The interpretation of quantum mechanics on the basis of independence from the background

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In this paper we consider the interpretation of quantum mechanics on the basis of independence from the background. Spin and tensor networks provide a clear geometric interpretation of quantum entanglement. Also the energy of the particles treated as elements of the spin volume.

The basis of presentation of the reality of our world is a relational view of the universe, this view corresponds to the theory of relativity and quantum mechanics. However, the latter theory is the most radical from the point of view of classical mechanics. It is based on operational approach to reality, as quantum mechanics teaches. The uncertainty principle departs from the classical concepts of momentum and coordinates, replacing the non-commutative rules

\[ p = \hbar k \]
\[ \{p, x\} = -i\hbar \]

For example, the weirdest thing in quantum mechanics is the double-slit experiment. In a strange way, the photon passes simultaneously through two slits and creates an interference pattern on the screen! A photon is an indivisible particle, but simultaneously be in different points of space.

There are many interpretations for this experiment. In this paper we stick to interpretation regardless of the background. This means that before measurement, the particle doesn't know about the specific background of space, she doesn't know about the volume of space. For the particle volume of space can be both large and small.

Based methods regardless of the background lies the notion of spin network, and tensor network. The main parameter is the connection \( \Omega \) of the spin networks ( Wilson loop ).

\[ \Omega^i_k = -\frac{1}{2}\omega^i_k + \lambda K^i_k \]

Where the spin connection \( \omega \) and extrinsic curvature \( K \).

Consider a volume element of the spin network. For this we introduce the concept of spin volume.

\[ V(\Omega) = \int d\Omega^\rho \int d\Omega^\sigma d\Omega^\varphi = \int d\Omega \otimes d\Omega \otimes d\Omega \]

Geometrically the spin volume can be represented in the form of a cube with sides equal to the spin connections.
This view is relative, because the spin volume is not a simple cubic multiplication is the multiplication in a tensor form of the spin connections.

In this work, we make a strong assumption in the form of a postulate, spin volume and time is not commutative, that is, the accuracy of the measurement of the spin volume is limited to the period of time

\[ \{ V(\Omega), t \} = i \frac{c^2}{G\hbar} \]

Where the combination of the speed of light, Planck's constant and the gravitational constant known as the Planck scale.

\[ l^2_p = \frac{G\hbar}{c^3} \approx 10^{-70} (m^2) \]

The non-commutative equation can be linked with others by the uncertainty principle of energy and time.

\[ \{ E, t \} = i\hbar \]

The result is that the energy of the quantum particle can be considered as an element of spin volume

\[ E = \frac{G\hbar^2}{c^2} \int d\Omega^\gamma d\Omega^\rho d\Omega^\beta = \frac{G\hbar^2}{c^2} V(\Omega) \]

Then the total action for the spin network will be as follows

\[ S = \frac{G\hbar^2}{c^2} \int d\Omega^\gamma d\Omega^\rho d\Omega^\beta dt \]

In this definition, the concept of a quantum particle in space, is replaced by the geometric concept of element of spin volume in the form of three-dimensional works of spin connections.

This means a quantum particle can be regarded as part of the spin and tensor networks that do not feel a particular background space, there is no selected volume of space.

This representation is interesting from the point of view of topology. For example, a quantum particle can be represented as a combination of spin connections in the form of a mathematical braid.
\[
E(a,b,c) = \frac{Gh^2}{c^2} \int d\Omega(a) \otimes d\Omega(b) \otimes d\Omega(c)
\]

This formula closer to the point of view of the common origin of the properties of fundamental particles in the standard model, which are combined in the gauge group.

Additionally, the formula can calculate the energy of nonlocal quantum entanglement of two particles. Let the energy of the two particles will be

\[
E(1) = \frac{Gh^2}{c^2} \int d\Omega(1) \otimes d\Omega(1) \\
E(2) = \frac{Gh^2}{c^2} \int d\Omega(2) \otimes d\Omega(2)
\]

Quantum entanglement of two particles can be represented in the form of additional links in the spin network

The distance between the two entangled particles in a spin network is equal to the length of the additional spin connection.

In this case, the energy of nonlocal quantum entanglement of the two parts can be represented as the volume of a truncated cone in the spin space

\[
E(1,2) = \frac{Gh^2}{c^2} \int d\Omega(1) \otimes d\Omega(1,2) \otimes d\Omega(2)
\]

Additional spin connection is determined from the wave function of entangled particles in ordinary space, it is the momentum of the particles, i.e. the wave number

\[
\Omega(1,2) = k(1) + k(2)
\]

In the end, the energy of nonlocal quantum entanglement of two particles will be in the following form

\[
E(1,2) = \frac{Gh^2}{c^2} (k(1) + k(2)) \int d\Omega(1) \otimes d\Omega(2)
\]

Where the metric entanglement

\[
S = tr(\rho \ln \rho)
\]
Thus, there is a nonlocal energetic connection between entangled particles. The formula allows to calculate the nonlocal energy. This means, a possible experimental test of the theory, regardless of background.

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