangian relation, Eq. (Eq.6), the new Lagrangian is equal to:

$$\mathcal{L} = \Pi\psi * + \Pi * \psi - \mathcal{H}$$
$$= i[\psi\psi * - \psi * \psi] + 2\psi * U\psi + \nabla\psi\nabla\psi * - 2\,\mathcal{R}\,[\,\delta/\delta\psi\, U\, \delta/\delta\psi *\ \mathcal{R}(\psi,t)] \quad \text{(Eq.23)}$$

The modified Schrödinger equation is produced at the QM level by varying this new Lagrangian in terms of ψor ψ∗ and using the Euler-Lagrange equation:

$$i\,\partial/\partial t\,\psi(x,t) = [-\nabla\,2/2 + U(x,t)]\,\psi(x,t) + \delta\,\delta\psi *\ \mathcal{Q}|\,\psi(x,t) \quad \text{(Eq.24)}$$

$$\mathcal{Q} = [\,\delta/\delta\psi\, U\, \delta/\delta\psi *\ \mathcal{R}(\psi,t)]/\mathcal{R} \quad \text{(Eq.25)}$$

Schrodinger equation and then quantizing it. This altered Schrodinger equation can produce a new quantum perspective for use in the Hamilton-Jacobi equation, which has massive effects on the path that the electrons take. The innovative constant of proportionality also features a new term, which would be due to second quantization. This new invention can describe concepts

Findings and Results

Researchers believe that all of the determines the optimal of the quantum theory can be seen in this extended dynamic perspective as a result of the fact that the experimental sets are built for the detection of electrons. In this essay, they arrived at the fundamental potential at the basis of the Schrodinger equation by starting with the

Second quantization denotes that it is a common structure of the quantum many-particle thesis. Quantum Field Theory and Condensed Matter Theory are involved basically in second quantization such as the conception and total destruction of the particulate, as well as the lack of environmental protection of chances at the level of components, despite the fact that the chance of the whole being preserved.

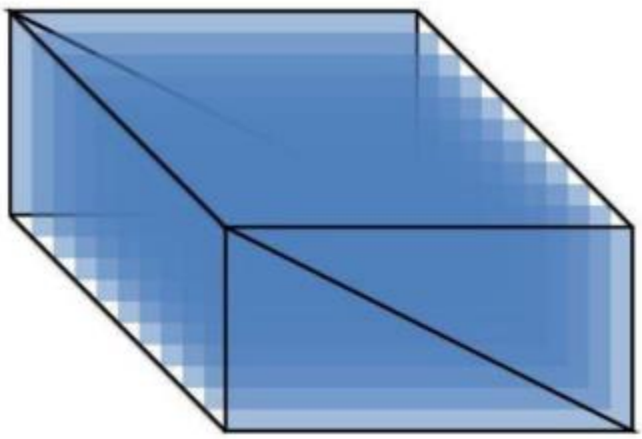

Figure X:

Bohmian quantum potential modification brought on by second quantization

At the quantum mechanical level, we have found a modified Schrödinger equation with an additional term in comparison to the original Schrödinger equation. Eq. (Eq.24) can be recast as follows in order to achieve the second quantized effects on a particle's dynamic and evolution:

$i\hbar\, \partial/\partial t\, \psi(x,t) \;=\; [-\, \hbar\, 2/2m\, \nabla\, 2 \;+\; U(x,t) \;+\; 1\, \psi\, \delta/\delta\psi *\, Q]\, \psi(x,t)$ (Eq.26)

We express the wave function in the polar form, much like in the Bohmian method [7]:

$\psi(x,t) \;=\; R(x,t)e\; i/\hbar\, S(x,t)$ (Eq.27)

R and S are real-world functions. Then, in the Equation (Eq.26), use the identity given below:

$1\, \psi\, \delta/\delta\psi * = \; 1\, R\, \delta/\delta R \;+\; i\hbar\, R2\, \delta/\delta S$ (Eq.28)

The modified Schrödinger equation (Eq. (Eq.26)), which we obtain as the following two real functions:

$-\, \partial/\partial t\, S \;=\; (\nabla S)\, 2/2m \;+\; U \;-\; \hbar\, 2/2m\, \nabla\, 2R/R \;+\; 1/R\, \delta/\delta R\, Q|\, R,S$ (Eq.29)

$\partial/\partial t\, R\, 2 \;+\; \nabla\, (R\, 2\, \nabla S/m\,) \;=\; -\, 2\, \delta/\delta S\, Q|\, R,S$ (Eq.30)

The first equation (Eq.29), with two additional terms, has the same structure as the standard Hamilton-Jacobi equation if the particle's speed is assumed to be equal to "∇ S□".

$-\, \partial/\partial t\, S \;=\; (\nabla S)\, 2/2m \;+\; U \;+\; \mathbb{Q}$ (Eq.31)

$\mathbb{Q} \;=\; -\, \hbar\, 2/2m\, \nabla\, 2R/R \;+\; 1\, R\, \delta/\delta R\, Q|\, R,S$ (Eq.32)

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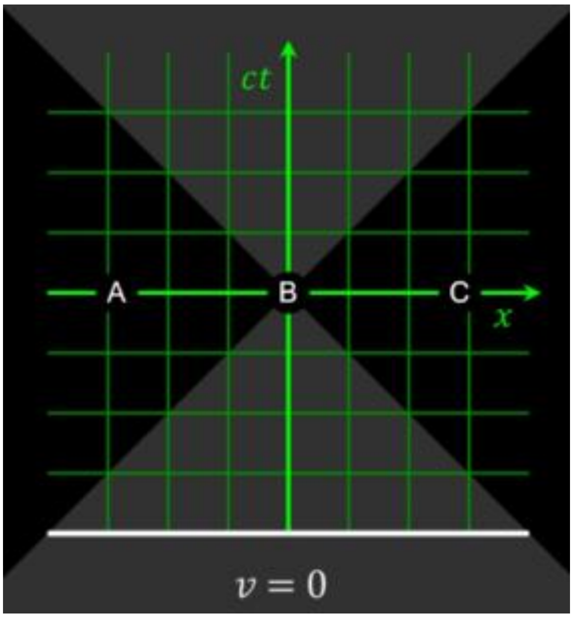

Figure X:

While the second term, which results from the second quantization, is a new Bohmian potential, the first term is still the standard Bohmian quantum potential. In actuality, the term potential Q refers to all QFT and QM level influences on the particle track (particle dynamics level).

The equation for continuity and evolutionary effects

With regard to Eq. (Eq.30), we can observe that it is identical to the standard Bohmian continuity equation [7] with the addition of a term brought on by second quantization and QFT effects:

$\partial/\partial t\; R\,2 \;+\; \nabla\,(R\,2\,\nabla S/m\,) \;=\; -2\,\delta/\delta S\; Q$ (Eq.33)

In the Bohmian statistical many particle QM, the phrase R 2 can be regarded as a particle density distribution (or probability distribution of the particle's position). In the conventional QM, the term R 2 is interpreted as the probability of the particle detection, following observation. As can be observed in Eq. (Eq.33), the extra term "2δ/δSQ" appears to be what prevents probability from being conserved. However, if we perform the computations again for the ψ∗ field, a different continuity equation is discovered, and it is as follows:

$\partial/\partial t\; \bar{R}2 \;+\; \nabla\,(\bar{R}2\,\nabla S/m\,) \;=\; -2\,\delta/\delta S\; Q$ (Eq.34)

where the $\bar{\mathbf{Q}}$ is equal to

$\bar{\mathcal{Q}} \;=\; [\,\delta/\delta\psi *\; U\; \delta/\delta\psi\; \mathcal{R}(\psi,t)]/\mathcal{R}$ (Eq.35)

If we take into account the anti-commutator relationship between Π∗ and Π, the outcome is:

$[\,\delta/\delta\psi *, \delta/\delta\psi\,]+ = \;0$ (Eq.36)

$\bar{\mathcal{Q}} \;=\; -\mathcal{Q}$ (Eq.37)

The continuity equation for the "ψ" field is equivalent to because of Equations (Eq.34) and (Eq.37), respectively.

$\partial/\partial t\bar{R}2 \;+\; \nabla\,(\bar{R}2\,\nabla S/m\,) \;=\; +2\,\delta/\delta S\; Q$ (Eq.38)

in the Bohmian interpretation, it influences the size of the pilot wave (which is interpreted as active information). However, we are aware that the quantum potential that results from it is not reliant on the size of the wave. However, as long as the wave magnitude is not zero, the effect of quantum potential is still applicable. There is no pilot wave or active information when R decreases to zero

It is possible to interpret a comparison using Equations (Eq.33) and (Eq.38) as the likelihood that the entire system, including particles and antiparticles, would survive. This is due to the unitary nature of the dynamical operations at the QFT level.

This additional term serves as the foundation for the causal description of the creation and annihilation occurrences in Bohmian QM, and development of new methods for solving this paradoxical problem [12].

Schrödinger's equation is used to understand the path that a particle takes in its orbit. However, there are other solutions for the path of a particle, such as those that are obtained by second quantization and those that use the concept of imaginary time. These solutions have led to new interpretations of the Schrödinger equation [13]. For example, in imaginary time, one considers particles moving on a circle divided into several parts with each section having a different speed. In addition to this, particles moving at different speeds may appear to move backward in time while they move forward in real-time. This can lead to significant problems because it destroys one of the fundamental principles – determinism – used in physics today [12,13].

In the paper Conditions for a real solution of the Schrödinger Equation in imaginary time, an approximation method was proposed to solve the problem with this paradoxical future [14]. This approximation method is based on how Schrödinger's equation is used in quantum mechanics and can also be used to study its effects in non-quantum cases. However, according to quantum mechanics, it cannot be assumed that there is only one wave function but only one orbit for a particle. In an attempt to provide a possible solution for the paradox of Fermi-Dirac statistics, Pomeranchuk and Schuster applied this approximation method based on imaginary time to solve the problem of zero interference [15,16].

Conclusion

The quantum potential in Bohmian mechanics is a summary of the consequences of the degree of possibilities, as defined by the wave function, on particle trajectories. We create a functional field that illustrates the potentials of the wave function through the quantization of the Schrödinger equation. We have demonstrated how adding a potential-like term to the Schrödinger equation results from this generalization to quantum field theory. The modified as a result of Equation (SA.33). So the reason why do we need to think about a particle without a wave function is that, this circumstance has what is known as an annihilation effect. And "ψ∗ "s reverse process might be seen as having a creative effect.

Discussion

In the paper Schrödinger's Equation and its Interpretations, Schrödinger showed how the second quantization of his equation could lead to interesting results. He predicted that if a particle moves in such a way that it crosses the orbit of its own wave function, then one could not answer if the particle was inside or outside its orbit. This is due to quantum mechanics dictating that there is no determinism, which means that both possibilities occur simultaneously at some point [10-12]. The post shows how this principle can be applied to solve two problems in physics: Fermi-Dirac statistics on particles and classical mechanics on a rotating top. There is a problem with the fact that the wave function of the system is the product of two functions (one for each particle) and not a single function [11].

Fermi-Dirac statistics are only applicable if one considers a wave function as being a single entity. However, according to the second quantization, these wave functions may be considered as being made up of two individual particle wave functions. This is an important difference because it means that Fermi-Dirac statistics do not apply in all cases in second quantization. For example, the most famous case is Dirac's paradox. This occurs when the particle wave function does not have a saddle point, which is a place where several wave function loops cross each other. Therefore, no one can answer whether the particle is in its orbit or outside [11,12].

In an attempt to solve this problem of Fermi-Dirac statistics, physicists considered the multi-particle case and had to consider that they may be inside and outside their orbits at once due to the wave function being a product of two functions. This has led to the

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Schrödinger equation is the name given to this new equation.

It has been demonstrated that the modified Schrödinger equation has two consequences on the evolution of the particle. One way is through the modified Bohmian potential, which has a new extra term with regard to it. It defines how the particle trajectory will be affected by the second quantization. Another is an additional term in the continuity equation that can serve as a foundation for a causal justification of QFT-level effects on the evolution of particles, such as creation and annihilation processes. Because it affects the nonlinearity of the modified Schrödinger equation and provides a foundation for creating a mechanism of converting active information to inactive information in the Bohmian interpretation and its relationship to the mental effect on matter, we suggest that this dissipative extra term may be considered as a solution for the measurement problem in standard QM.

Recommendations

The authors suggest more studies should be conducted on dissipative extra term as it can provide a solution for formulating a mechanism of transformation of active information to inactive one based on Bohmian interpretation and its relation to the mind effect on matte.

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