A possible Connection between Quantum and General Relativity theories

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Abstract

Quantum field theory and general relativity are considered very successful theories that together describe the four fundamental forces in the universe. However, it is difficult to combine them into one unified theory. We propose a novel model, based on two postulates, which provides a new perspective on the fundamental forces using special and general relativity concepts. Many studies address the relations between the particles and the spacetime manifold, and the latter’s physical structure, whether it is Continuous or Discrete. In the proposed model the properties of the particles are classical in the sense of general relativity, whereas their quantum properties arises due to the experiments, the differences of the inertial reference frames and energy values between the measurement device and the particles. We consider all of the discrete values of the particles to be constructed by an interference between fields. Under this approach we show that the model dismisses hidden variables. The model provides general field equations for the interactions of the particles, and their Lagrangian density, where the Lagrangian densities of Yang-Mills theory for SU(n), n=1,2,3,4, and of general relativity theory arises as a special cases.

Keywords: General relativity; Quantum field theory; Special relativity; Superposition

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1 Introduction

We consider the physical realm to be the \((3+1)\) spacetime dimensions where any physical objects in the universe, in particular particles, are a curvature of the spacetime manifold. Furthermore, we assume (as a postulate) that any particle is a local \((3+1)\) field with vibration and curvature, where, without interactions it remains with the same properties.

The model is constructed from the following two postulates:

- The particles are a function of the spacetime manifold, where all of the objects in the physical reality are of \((3+1)\) dimensions and not less.

- The discrete properties of particles arises only by an interference between the particle and: itself, other particles, or other fields.

From Postulate 1 we deduce that special relativity concepts (e.g. Lorentz-FitzGerald contraction, relativity of simultaneity, and time dilation) and general relativity concepts are important for describing the particles. Postulate 2 describes the physical structure of the discrete properties of particles which arises under the spacetime continuum.

2 The model

The model represented in the paper is derived from the above Postulates. We show that under this approach we can construct a general model which describes the Lagrangians of the fundamental forces, and provides a new innovative presentation of those forces between the particles.

2.1 General field equations

Let us consider the Einstein field equations as the description of the gravity force, which provides the interaction between the object and the spacetime manifold which of course is expressed as follows

\[ G_{\mu\nu} = \kappa T_{\mu\nu}, \]  

(1)

where the left part, \(G_{\mu\nu}\), describes the curvature of the spacetime manifold, and the right side, \(T_{\mu\nu}\), describes the stress-energy tensor of the object.
Notice that from Postulate 1 we restrict equation (1) to be without any singularities. Since (1) represent the gravity force where $T_{\mu\nu} = T_{\nu\mu}$, for the other forces $T_{\mu\nu}$ should be non-symmetric tensor, because we associate the equation (1) and the property $T_{\mu\nu} = T_{\nu\mu}$ to the gravity force. Furthermore, since we assume that the only force in nature is the interaction between the object and the spacetime manifold, for getting a tensor $T_{\mu\nu}$ to be a non-symmetric tensor, consider, as a special case, the case of the metric between two gravitational objects. Suppose we have two objects, $\alpha^1$ with stress-energy tensor $T_{\mu\nu}^1$ and $\alpha^2$ with stress-energy tensor $T_{\mu\nu}^2$, then the field equations takes the form

\begin{align*}
G^j_{\mu\nu} &= \kappa T^j_{\mu\nu}, \\
G^j_{\mu\nu} &:= R^j_{\mu\nu} - \frac{1}{2} g^j_{\mu\nu} R + g^j_{\mu\nu} \Lambda, \quad j = 1, 2.
\end{align*}  \tag{2}

For the sequel, we define a tensor $A_{\mu\nu}$ which represents the interaction (we refer it as an "imaginary force" which is a curvature of spacetime that was generated by at least two gravitational objects) between the objects. Further, let us define a range of energies with a certain distance ranges as \( \{ e(i) \}_{i=0}^\infty \) such that any physical object, including a measurement device, with a certain amount of energy and distance range of the field is define by $e(i)$, where at least one physical property in $e(i + 1)$ takes a different interpretation than a measurement device with $e(i + 1)$ that observe it. Therefore let us define the energy of a measurement device that observe the curvature of spacetime manifold as $e(0)$ where the other forces are in different scales of energies and distance ranges.

In the point of view of $e(0)$, we can write a tensorial equation which represent the interaction force under the spacetime manifold

\begin{equation}
G_{\mu\nu}^{12} = T_{\mu\nu}^{12}. \tag{3}
\end{equation}

Here

\begin{align*}
G_{\mu\nu}^{12} &:= G_{\mu\nu}^1 - A_{\mu\nu} G_{\mu\nu}^2 \\
&= R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R + g_{\mu\nu} \Lambda,
\end{align*} \quad (4)

and

\begin{align*}
T_{\mu\nu}^{12} &:= \kappa T_{\mu\nu}^1 - A_{\mu\nu} \kappa T_{\mu\nu}^2,
\end{align*} \quad (5)
where $\mathcal{R}_{\mu\nu}$ is the Ricci tensor with, in general, non-symmetric metric $g_{\mu\nu}$, and $\mathcal{R} := \mathcal{R}^\mu_\mu$. The form of (4) was concluded directly from Einstein-Cartan theory since in general $\mathcal{G}^{12}_{\mu\nu} \neq \mathcal{G}^{12}_{\nu\mu}$.

Equation (3) was obtained by the fact that equations (2) holds, and further the following equation

$$A_{\mu\nu}G^{2}_{\mu\nu} = A_{\mu\nu}\kappa T_{\mu\nu}^2,$$

also hold.

It is easy to see that in the case that $A_{\mu\nu} = A_{\nu\mu}$ the tensor $T^{12}_{\mu\nu}$ is immediately symmetric and therefore interpreted as the gravitational force, but, if we assume that equation (3) does not refer to the gravity force, for an observer with $e(0)$ we should consider $A_{\mu\nu}$ such that $T_{\mu\nu}^{12}$ is not a symmetric tensor.

Note that $T_{\mu\nu}^{12}$ is not a stress energy tensor, we refer $T_{\mu\nu}^{12}$ as the strength tensor of the field. Since we consider, in general, $A_{\mu\nu}$ to be a non-symmetric matrix, hence it is clear that $T_{\mu\nu}^{12}$ can be a non-symmetric tensor. Notice that from Postulate 1 we restrict equation (3) to be without any singularities. From the general properties of the tensor $T_{\mu\nu}^{12}$ equations (3) can be interpreted as the field equations of Einstein-Cartan theory, although our model does not assume torsion of the spacetime manifold, i.e., as a pure mathematical concept (3) is equivalent to a field equations with torsion. Now, since Einstein-Cartan theory is a Lorentz invariant theory (see, for instance, [10], [3]) our model is also an invariant Lorentz theory.

Since we associates the case that $g_{\mu\nu}$ is symmetric to the gravity force, and for $g_{\mu\nu}$ to be a skew-symmetric tensor to the Electromagnetic force [5], to define a different force, in the point of view of an observer with $e(0)$ we can consider the case where $g_{\mu\nu}$ is not symmetric and no skew-symmetric tensor, therefore, now, $g_{\mu\nu} \neq g_{\nu\mu}$ and $g_{\mu\nu} \neq -g_{\nu\mu}$.

Remark 1 Maxwell’s equations: In [5] it was shown that the non-symmetric Riemannian tensor $\mathcal{R}_{\mu\nu}$ arises due to the following relation of $\Gamma^\mu_\alpha_\beta$ field that defines an infinitesimal vector shifts

$$dA^\mu = -\Gamma^\mu_\alpha_\beta A^\alpha dx^\beta,$$

then

$$\mathcal{R}^\alpha_{\mu\nu\beta} = -\frac{\partial \Gamma^\alpha_\mu}{\partial x^\beta} + \Gamma^\alpha_\sigma_\mu \Gamma^\sigma_\nu_\beta + \frac{\partial \Gamma^\alpha_\mu}{\partial x_\nu} + \Gamma^\mu_\nu \Gamma^\alpha_\beta.$$
and hence
\[ R_{\mu\nu} = R^\alpha_{\mu,\nu\alpha} = -\frac{\partial \Gamma^\alpha_{\mu\nu}}{\partial x^\alpha} + \Gamma^\alpha_{\mu\beta} \Gamma^\beta_{\alpha\nu} + \frac{\partial \Gamma^\alpha_{\mu\alpha}}{\partial x^\nu} + \Gamma^\alpha_{\mu\nu} \Gamma^\beta_{\alpha\beta}, \]

where \( \Gamma^\alpha_{\mu\nu} \) is in general not a symmetric tensor. From Einstein UFT this generality of the Riemannian tensor, \( R_{\mu\nu} \), gives the Maxwell’s equations, and hence Maxwell’s equations arise also under the proposed model.

### 2.1.1 The Lagrangian density

Since Einstein-Cartan theory considers the stress-energy tensor to be with torsion, and hence \( T^{12}_{\mu\nu} \neq T_{\mu\nu}^{12} \), it is clear that the Lagrangian density of this theory is also the Lagrangian density in our case, although, we recall that we do not assume a torsion in the spacetime manifold, and we do not consider \( T^{12}_{\mu\nu} \) to be a stress energy tensor.

Therefore, we recall the equation
\[ G^{12}_{\mu\nu} = T^{12}_{\mu\nu}, \quad (6) \]

and consider \( G^{12}_{\mu\nu} \) with the form
\[ T^{12}_{\mu\nu} = G^{12}_{\mu\nu} := R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R + g_{\mu\nu} \Lambda. \]

Then, the Lagrangian density takes the form
\[ \mathcal{L} = \frac{1}{2} R \sqrt{\det g_{\mu\nu}}. \]

**Lagrangian approximation** Consider the field \( g_{\mu\nu} \) to be with a little difference (in the point of view of observer with \( e(0) \)) from the Euclidean metric, we consider \( g_{\mu\nu} \) to be with the form \( g_{\mu\nu} = \delta_{\mu\nu} + \phi_{\mu\nu} \varepsilon \), and \( \varepsilon \) is an infinitely small parameter. Then, the Lagrangian \( \mathcal{L} \) takes the form
\[ \mathcal{L} = R \sqrt{\det (g_{\mu\nu})} = R \sqrt{\det (\delta_{\mu\nu} + \phi_{\mu\nu} \varepsilon)}, \]

using the well known identity
\[ \det (\delta_{\mu\nu} + \phi_{\mu\nu} \varepsilon) = 1 + Tr (\phi_{\mu\nu}) \varepsilon + O (\varepsilon^2), \]

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we clearly have
\[ \mathcal{L} = \mathcal{R} \sqrt{1 + Tr(\phi_{\mu\nu}) \varepsilon + O(\varepsilon^2)}. \]

Now, since \( O(\varepsilon^2) \) is infinitely small, we have
\[ \mathcal{L} \simeq \mathcal{R} \sqrt{1 + Tr(\phi_{\mu\nu}) \varepsilon} =: \mathcal{L}_1. \]

Recall that \( \varepsilon \) is an infinitely small parameter, we consider \( \varepsilon \) such that \( \varepsilon < |Tr(\phi_{\mu\nu})|^{-1} \), so \( |Tr(\phi_{\mu\nu})| \varepsilon < 1 \) and by Taylor expansion we obtain \( \mathcal{L}_1 \) with the following form
\[
\mathcal{L}_1 = \mathcal{R} \left( 1 + \frac{Tr(\phi_{\mu\nu}) \varepsilon}{2} + O\left(\varepsilon^2 Tr(\phi_{\mu\nu})^2\right) \right),
\]
and define an approximate to \( \mathcal{L}_1 \) Lagrangian \( \mathcal{L}_2 \)
\[ \mathcal{L}_2 := \mathcal{R} \left( 1 + \frac{Tr(\phi_{\mu\nu}) \varepsilon}{2} \right). \]

Now, by considering the field \( \phi_{\mu\nu} \varepsilon \) to be with the form
\[ \phi_{\mu\nu} \varepsilon = -F_{\mu\nu} F^{\mu\nu}, \]
and define \( g_{YM} \) such that
\[ \mathcal{R} =: g_{YM}^{-2} \]
\( \mathcal{L}_2 \) is now taking the form
\[ \mathcal{L}_2 = -\frac{1}{2g_{YM}^2} Tr(F_{\mu\nu} F^{\mu\nu}) + \frac{1}{g_{YM}^2}. \]

Let \( g_{YM}^2 \) be a coupling constant, we clearly can reduce \( 1/g_{YM}^2 \) from \( \mathcal{L}_2 \) as follows
\[ \mathcal{L}_2 = -\frac{1}{2g_{YM}^2} Tr(F_{\mu\nu} F^{\mu\nu}) = \mathcal{L}_{YM}, \]
which can be interpreted as the classical Yang-Mills (YM) for \( SU(n) \), \( n = 1, 2, 3, 4 \) Lagrangian \( \mathcal{L}_{YM} \) with the coupling constant \( g_{YM}. \)
Now, recall (7), we define the residual of the Lagrangian as $\Delta \mathcal{L}$

$$\Delta \mathcal{L} := O(\varepsilon^2 Tr (\phi_{\mu\nu})^2),$$

and therefore $\mathcal{L}_1$ can be interpreted as the YM Lagrangian plus the residual $\Delta \mathcal{L}$

$$\mathcal{L}_1 = \mathcal{L}_{YM} + \Delta \mathcal{L},$$

notice that there is no need for renormalization method, since $\mathcal{L}_1$ is convergent. YM is not necessary convergent theory since we drop out $O(\varepsilon^2)$ and $\Delta \mathcal{L}$.

As we seen, $\mathcal{L}_2$ is an approximation of the physical Lagrangian $\mathcal{L}$ which perform as a Lagrangian of a physical field. In quantum electrodynamics the Lagrangian of the force is expressed as a Yang-Mills Lagrangian. Since $O(\varepsilon^2 Tr (\phi_{\mu\nu})^2)$ is infinitely small from the point of view of $e(0)$, the Lagrangian $\mathcal{L}_1$ for a force with $e(i), i \geq 1$, takes the form of $\mathcal{L}_2$. Therefore we can consider $\mathcal{L}_2$ as a Lagrangian under censored information of the physical action. Recall that for the Lagrangian of QED, for instance, the equations of motion under $\mathcal{L}_2$ provides a wave function with a superposition solution of the form

$$|\psi\rangle := |\psi_1\rangle + |\psi_2\rangle + \ldots + |\psi_n\rangle,$$  

(8)

where $|\psi\rangle$ is the general wave function. Now, consider the states $|\varphi_j\rangle$, $j = 1, 2, \ldots, n$ which contains information of the degrees of freedom the were lost because we reduced $\Delta \mathcal{L}$ from the solution $|\psi_j\rangle$, so we need to consider the solutions to be with the form:

$$|\psi\rangle_{\varphi} := |\psi_1\rangle \otimes |\varphi_1\rangle + |\psi_2\rangle \otimes |\varphi_2\rangle + \ldots + |\psi_n\rangle \otimes |\varphi_n\rangle,$$  

(9)

and not as $|\psi\rangle$, because now we are taking into account the censored information. Notice that (9) is a physical state since it taking into account $\Delta \mathcal{L}$ while (8) is not.

Now, since we consider $O(\varepsilon^2 Tr (\phi_{\mu\nu})^2)$ to be infinitely small, we censoring $|\varphi_j\rangle$ and therefore we get the following density matrix with a normalizing constant $N$ (under the probabilistic interpretation of quantum theory)

$$\rho = \frac{|\psi_1\rangle \langle \psi_1| + |\psi_2\rangle \langle \psi_2| + \ldots + |\psi_n\rangle \langle \psi_n|}{N},$$  

(10)
which describes a separable state. Notice that this method is well known for a macroscopic object, where by dropping out some degrees of freedom from the quantum state we have a separable state without the superposition state, but, we consider this method to be for all of the quantum states.

Remark 2 Second quantization: In many cases of interactions between objects in the universe the number of the objects does not conserved (from the number of planets to the number of particles), therefore there is a natural need for deriving a theory which describing a field that does not conserved the number of objects in the field. A particular theory that provides this property is the second quantization method, that uses a creation and annihilation operators that describe a non conserving number of the particle in the universe. Notice that since we consider the objects in the universe (planets nor particles) to be a curvature of the spacetime manifold this method can be applying also to the "classical objects" in the universe that, for example, collide to each other.

The coupling constant $g_{YM}$: In the "Lagrangian approximation" subsection we considered the Ricci curvature to be a coupling constant since this way of thinking leads us into the framework of Yang-Mills Lagrangian, although this is not a physical Lagrangian according to our model. Therefore, we have to consider $g_{YM}$ to be a non constant variable that depend, for instance, on the energy scales between the particles. Notice that the treatment of $g_{YM}$ as a non constant variable is a basic concept in quantum field theory and string theory (see [11], [12], [7], [13]).

2.1.2 Newtonian approximation

In the context of general relativity, the Newtonian approximation can be interpreted as the case that the gravitational field is weak with a global inertial reference frame, i.e., "absolute observers". It is well known that this way of thinking leads us to a similar equations, both, for the electrostatic field and a gravitational field, the equations known as the Poisson equations. Taking into account our proposed model, this phenomena is occur since we consider
the different forces in the universe as a physical properties that are depend’s on the scales of the "observer", i.e., if we drop out the relativity theories, the "observer" will measure, both, the electrostatic field and a gravitational field as a fields with the same properties since they are of the same type.

**Remark 3** Energy: Since mass in relativity theory is corresponds to its energy, it is simple to notice that energy implies the conservation of the mass for each observer with each inertial reference frame.

**Remark 4** Non singularities at the spacetime continuum: Since the model consider all of the particles to be with \((3 + 1)\) dimensions it rejects the existence of objects with less dimensions, such as a point-like physical objects (e.g. particles). Therefore, such as Einstein-Cartan theory, the model provide a solution to the problem of the unphysical singularity of the big-bang, since according the model there is not singularity at all. Therefore space and time does not have a beginning point, they were always exist.

**Remark 5** Self force of particles: We can describe the Self force (also known as the Abraham–Lorentz force) using the model, since this phenomena is occurring, theoretically, only for a non point-like particles.

### 3 Physical properties of the particles: From classical to quantum

From the model, all of the properties of the particle are describe by using the field equations of GR, where any other properties of the particle arises from the interactions between the particle and different particles or fields. Therefore, according to the model properties such as spin are not exist at all, for the particle, before we test his polarization, since this property is hidden in the properties of the particle which are his vibration, stress-energy tensor, etc. and the physical properties of the field of the experiment. Notice that the model is not a hidden variable theory since we can not consider those properties to the model and we can not consider his properties has the construction of those properties such as spin since we recall that they arises from interactions.
Remark 6 The model is partially agree with the Copenhagen interpretation in the sense that quantum physical properties of a particle "does not exist" without any interaction of the particle with particles or interaction fields which arises those properties.

3.1 From continuos into discrete values

Since the model consider all of the properties of the particles to be in general continue with a continue spacetime manifold, we consider a discrete values to be arises from a wave interference with the following possible actions:

1. Interference between the particle and other particles:
   Since we consider the particles to be a function of the spacetime manifold with a certain curvature and vibration we they have a wave properties such as amplitudes, etc., therefore some properties of the particles which are constructed by the spacetime manifold can get discrete values, examples will be shown at a sequel.

2. Interference of the particle with himself: By that we can get the discrete energy of a free particle which is a particle without any interactions.

3. Interference of the particle with local fields.
   We realize that the discrete properties of the particles are a function of the structure of the experiments and the interactions with the particles, i.e., the structure of the experiment provides the continuity of some properties of the particles.

3.2 The spin property

The spin property, which is an important property that describes the behavior of the particle under experiments such as Stern-Gerlach experiment. The tensorial definition of this property is as follows:

Consider a strength tensor $T^{12}$, from conservation laws we obtain

$$\partial_\nu (T^{12})^{\mu\nu} = 0,$$

where the four-momentum vector at time $t$ is $P^\mu = \int d^4x (T^{12})^{\mu 0} (x, t)$. It is well known that for getting, both, the orbital angular momentum and the spin angular momentum for a particle we need that the stress energy tensor
would not be symmetric, i.e.,

\[ \partial_\mu S^{\alpha\beta\mu}(x) = (T^{12})^{\beta\alpha} - (T^{12})^{\alpha\beta} \neq 0, \]

\[ T^{12}_{\beta\alpha} \neq T^{12}_{\alpha\beta}, \]

where \( S^{\alpha\beta\mu}(x) \) is the well known spin tensor, and

\[ T^{12}_{\beta\alpha} - T^{12}_{\alpha\beta} \]

Gives the torque density showing the rate of conservation between the orbital angular momentum and spin. In the case that the stress energy is a symmetric tensor we get simply the orbital angular momentum and not the spin property, which is the property of the particle without any interaction, according to the proposed model.

4 Quantum formalism, it’s probabilistic structure, and the relation to the model

Consider the field of the particle \( \varphi(r,t) \) and the field that the particle is interact with (it can be other particles, that particle himself or other force fields, "the environment of the particle") as \( \theta(r,t) \), then we write an operator \( * \) which is the convolution of \( \varphi(r,t) \) and \( \theta(r,t) \) such that

\[ \varphi(r,t) * \theta(r,t) = \Lambda_{\varphi,\theta}(r,t). \]

The field \( \Lambda(r,t) \) describes also the quantum properties of the particle \( \varphi(r,t) \) which arises from the interferences between the particle to the environment, including his rotations, which can interference to other rotational field, as a by product of general relativity concepts.

In general

\[ \varphi(r,t) * \theta(r,t) \neq \theta(r,t) * \varphi(r,t). \]

Since we consider this convolution on the particle \( \varphi \), i.e., \( \Lambda_{\varphi,\theta} \) is the evolution of the particle \( \varphi \) under or after the interaction. Under an experiment which
includes the spin property we write, for the quantum formalism

\[ \Lambda_{\varphi, \theta}(\mathbf{r}, t) \xrightarrow{\text{Spin}} \psi(\mathbf{r}, t) = \begin{pmatrix} \psi_1(\mathbf{r}, t) \\ \psi_2(\mathbf{r}, t) \\ \vdots \\ \psi_n(\mathbf{r}, t) \end{pmatrix}, \]

first, we do not consider the physical particle \( \varphi(\mathbf{r}, t) \) as a vector. Therefore, theoretically we shall consider all of the particles to be a scalar fields with zero spin, where under the polarization experiment with magnets we would have the spin property.

From the model it is clear that the quantum properties of the particles are not exist without the experiment that creates those properties, therefore if we want to derive a theory that already consider those properties of the particles to be exist without any of those interactions (such as the spin property) those properties needs to be with superposition state, because it is like to ask a ball in a world without colors what is his color, under the assumption that the ball has the color property, the answer, in QM theory gives all the possible solutions.

### 4.1 Structure of the particles as stationary in spacetime

First, we consider the property of stationary for the spacetime manifold of the particle since we consider the particle to be a curvature and vibration of the spacetime manifolds, where this function of spacetime is stationary and does not depend on the time line, since these particles are supposed to remain with the same physical properties if they would be without any interactions.

Using the Newtonian limit and consider the metric \( g_{\mu\nu} \) we get the well known equation for stationary spacetime

\[ \Box \phi = R, \]

where \( R \) is the Ricci scalar. Suppose that \( R = -\left( \frac{m}{\lambda} \right)^2 \phi \), i.e., \( \lambda \) is a parameter represents the curvature of the field, we have the following equation

\[ \Box \phi = -\left( \frac{m}{\lambda} \right)^2 \phi, \quad (11) \]
which takes the form of the KG equation, which represent's the particle's possible paths arises by the interaction between him to himself or other fields, which depends on the way how we do the experiment.

Notice that according to our model $\phi$ represent all of the particles, and not only a spin zero particle, since we consider the spin property of the particle to be a function of the GR properties of the particle and the properties of the physical environment of the experiment. The solutions of equation (11) provides a discrete energy levels, which can be explained by interference pattern of the field himself or with other fields.

Using the conceptual concepts of the model, the energy values of the particles should not be with the form of special relativity theory, i.e., $E = \sqrt{p^2 + m^2}$ since this is implies on a flat spacetime manifold. Moreover, the physical energy values should be as they appear in general relativity theory under the conservation of energy. Therefore, if we taking into account this concepts, together with the fact that we consider quantum equations, such as the KG equation to be non-physical since it considers a superposition property for the particles, we get that quantum field theory is not a physical theory since it considers special relativity formulae rather than general relativity one, and furthermore it considers the superposition property. Therefore we argue that although this theory is very accurate and useful it is not the physical one. The theory is very close to the real one since we deals with particles that the energy is closed to be with a flat like spacetime, i.e., $E \approx \sqrt{p^2 + m^2}$, where we also consider that the quantum wave equations are correct since they are taking into account the geodesics of the physical environment and the physical fields involving with the interactions of the particles. Since without taking the superposition solution of the wave equations, and consider those solutions simply as a scale of a possible outcomes we can consider QFT to be a close theory to the model proposed here. The model proposed here is not provide a new formulae for the quantum interactions of the particles since we argue that QFT is a useful and precise theory for describing the physical interactions between the particles, where the mathematics of general relativity in its exact solutions is well known to be a very complex solutions, so by dropping our properties that are not coincides with the proposed model, such as superposition, the model of QFT is reliable and useful as a fundamental theory of the physical realm.
4.2 Probabilistic interpretation

Suppose that a particle \( p \) can be described by a finite number of properties \( X_1 + X_2 + \ldots + X_a \) and the properties of the particles and fields that the particle would interact with are represented by a finite number of properties \( Y_1 + Y_2 + \ldots + Y_b \), where the combination of those physical properties provides a new property \( Z_1 \) of the interaction field, this can be represented by the following equation

\[
(X_1 + X_2 + \ldots + X_a) + (Y_1 + Y_2 + \ldots + Y_b) = Z_1,
\]

using the proposed model we taking into account the physical properties of the measurement device as \( T_n \), where we suppose that the measurement device as an influence of the solution of the interaction, and hence

\[
(X_1 + X_2 + \ldots + X_a) + (Y_1 + Y_2 + \ldots + Y_b) + T_n = Z_2 \neq Z_1. \tag{12}
\]

Now, suppose that we consider an order of the properties of the measurement device

\[
T_1, T_2, \ldots
\]

such that a measurement device with \( T_i \) influence of the experiment more than a measurement device with \( T_j, j < i \). So we consider for \( n \to \infty \) the following influence

\[
\lim_{n \to \infty} T_n = \varepsilon \to 0,
\]

therefore for the case that \( n \to \infty \) we get a predictable theory, i.e.

\[
\left( \underbrace{X_1 + X_2 + \ldots + X_a}_\text{Known} \right) + \left( \underbrace{Y_1 + Y_2 + \ldots + Y_b}_\text{Negligible} \right) + \underbrace{\varepsilon \to 0}_\text{Negligible} = Z_3 = Z_1.
\]

In GR the measurement device changes the physical results, when he is particle and he examine a particle, the influence on the result is much more greater.

For particle physics, since the measurement device is also at least a particle-like object we have

\[
\left( \underbrace{X_1 + X_2 + \ldots + X_a}_\text{Known} \right) + \left( \underbrace{Y_1 + Y_2 + \ldots + Y_b}_\text{Unknown} \right) + \underbrace{T_n}_\text{Unknown} = Z_2.
\]

Because of the interference we have a discrete possible values of \( Z_2 \), so for prediction of this value we should use probabilistic models under a discrete
random variables $Z_2$. But, Suppose that we know the physical properties of
the observer, $T_n$, therefore, we should know the value of $Z_2$, but we now
measured it with another, different, measurement device, with the physical
properties $T'_n$, hence

\[
\begin{align*}
\text{Known} & \quad (X_1 + X_2 + \ldots + X_a) + (Y_1 + Y_2 + \ldots + Y_b) + T_n + T'_n = Z_3,
\end{align*}
\]

so again, we would not know the result $Z_3$ so we must use probability. This
under infinite number of measurement devices, and therefore we would use a
probabilistic model.

Finally, in the case the there is not measurement device in the physical
process, and only after the end of the process, such in the case of the double
slit experiment, where a measurement device observe the particle only after
the particle hit the wall. In this case there is no information about the
state of the particle before and during the process of the experiment, and
the physical field of the experiment, thus in this case we also would use a
probabilistic model, since we do not have enough information.

### 4.3 Bell’s theorem and quantum entanglement

From the model it is clear that the quantum properties of the particles are
evolving from the interactions of the particles, i.e., of the field, which is the
particle and other field, which can be the particle himself (e.g. this creates
the self force), or other fields such as other particles or force fields that are
generated by the way that we do the experiment. Let us take, for instance,
the spin property of an electron. By considering two entanglement electrons
with the particle fields $\varphi_1(r,t)$ and $\varphi_2(r,t)$, and suppose that there is anti-
correlation in the spin values. Then by asking, according to the model, what
is the value of the spins of $\varphi_1(r,t)$ and $\varphi_2(r,t)$ this question is meaningless
since they does not have this property since this property is arises due to the
experiments, and the observers that observe this fields. Therefore, The model
rejects the entanglement concept in quantum theory, but together with it,
this model is not a hidden variable model since unlike hidden variable theo-
ries, the question "what is the spin of the particle" is meaningless since this
property does not exist at all for the particle. The "hidden variables" are at
the properties of the field $\varphi(r,t)$ and at the field of the environment of the
The Heisenberg uncertainty principle is well known to be a fundamental concept in quantum theory. This concept can be obtained from the proposed model as follows:

Consider two sets of finite properties of the particle, which describes a quantum property $P_1$ and a different quantum property $P_2$ the physical field of the experiment, respectively,

$$S_{P_1} = \{U_i\}_{i=1}^{N_1}, \quad S_{P_2} = \{V_i\}_{i=1}^{N_2}.$$ 

From (12), in the case that

$$S_{P_1} \cap S_{P_2} \neq \emptyset,$$

where $\emptyset$ is the empty set, we conclude that by measuring property $P_1$ we influence property $P_2$ and vice versa, and we that sat that $P_1$ and $P_2$ are complementary properties. In the case that

$$S_{P_1} \cap S_{P_2} = \emptyset,$$

we conclude that measuring property $P_1$ we do not influence property $P_2$.

5 Hidden variable theories

According to our model, the quantum properties of a physical field $\alpha (x, t)$, i.e., the particle, for some observer are determine according to the physical field of the observer and the physical environment of the particle, and therefore this idea is adverse the hidden variable theories since those properties are not embedded in $\alpha (x, t)$, moreover they are depend on the observer himself (his physical field), and the exterior physical properties of the environment.
6 Further conceptual consequences of the proposed model

- For a different kinds of experiments the properties of the particles should be discrete or continuous, i.e., the properties of the particles can be classical or not, there exist experiments such that the particles would be modeled with classical theories.

- For a free field with a measurement device that closed in its energy value and its physical properties, e.g. photon as a measurement device which examine other photon, the quantum properties should be classical if there is not interference between the particles to himself or to the measurement device.

- The probabilistic nature of the particles as describe in quantum theory is not the physical nature of reality according to the model, as we argue in the paper. Together with that, the model is not a hidden variable theory since those quantum properties of the model does not exist at all if the particle is a free particle without any interaction including any measurements that measure him.

- Since our proposed model states that the different forces in the universe are essentially concludes from the frame reference of the measurement device, the model does not necessarily consider a Lie group that contains $SU(3) \times SU(2) \times U(1)$ since we consider the forces in the universe as different aspects of the same force, and therefore it is sufficient to consider a Lie group that contains $SU(3)$, $SU(2)$ and $U(1)$.

- Zero point energy of the forces: From the model it is clear that the energy of the ground state of the three imaginary forces, in general, can be represented by the Minkowski spacetime metric, since those forces are relying on the curvature of spacetime manifold, although many vacuum states can be represented by very weak curvature metric, but not a flat metric, i.e., the Minkowski space-time metric.

- The model relates between the charge of the particle and his mass, since we consider the charge of the particle as a consequence of the curvature of the spacetime dimensions, and thus, a massless particle does not have
charge, which coincides with the experiments on the charge of massless particle.

- The expanding of the universe: As a conjecture, by assuming that there exist a physical objects which are analog to the visible universe and a single particle, into this objects and our visible universe which we can denote by an object with $e(-1)$ we can, by that, relates the gravitational force (which has infinite distance) of these objects has the "dark matter" (similar to a theory in string theory that conjecture that the visible universe is live of a 4–dimensional membrane where the dark matter is simply the other membranes).

- The property of a particle such as "charge" is "exist" only if he interacting with other particles, since this force is obtained only by the interactions between particles. (the force is simply a function, such as curvature, of spacetime).

- Black holes and singularities: Under Postulate 1 of the proposed model, black holes exist, but, without gravitational singularity. Notice that it is well known that dismissing the singularity from a black hole provide a solution to the information paradox.

6.1 Renormalizable Theories

It is well known that one of the major difficulties of the combination of quantum and general relativity theories arises due to the fact that while quantum field theory is a renormalizable theory, general relativity is not. Unlike the classical quantum models, the proposed model dismisses this major difficulty since the model consider the fundamental forces to be arises from general relativity equations, and therefore all of the models that describe the four fundamental forces are non-renormalizable.

6.2 Quantum superposition and Mach-Zehnder interferometer

First, let us recall that the model dismiss the wave function collapse concept of quantum theory. Since we consider the particles to be a curvature of the
spacetime manifold, we can consider a particle such that in any point in time \( t' \) with a curvature \( G(t') \), the particle provides a trails of geodesics in spacetime (during the interactions), where those trails are not particles, the can be regarded as an "empty waves", this premature property is partially agree with the Bohm interpretation to quantum theory, since it also considers an "empty waves" and a "pilot wave" for describing quantum phenomena which need the superposition property. Notice that this way of thinking provides also an explanation to properties of the particles arises due to the Mach-Zehnder interferometer.

7 Dependence structure of the metric to the interaction tensor

Define an infinitesimal vectors shifts, \( d(A_1)^\mu \) and \( d(A_2)^\mu \)

\[
d(A_j)^\mu = - (\Gamma_j)^\mu_{\alpha\beta} A^\alpha dx^\beta, \quad j = 1, 2,
\]

and define \( dA^\mu \) as follows

\[
d A^\mu = d(A_1)^\mu - D^\mu d(A_2)^\mu = - \left( (\Gamma_1)^\mu_{\alpha\beta} - D_{\alpha\beta} (\Gamma_2)^\mu_{\alpha\beta} \right) A^\alpha dx^\beta
\]

\[
= -\Gamma^\mu_{\alpha\beta} A^\alpha dx^\beta,
\]
where $D^\mu_{\alpha\beta}$ is the interaction tensor of this structure. Thus, the Riemannian tensor $R^\alpha_{\mu\nu\beta}$ in this case takes the form

$$R^\alpha_{\mu\nu\beta} = -\frac{\partial \Gamma^\alpha_{\mu\nu}}{\partial x_\beta} + \Gamma^\alpha_{\sigma\nu} \Gamma^\sigma_{\mu\beta} + \frac{\partial \Gamma^\alpha_{\mu\beta}}{\partial x_\nu} + \Gamma^\alpha_{\mu\nu} \Gamma^\sigma_{\sigma\beta}$$

$$= -\frac{\partial}{\partial x_\beta} (\Gamma_1^\alpha_{\mu\nu} - D^\alpha_{\mu\nu} (\Gamma_2^\alpha_{\mu\nu})) + (\Gamma_1^\alpha_{\nu\nu} - D^\alpha_{\nu\nu} (\Gamma_2^\alpha_{\nu\nu})) \cdot (\Gamma_1^\sigma_{\mu\beta} - D^\sigma_{\mu\beta} (\Gamma_2^\sigma_{\mu\beta}))$$

$$+ \frac{\partial}{\partial x_\nu} (\Gamma_1^\alpha_{\mu\beta} - D^\alpha_{\mu\beta} (\Gamma_2^\alpha_{\mu\beta})) + (\Gamma_1^\alpha_{\mu\nu} - D^\alpha_{\mu\nu} (\Gamma_2^\alpha_{\mu\nu})) \cdot (\Gamma_1^\sigma_{\sigma\beta} - D^\sigma_{\sigma\beta} (\Gamma_2^\sigma_{\sigma\beta}))$$

$$= -\frac{\partial (\Gamma_1^\alpha_{\mu\nu})}{\partial x_\beta} + \frac{\partial D^\alpha_{\mu\beta}}{\partial x_\nu} + (\Gamma_1^\alpha_{\sigma\nu} (\Gamma_1^\sigma_{\mu\beta}) + D^\sigma_{\sigma\nu} (\Gamma_2^\sigma_{\sigma\nu}) D^\sigma_{\mu\beta} (\Gamma_2^\sigma_{\mu\beta}))$$

$$+ \frac{\partial \Gamma^\alpha_{\mu\beta}}{\partial x_\nu} - \frac{\partial D^\alpha_{\mu\beta}}{\partial x_\nu} + (\Gamma_1^\alpha_{\nu\nu} (\Gamma_1^\sigma_{\nu\nu}) - (\Gamma_1^\sigma_{\nu\nu} D^\sigma_{\nu\nu} (\Gamma_2^\sigma_{\nu\nu}))$$

The Ricci tensor is

$$R^\alpha_{\mu\nu} = R^\alpha_{\mu\nu\alpha} = -\frac{\partial \Gamma^\alpha_{\mu\nu}}{\partial x_\alpha} + \Gamma^\alpha_{\mu\beta} \Gamma^\beta_{\nu\alpha} + \frac{\partial \Gamma^\alpha_{\mu\nu}}{\partial x_\alpha} + \Gamma^\alpha_{\mu\nu} \Gamma^\beta_{\nu\alpha}$$

$$= -\frac{\partial}{\partial x_\alpha} (\Gamma_1^\alpha_{\mu\nu} - D^\alpha_{\mu\nu} (\Gamma_2^\alpha_{\mu\nu}))$$

$$+ (\Gamma_1^\alpha_{\mu\beta} - D^\alpha_{\mu\beta} (\Gamma_2^\alpha_{\mu\beta})) \cdot (\Gamma_1^\beta_{\nu\nu} - D^\beta_{\nu\nu} (\Gamma_2^\beta_{\nu\nu})) + \frac{\partial}{\partial x_\nu} (\Gamma_1^\alpha_{\mu\nu} - D^\alpha_{\mu\nu} (\Gamma_2^\alpha_{\mu\nu}))$$

$$+ (\Gamma_1^\alpha_{\nu\nu} (\Gamma_1^\sigma_{\nu\nu}) - (\Gamma_1^\sigma_{\nu\nu} D^\sigma_{\nu\nu} (\Gamma_2^\sigma_{\nu\nu}))$$

$$= -\frac{\partial (\Gamma_1^\alpha_{\mu\nu})}{\partial x_\alpha} + \frac{\partial D^\alpha_{\mu\beta}}{\partial x_\alpha} + (\Gamma_1^\alpha_{\nu\nu} (\Gamma_1^\sigma_{\nu\nu}) - D^\beta_{\nu\nu} (\Gamma_2^\beta_{\nu\nu}) + (\Gamma_1^\beta_{\nu\nu} - D^\beta_{\nu\nu} (\Gamma_2^\beta_{\nu\nu}))$$

$$+ \frac{\partial \Gamma^\alpha_{\mu\nu}}{\partial x_\nu} - \frac{\partial D^\alpha_{\mu\beta}}{\partial x_\nu} + (\Gamma_1^\alpha_{\nu\nu} (\Gamma_1^\sigma_{\nu\nu}) - (\Gamma_1^\sigma_{\nu\nu} D^\sigma_{\nu\nu} (\Gamma_2^\sigma_{\nu\nu}))$$

$$+ \frac{\partial \Gamma^\alpha_{\mu\nu}}{\partial x_\alpha} - \frac{\partial D^\alpha_{\mu\beta}}{\partial x_\alpha} + (\Gamma_1^\alpha_{\nu\nu} (\Gamma_1^\sigma_{\nu\nu}) - (\Gamma_1^\sigma_{\nu\nu} D^\sigma_{\nu\nu} (\Gamma_2^\sigma_{\nu\nu}))$$

$$+ D^\alpha_{\mu\nu} (\Gamma_2^\alpha_{\mu\nu}) + D^\alpha_{\mu\nu} (\Gamma_2^\alpha_{\mu\nu})$$

$$+ D^\alpha_{\nu\nu} (\Gamma_2^\alpha_{\nu\nu}) + D^\alpha_{\nu\nu} (\Gamma_2^\alpha_{\nu\nu}).$$
The variation with respect to the metric $R^{\mu\nu}$ provides the field equations

$$\frac{\partial D^\alpha_{\mu\nu} (\Gamma_2)^{\alpha}_{\mu\nu}}{\partial x_\alpha} + (\Gamma_1)^{\alpha}_{\mu\beta} (\Gamma_1)^{\beta}_{\alpha\nu} + D^\alpha_{\mu\beta} (\Gamma_2)^{\alpha}_{\mu\beta} D^\beta_{\alpha\nu} (\Gamma_2)^{\beta}_{\alpha\nu} + \frac{\partial (\Gamma_1)^{\alpha}_{\mu\alpha}}{\partial x_\nu}$$

$$+ (\Gamma_1)^{\alpha}_{\mu\nu} (\Gamma_1)^{\beta}_{\alpha\beta} + D^\alpha_{\mu\nu} (\Gamma_2)^{\alpha}_{\mu\nu} D^\beta_{\alpha\beta} (\Gamma_2)^{\beta}_{\alpha\beta}$$

$$= \frac{\partial (\Gamma_1)^{\alpha}_{\mu\nu}}{\partial x_\alpha} + D^\beta_{\alpha\nu} (\Gamma_2)^{\beta}_{\alpha\nu} (\Gamma_1)^{\alpha}_{\mu\beta} + D^\alpha_{\mu\beta} (\Gamma_2)^{\alpha}_{\mu\beta} (\Gamma_1)^{\beta}_{\alpha\nu} + \frac{\partial D^\alpha_{\mu\alpha} (\Gamma_2)^{\alpha}_{\mu\alpha}}{\partial x_\nu}$$

$$+ (\Gamma_1)^{\alpha}_{\mu\nu} D^\beta_{\alpha\beta} (\Gamma_2)^{\beta}_{\alpha\beta} + D^\alpha_{\mu\nu} (\Gamma_2)^{\alpha}_{\mu\nu} (\Gamma_1)^{\beta}_{\alpha\beta},$$

which, in general, contains 16 equations.

Further, the variation principle respect to Christoffel symbols $\Gamma^{\alpha}_{\mu\nu}$ contains the 64 equations

$$\frac{\partial g^{\mu\nu}}{\partial x_\alpha} + g^{\beta\nu} \Gamma^{\mu}_{\beta\alpha} + g^{\mu\beta} \Gamma^{\nu}_{\alpha\beta} - \delta^{\mu}_{\alpha} \left( \frac{\partial g^{\beta\nu}}{\partial x_\beta} + g^{\sigma\beta} \Gamma^{\mu}_{\sigma\beta} \right) - g^{\mu\nu} \Gamma^{\beta}_{\alpha\beta} = 0.$$

Here, in general,

$$g^{\mu\nu} \neq g^{\nu\mu}.$$

Now, our goal is to define $g^{\mu\nu}$ as dependent on the interaction variables $D^\mu_{\alpha\beta}$:

$$\frac{\partial g^{\mu\nu}}{\partial x_\alpha} + g^{\beta\nu} \left( (\Gamma_1)^{\mu}_{\beta\alpha} - D^\mu_{\beta\alpha} (\Gamma_2)^{\mu}_{\beta\alpha} \right) + g^{\mu\beta} \left( (\Gamma_1)^{\nu}_{\alpha\beta} - D^{\nu}_{\alpha\beta} (\Gamma_2)^{\nu}_{\alpha\beta} \right)$$

$$= \delta^{\nu}_{\alpha} \left( \frac{\partial g^{\mu\beta}}{\partial x_\beta} + g^{\sigma\beta} \left( (\Gamma_1)^{\mu}_{\sigma\beta} - D^{\mu}_{\sigma\beta} (\Gamma_2)^{\mu}_{\sigma\beta} \right) \right) + g^{\mu\nu} \left( (\Gamma_1)^{\beta}_{\alpha\beta} - D^{\beta}_{\alpha\beta} (\Gamma_2)^{\beta}_{\alpha\beta} \right).$$

### 8 Quantization of fields

Since we consider the matrix interaction $A_{\mu\nu}$ to describe the interaction between particles/fields we can consider the case of interference of those fields, using $A_{\mu\nu}$. Recall that we consider $A_{\mu\nu}$ to be, in general, a function of the coordinates of the matrices where this matrix is not, in general, symmetric. Since $A_{\mu\nu}$ is a function of the coordinates $x^\alpha$ every exact value $x^\alpha_0$ is an exact state of $A_{\mu\nu}$. Therefore we can describe $A_{\mu\nu}$ under conditions an a sequence of interaction part

$$A^{1}_{\mu\nu}, A^{2}_{\mu\nu}, ..., A^{\infty}_{\mu\nu},$$

(13)
where any $A_{j\mu}^i$ is for different ranges of the components $x^\alpha$. Thus, we consider $\Sigma$ as a mapping from space $\mathcal{R}$ of the random variable $X$, to the real line $R$

\[
E : A_{\mu\nu} \mapsto E (A_{\mu\nu}) \in \mathcal{D}^E,
\]

\[
A_{\mu\nu} = \{ A_{\mu\nu}^j \}_{j=1}^\infty
\]

$\mathcal{D}^E$ is the support of the discrete values of energy.

\[
S : A_{\mu\nu} \mapsto (T^{12}_{\mu\nu})_j - (T^{12}_{\nu\mu})_j \mapsto S (A_{\mu\nu}) \in \mathcal{D}^S
\]

$\mathcal{D}^S$ is the support of the discrete values of spin.

\[
L : A_{\mu\nu} \mapsto (T^{12}_{\mu\nu})_j - (T^{12}_{\nu\mu})_j \mapsto L (A_{\mu\nu}) \in \mathcal{D}^L
\]

$\mathcal{D}^L$ is the support of the discrete values of the orbital momentum.

Notice, that in general relativity for a rotating physical object, the rotation provides an interference pattern of spacetime since all of the physical objects are not point-like objects.

We have the sequence $A_{\mu\nu}^1, A_{\mu\nu}^2, ..., A_{\mu\nu}^\infty$ which provides a "support" of energies $E (A_{\mu\nu})_1, E (A_{\mu\nu})_2, ..., E (A_{\mu\nu})_\infty$. Therefore, the zero point energy is

\[
E^0 = \min (E (A_{\mu\nu})_1, E (A_{\mu\nu})_2, ..., E (A_{\mu\nu})_\infty).
\]

If $A_{00}^j$ is not a function of the components $x^\alpha$ therefore

\[
E (A_{\mu\nu})_j = \int_V T^{12}_{00} dV = \int_V (T^{11}_{00} - A_{00}^j T^{22}_{00}) dV = \int_V T^{11}_{00} dV - A_{00}^j \int_V T^{22}_{00} dV = E_1 - A_{00}^j E_2,
\]

and since $E_i, i = 1, 2$, are constants, the discretization of $A_{00} = \{ A_{00}^1, A_{00}^2, ..., A_{00}^\infty \}$ provides the discrete energy levels.

Notice that the discretization of $A_{00}$ provides also a discretization of the orbital angular momentum and spin, since they are depending on the strength tensor, which is

\[
(T^{12}_{\mu\nu})_j - (T^{12}_{\nu\mu})_j = T^{22}_{\mu\nu} (A_{\nu\mu}^j - A_{\mu\nu}^j).
\]
Remark 7 Interaction variables $A_{00}$ for the energy levels of harmonic quantum oscillator: In this case, and recall (14) the energy levels takes the form

$$E_n = \hbar \omega \left( n + \frac{1}{2} \right) = E_1 - A^n_{00} E_2,$$

now, the differences between the energy levels are

$$E_n - E_{n-1} = \hbar \omega = E_2 \left( A^{n-1}_{00} - A^n_{00} \right),$$

so

$$A^n_{00} = A^{n-1}_{00} - \frac{\hbar \omega}{E_2}, \quad n = 1, 2, \ldots,$$

$$A^0_{00} = \frac{E_1}{E_2} - \frac{1}{2} \frac{\hbar \omega}{E_2},$$

which is the sequence of the interaction part $A^n_{00}$.

9 Quantum properties of Black holes

Notice that the vacuum solutions such as Schwarzschild solution is referred to the structure of black holes, therefore, physically one can argue that black holes has no quantum properties since form the above formulation the interaction variable $A_{\mu\nu}$ is vanish or the strength tensor $T^{12}_{\mu\nu}$ is a symmetric tensor and therefore describes the general relativity force.

10 Conclusion

In this paper we obtained an innovative model by postulating two axioms which provide a general structure for the particles and the fundamental forces using special and general relativity theories. We provide a general field equations for describing the interactions in particle physics, where the model rejects the superposition phenomena while we show that the model is not a hidden variable theory. We provides a justification to the probabilistic nature of quantum theory using the model and dismiss quantum entanglement phenomena including the correctness of Bell’s Theorem. We noticed that the model provides many properties of the objects under the spacetime continuum, such as the solution to the black hole information problem since
we dismisses the existence of singularities in the spacetime manifold. Furthermore, we provide a new interpretation to the double slit experiment and provides a testable thought experiment to prove or disprove the proposed model.

References


