

Direct Quantum Energy and Information Transfer, Direct Quantum Gravity and Superluminal Phenomena

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Abstract

In quantum physics there are some experiments where energy and information transfers seem to be faster than light speed. In order to overcome this puzzle, the option proposed here is that in these experiments energy and information are not carried by photon or other particles. In the quantum domain space itself is the direct medium of energy and information transfers. This solution provides an original interpretation of the Einstein-Podolski-Rosen experiment and of causality problems for Fermi's two-atom system. In both examples space is a direct medium of energy and information transfer between the particles under consideration. This interpretation of space can be considered plausible and consistent also in virtue of the fact that in the quantum gravity domain the stage of processes functions as a direct medium of information.

Key words: time, space, information transfer, energy transfer, symmetrized quantum potential, light speed, infinite speed, quantum gravity

1. Introduction

We have only an indirect access to reality. It is always something – an image, an idea – that we build on the basis of our experiences. Our reality is built on the foundations provided by the results of our observations. These observations are indeed essential. And the results of the observations are nothing but informations, answers to questions. In the case of quantum physics, we practically make questions to nature, that somewhat answers. An important result that we can draw from these answers is that in the quantum domain it is not possible to separate, from the operative point of view, reality and information and thus information can be considered as the primordial matter of the universe [1]. Information is certainly a primary element in quantum mechanics, it is that which gives form to energy. Information would have an objective nature. It would play an active role in giving "form" to energy and be responsible for quantum processes.

In the course of a quantum experiment, it is information the fundamental element which moves between "source" and "detector" that exist in space. In this picture, clocks can be defined as instruments with

which we measure duration of information motion from source to detector. In quantum physics, time can be considered a measure of information motion. The maximum speed of information motion is light speed.

As regards the actual nature of the information and the way it is carried, the ideas are not yet entirely clear. It is really correct, for example, to speak of a "field" of information, since information does not fall off with distance, neither is it associated with energy in the usual sense. Possibly the notion of field should be widened or, at the quantum level, we should be talking about pre-space structures, or about algebraic relationships that precede the structure of space and time (as it happens in Bohm's view of the implicate order).

In this article, it is considered the situation in which information and energy transfer between source and detector is immediate: in this regard, the suggestive idea is proposed that quantum space itself is the direct information and energy transfer medium between source and detector.

2. The immediate symmetric interpretation of Einstein-Podolski-Rosen experiment and quantum nonlocality

Einstein-Podolski-Rosen (EPR) experiment shows that two quanta A and B which have been together and then sent in space in opposite directions, "are aware" for each other in an instant moment. To be more explicit and illustrate in more detail EPR experiment, let us consider an example given by Bohm [2] in 1951, in which we have a physical system given by a molecule of total spin 0 composed by two spin $1/2$ atoms in a singlet state:

$$\psi(\vec{x}_1, \vec{x}_2) = f_1(\vec{x}_1)f_2(\vec{x}_2)\frac{1}{\sqrt{2}}(u_+v_- - u_-v_+) \quad (1),$$

where $f_1(\vec{x}_1)$, $f_2(\vec{x}_2)$ are non-overlapping packet functions. Here u_{\pm} are the eigenfunctions of the spin operator \hat{s}_{z_1} in the z-direction pertaining to particle 1 and, in analogous way, v_{\pm} are the eigenfunctions of the spin operator \hat{s}_{z_2} in the z-direction pertaining to particle 2: $\hat{s}_{z_1}u_{\pm} = \pm\frac{\hbar}{2}u_{\pm}$,

$\hat{s}_{z_2}v_{\pm} = \pm\frac{\hbar}{2}v_{\pm}$. Given such a state, suppose we perform a spin measurement on system 1 in the z-direction and that we obtain the result spin up. Then, according to the usual quantum theory, the wave function (1) reduces to the first of its summands:

$$\psi \rightarrow f_1f_2u_+v_- \quad (2).$$

As a result, the final wave function is factorizable and we know the state of the unmeasured system 2, namely ψ_- which indicates that the system 2 has spin down. But this outcome depends on the kind of measurement carried out on particle 1. By performing different types of measurement on atom 1 we will bring about distinct states of the atom 2, and this means that as regards spin measurements there are correlations between the two atoms. Although the two partial systems (the atom 1 and the atom 2) are clearly separated in space (in the conventional sense that the outcomes of position measurements on the two systems are widely separated), indeed they cannot be considered physically separated because the state of the atom 2 is instantaneously influenced by the kind of measurements made on the atom 1. Bohm's example shows clearly that entanglement in spin space implies non-locality and non-separability in Euclidean three-dimensional space: this comes about because the spin measurements couple the spin and space variables.

According to EPR experiment, when the spin of a particle A is unilaterally changed, an astounding experimental result is that the other (B) particle's spin "immediately" flips of its own accord. Furthermore, it seems legitimate to think that the means by which the information of the first spin flip is transferred to the second particle (so that it too can flip) is an information which is required to travel faster than the speed of light. While the information transfer may not be simultaneous (limitations on the experimental apparatus prohibit any proof of simultaneity), it nevertheless -- within the time frame of the Planck constant or speeds in excess of the speed of light -- must connect the two particles in some fundamental manner.

Here it is considered the possibility that in EPR experiment space is the direct information medium between elementary particles. There is no information signal in form of photon or some other particle traveling between particles A and B. The time of information transfer between particle A and particle B is zero [3]. In other words, it is space the fundamental entity which assumes an important role in determining non-locality, which produces an instantaneous connection between the two particles as regards the spin measurements: by disturbing system 1, system 2 may indeed be instantaneously influenced despite the big distance separating the two systems thanks to space which puts them in an immediate contact.

In particular, according to a recently suggested interpretation, the instantaneous communication of two subatomic particles in an EPR-type experiment can be seen as an effect of physical space in virtue of the symmetrized quantum potential. The symmetrized quantum potential is an extension of bohmian quantum potential which implies that the space-

like, non-local, instantaneous action of the quantum potential is predicted not only by the forward-time process but also by the time-reverse process and thus it allows us to interpret in the correct way also the time-reverse of quantum processes [4]. In the case of the one-body system the symmetrized quantum potential assumes the form

$$Q = -\frac{\hbar^2}{2m} \left(\begin{array}{c} \frac{\nabla^2 R_1}{R_1} \\ -\frac{\nabla^2 R_2}{R_2} \end{array} \right) \quad (3)$$

where R_1 is the amplitude function of the wave-function $\psi = R_1 e^{iS_1/\hbar}$ describing the forward-time process and R_2 is the amplitude function of the wave-function $\phi = R_2 e^{iS_2/\hbar}$ describing the time-reverse process. The first component, $Q_1 = -\frac{\hbar^2}{2m} \frac{\nabla^2 R_1}{R_1}$, indicates that in the forward-time process

the action of the quantum potential on the particle under consideration is instantaneous, space-like; the second component, $Q_2 = \frac{\hbar^2}{2m} \frac{\nabla^2 R_2}{R_2}$, allows

us to reproduce in the correct way also the time-reverse of the process of the instantaneous action of the quantum potential on that particle. In the case of a many-body system constituted by N particles the symmetrized quantum potential becomes

$$Q = \sum_{i=1}^N -\frac{\hbar^2}{2m_i} \left(\begin{array}{c} \frac{\nabla_i^2 R_1}{R_1} \\ -\frac{\nabla_i^2 R_2}{R_2} \end{array} \right) \quad (4).$$

The symmetrized quantum potential (4) can explain quantum non-locality in many-body systems – and thus EPR experiments - in the correct way (namely also taking into consideration the time-reverse process): it reproduces the fact that the communication between subatomic particles is instantaneous and allows us to interpret in the correct way also the time-reverse of the process of this instantaneous communication. We can say that by means of the symmetrized quantum potential, space itself is informing one particle about the behaviour of the other and opposite [5]. This means, in other words, that in the subatomic world at a fundamental level physical space can be interpreted as an immediate information medium, as an entity that puts the particles in an immediate contact, just thanks to its special state represented by the symmetrized quantum potential. According to the authors' point of view, the symmetrized quantum potential (4) represents the most adequate candidate to introduce in the correct way the idea of space as a direct,

immediate information medium between elementary particles. In synthesis, we can say that in the presence of subatomic particles, space assumes the special state represented by the symmetrized quantum potential which produces an instantaneous communication between them and allows us to interpret in a correct and appropriate way both the forward-time and the time-reverse of the same physical process. We can call this peculiar interpretation of quantum non-locality as the “immediate symmetric interpretation” of quantum non-locality.

3. Causality problems for Fermi’s two-atom system

Space as the “direct information medium” in the form of the symmetrized quantum potential resolves the causality problem of Fermi’s two atoms system: “Let A and B be two atoms or, more generally, a “source” and a “detector” separated by some distance R . At $t=0$ A is in an excited state, B in its ground state, and no photons are present. A theorem is proved that in contrast to Einstein causality and finite signal velocity the excitation probability of B is nonzero immediately after $t=0$. Implications are discussed” [6].

According to the immediate symmetric interpretation of quantum non-locality, excitation probability of B is nonzero because the space in which atoms exist functions as a “direct medium of excitation”. Excitation from atom A to atom B is direct and immediate via space through its special state represented by the symmetrized quantum potential, and not indirect via intermediate particles which move in space from atom A to atom B .

Moreover, it is important to point out that standard quantum mechanics can reproduce only the forward-time process of the causality problem of Fermi’s two atom system, namely only the forward-time process of the excitation from atom A to atom B . Instead, in the symmetrized extension of Bohm’s theory, the special state represented by the symmetrized quantum potential allows us to reproduce in the correct way also the time-reverse of the excitation from atom A to atom B , namely just through the idea of the direct information. The excitation from atom A to atom B arrives instantaneously thanks to the direct, immediate action of space in its special state represented by the symmetrized quantum potential, which allows us to explain in the correct way also the time-reverse of this process.

4. Indirect and Direct Quantum Information and Quantum Energy Transfer

Space in its special state represented by the quantum potential can be considered the real direct medium of information (I) and energy (E) transfers between elementary particles. In a complete physical theory the possibility is opened that the fundamental level of physical reality in which space functions as a direct, immediate information medium (in the form of the special state represented by the symmetrized quantum potential) is the primary element from which every field and object of physics derives and which is able to reproduce the fundamental interactions and physical fields in an unified way. In fact, if non-locality represents the essential characteristic of the physical world and the idea of the symmetrized quantum potential seems the most general and consistent way to introduce non-locality, in a fundamental physical theory the symmetrized quantum potential should assume a fundamental role and the possibility is opened that all the objects of physics emerge from it as special states. In particular, the possibility is opened that there is an important link between this fundamental arena and Planck scale, in particular with the granular structure of space predicted by loop quantum gravity [7].

According to loop quantum gravity, space is made out of quanta of space [8]. Taking into account the immediate symmetric interpretation, the perspective is thus opened that direct quantum information and direct quantum energy transfers run over quanta of space which have the size of Planck length. According to this interpretation, time (t) of direct quantum information transfer and direct energy transfer between particles is zero, velocity (v) is infinite. On the other hand, the time (t) of indirect quantum information and indirect quantum energy transfers via photons or other particles which move in quantum space is more than zero, velocity (v) is light speed.

$(I),(E) \xrightarrow{\text{transfer}} 10^{-35} \rightarrow t = 0, v = \infty$ immediate (timeless) transfer

$(I),(E) \xrightarrow{\text{transfer}} \triangleright 10^{-35} \rightarrow t \triangleright 0, v = c$ temporal transfer

5. A symmetrized extension of Wheeler-DeWitt equation and the symmetrized quantum potential for gravity

In the fundamental level of physical reality where space acts as an immediate information medium, also gravity energy transfer between elementary particles and massive bodies through the elementary grains

of space is direct and immediate. Gravity is generated by the quantum structure of space. The quantum structure of space defines the curvature of space and so the gravity force. Time of energy transfer by gravity is zero.

In order to develop a mathematical model of quantum gravity in which the idea of stage of processes as a direct, immediate information medium can be embedded, we take into consideration here the Wheeler-DeWitt equation, which is a sort of Schrödinger equation for the gravitational field. As we know, in quantum gravity and cosmology universe can be described by a wave-functional Ψ which satisfies the Wheeler-DeWitt (WDW) equation (here we have made the position $\hbar = c = 1$):

$$\left[(8\pi G)G_{abcd} p^{ab} p^{cd} + \frac{1}{16\pi G} \sqrt{g} (2\Lambda - {}^{(3)}R) \right] \Psi = 0 \quad (5),$$

where $G_{abcd} = \frac{1}{2} \sqrt{g} (g_{ac} g_{bd} + g_{ad} g_{bc} - g_{ab} g_{cd})$ is the supermetric, p^{ab} are the momentum operators related to the 3-metric g_{ab} , $g = \det g_{ij}$, ${}^{(3)}R$ is the 3-dimensional curvature scalar, Λ is the cosmological constant, G is the gravitational constant. In the bohmian approach, decomposing the wavefunction Ψ in polar form $\Psi = R e^{iS/\hbar}$ the WDW equation becomes

$$(8\pi G)G_{abcd} \frac{\delta S}{\delta g_{ab}} \frac{\delta S}{\delta g_{cd}} - \frac{1}{16\pi G} \sqrt{g} (2\Lambda - {}^{(3)}R) + Q_G = 0 \quad (6),$$

where

$$Q_G = \hbar^2 N g G_{abcd} \frac{1}{R} \frac{\delta^2 R}{\delta g_{ab} \delta g_{cd}} \quad (7),$$

N being the lapse function. The term Q_G can be defined “quantum potential for gravity”. Besides, in the bohmian approach, Einstein’s equations – in absence of source of matter-energy - assume the following forms:

$$R^{\mu\nu} - \frac{1}{2} g^{\mu\nu} R = -\frac{1}{N} \frac{\delta \int Q_G d^3x}{\delta g_{ij}} \quad (8)$$

for the dynamical parts, and

$$R^{0\nu} - \frac{1}{2} g^{0\nu} R = \frac{Q_G}{2\sqrt{-g}} g^{0\nu} \quad (9)$$

for the non-dynamical part [9, 10]. Equations (6), (8) and (9) show that the term Q_G is responsible of the behaviour of the universe intended as a

whole. It seems therefore that the universe has a sort of aggregate, comprehensive “order” which guides it: this order is just determined by this term, the “quantum potential for gravity”.

This quantum potential for gravity is a sort of generalization of the bohmian quantum potential to the universe as a whole: since its action is instantaneous, like-space, it can be thus considered an appropriate candidate to represent the state special of space in the quantum gravity domain as an immediate, direct information medium. However, just like it happens in the original Bohm ‘s approach, if we imagine to film the process of the instantaneous communication determined by this quantum potential for gravity backwards, namely inverting the sign of time, in the original Bohm’s approach to quantum gravity there is no guarantee that we obtain something that corresponds to what physically happens. In fact, the standard quantum laws regarding WDW equation are not time-symmetric and therefore inverting the sign of time, the filming of the process could not correspond to what physically happens. Although the quantum potential for gravity has a like-space, an instantaneous action, however it comes from WDW equation which is not time-symmetric and therefore its expression cannot be considered completely satisfactory just because it can meet problems inverting the sign of time. Also the bohmian approach to quantum gravity, although allows us to explain quantum non-locality, cannot be considered completely convincing because it is not time-symmetric.

On the basis of these considerations, in order to develop a more appropriate candidate for the state of space in presence of gravitation namely also in symmetric terms in the exchange of t in $-t$, we propose now to introduce a new symmetrized version of the quantum potential for gravity.

In this regard, let us start taking into consideration the standard WDW equation. The standard interpretation of this equation is not time-symmetric. This fact provides an important motivation to search for an interpretation of WDW equation in which a forward-time and reversed-time perspective of the same physical events would be interpreted in the same manner. In this regard, one can think to resolve the problem of time-symmetry in WDW equation, in analogous manner to the considerations made by Wharton in his attempt to develop a time-symmetric formulation of standard quantum mechanics. Let us remember that in Wharton’s model the wave function is no longer a solution of the Schrödinger equation, but instead is the solution $|C(t)\rangle$ to the time-symmetric equation

$$\begin{pmatrix} H & 0 \\ 0 & -H \end{pmatrix} |C(t)\rangle = i\hbar \frac{\partial}{\partial t} |C(t)\rangle \quad (10)$$

where $|C(t)\rangle = \begin{pmatrix} \psi(t) \\ \phi(t) \end{pmatrix}$, $\psi(t)$ is the solution of the standard Schrödinger equation, $\phi(t)$ is the solution to the time-reversed Schrödinger equation. In analogous way, we can introduce a time-symmetric extension of WDW equation of the form

$$\begin{pmatrix} H & 0 \\ 0 & -H \end{pmatrix} C = 0 \quad (11)$$

where

$$H = \left[(8\pi G) G_{abcd} p^{ab} p^{cd} + \frac{1}{16\pi G} \sqrt{g} (2\Lambda - {}^{(3)}R) \right] \quad (12)$$

and $C = \begin{pmatrix} \Psi \\ \Phi \end{pmatrix}$, Ψ is the solution of the standard WDW equation, Φ is the solution of the time-reversed WDW equation.

Now, since bohmian quantum potential for gravity is the element which can reproduce the like-space, instantaneous action of gravity, in order to assure the symmetry in time needed to interpret also the time-reverse process in the correct manner and thus to find the most appropriate candidate for the state of space in the quantum gravity domain as a direct information medium, we can reformulate the bohmian mechanics for the time-symmetric equation (10). In this regard, just like in the original bohmian theory, we decompose the time-symmetric equation (8) into two real equations, by expressing the wave-functionals Ψ and Φ in polar form:

$$\Psi = R_1 e^{iS_1} \quad (13),$$

$$\Phi = R_2 e^{iS_2} \quad (14)$$

where R_1 and R_2 are real amplitude functionals and S_1 and S_2 are real phase functionals. Inserting (13) and (14) into (11) and separating into real and imaginary parts we obtain the following quantum Hamilton-Jacobi equation for quantum general relativity

$$(8\pi G) G_{abcd} \begin{pmatrix} \frac{\delta S_1}{\delta g_{ab}} & \frac{\delta S_1}{\delta g_{cd}} \\ \frac{\delta S_2}{\delta g_{ab}} & \frac{\delta S_2}{\delta g_{cd}} \end{pmatrix} - \frac{1}{16\pi G} \sqrt{g} \begin{pmatrix} 2\Lambda - {}^{(3)}R \\ -2\Lambda + {}^{(3)}R \end{pmatrix} (2\Lambda - {}^{(3)}R) + \begin{pmatrix} Q_{G1} \\ Q_{G2} \end{pmatrix} = 0 \quad (15)$$

where

$$Q_{G1} = \hbar^2 NgG_{abcd} \frac{1}{R_1} \frac{\delta^2 R_1}{\delta g_{ab} \delta g_{cd}} \quad (16),$$

$$Q_{G2} = -\hbar^2 NgG_{abcd} \frac{1}{R_2} \frac{\delta^2 R_2}{\delta g_{ab} \delta g_{cd}} \quad (17).$$

We obtain in this way a symmetrized extension of bohmian version of WDW equation which is characterized by a symmetrized quantum potential for gravity at two components. The first component

$Q_{G1} = \hbar^2 NgG_{abcd} \frac{1}{R_1} \frac{\delta^2 R_1}{\delta g_{ab} \delta g_{cd}}$ can explain the forward-time process of the

space-like, instantaneous action of quantum gravity, the second

component $Q_{G2} = -\hbar^2 NgG_{abcd} \frac{1}{R_2} \frac{\delta^2 R_2}{\delta g_{ab} \delta g_{cd}}$ can reproduce also the time-

reverse of this process, namely the quantum gravity through the instantaneous action. As a consequence, the symmetrized quantum potential for gravity can be considered a good candidate for the state of space in the quantum gravity domain as a direct, immediate information medium. The symmetrized quantum potential for gravity suggests therefore that also in the quantum gravity domain a fundamental stage of physical processes exists which acts as an immediate information medium. On the basis of the symmetrized Bohm's version of non-relativistic quantum mechanics and of the symmetrized Bohm's version of WDW equation, we can therefore conclude that both the wavefunctions of subatomic particles both the wavefunctionals of the gravitational field in the quantum gravity domain determine a space medium, a special state of physical reality (represented, respectively, by the symmetrized quantum potential and the symmetrized quantum potential for gravity) which acts as a direct, immediate information medium.

6. Perspectives about the “immediate interpretation” of subatomic particles and superluminal phenomena

According to the immediate symmetric interpretation of the subatomic world physical phenomena where speed of information and energy transfer is higher than light speed exist. In this regard, it is important to mention, for example, that an experiment was carried out recently from which one can conclude that an electron can tunnel through the potential barrier of an He atom in practically no time.

It is well established that electrons can escape from atoms through tunneling under the influence of strong laser fields, but the timing of the process has been controversial and far too rapid to probe in detail. Eckle and other authors used attosecond angular streaking to place an upper limit of 34 attoseconds and an intensity-averaged upper limit of 12 attoseconds on the tunneling delay time in strong field ionization of a helium atom. The ionization field derives from 5.5-femtosecond-long near-infrared laser pulses with peak intensities ranging from 2.3×10^{14} to 3.5×10^{14} watts per square centimeter (corresponding to a Keldysh parameter variation from 1.45 to 1.17, associated with the onset of efficient tunneling). The technique relies on establishing an absolute reference point in the laboratory frame by elliptical polarization of the laser pulse, from which field-induced momentum shifts of the emergent electron can be assigned to a temporal delay on the basis of the known oscillation of the field vector [11].

It is considered here that electron, and more in general each subatomic particle, can be understood as a direct energy transfer between quanta of space (that have a size of Planck length) and so its speed is infinite. Taking into account the results of sections 2 and 5, this option can be considered plausible in virtue of the following facts. On one hand, in the symmetrized extension of Bohm's non-relativistic quantum mechanics, a fundamental arena (in the form of the special state represented by the symmetrized quantum potential) exists in which space functions as an immediate information medium and, on the other hand, in the symmetrized Bohm's version of WDW equation, space in the quantum gravity domain assumes the special state represented by the symmetrized quantum potential for gravity that acts as an immediate information medium in the universe as a whole.

According to a model introduced recently [12, 13], each subatomic particle is interpreted as the result of the interaction of energy and information with one or more quanta of space, determined by the vibration of these quanta of space at appropriate frequencies. We propose that particles devoid of internal structure, such as quarks, leptons and intermediate bosons, can be seen as the result of the interaction of energy and information with one quantum of space (caused by the vibration of this quantum of space at a certain appropriate frequency); instead, particles endowed with an internal structure such as baryons (constituted by three quarks) and mesons (constituted by a quark-antiquark pair) are given by the interaction of energy and information with more quanta of space (caused by the vibration of these quanta of space at certain appropriate frequencies). These energies and information which are associated with material particles are transmitted

from one quantum of space to another (in the non-relativistic domain) via the symmetrized quantum potential

$$Q = -\frac{\hbar^2}{2m} \left(\frac{\nabla^2 R_1}{R_1} - \frac{\nabla^2 R_2}{R_2} \right) \quad (3).$$

More precisely, according to this model, each quantum of space which gives origin to matter can be described by an harmonic oscillator vibrating at a frequency given by the relation

$$\nu = \frac{|E_n|}{h(k + \frac{3}{2})} \quad (18)$$

where k is a natural number and E_n is the (quantized) energy of the quantum of space and that depends on the ambient situation existing in the region of space under study (of course, E_n will be a positive quantity for unbound states of matter and will be a negative quantity for bound states of matter). Therefore, in the model here proposed we will say that each subatomic particle devoid of internal structure can be interpreted as an entity deriving from an harmonic oscillator vibrating at a frequency given by (18). To each value of the energetic spectrum of a quantum of space there corresponds a particular value of the frequency of vibration of that quantum of space. As regards the link between the value of E_n and the value of k , we assume that the minimum value of k , i.e. $k=0$, corresponds to the first eigenvalue of E_n , that $k=1$ corresponds to the second eigenvalue of E_n , and so on [14]. In the relativistic domain the eigenvalues E_n of the energetic spectrum of the harmonic oscillator of each quantum of space which gives origin to matter are solutions to the Wheeler-DeWitt type equation

$$H\psi(\alpha, t) = 0 \quad (19)$$

where α is a lagrangian variable describing the elongation of the harmonic oscillator and H is the Hamiltonian characterizing it. In particular, in the non-relativistic domain equation (19) reduces to a Schrödinger type equation

$$\left(-i\hbar \frac{\partial}{\partial t} - \frac{\hbar^2}{2m} \frac{\partial^2}{\partial \alpha^2} + 2m\pi^2 \nu^2 \right) \psi(\alpha, t) = 0 \quad (20).$$

In synthesis, the model here introduced opens the perspective that, an electron, for example, can be seen as the result of the interaction of energy and information with one quantum of space, as a consequence of the vibration of this quantum of space at an appropriate frequency. The discrete quantity of energy that a quantum of space assumes when it gives origin to an electron depends on the features of the region into examination, on the situation characterizing that particular region (namely on the type of interaction to which this region is subjected) and is a solution of a Wheeler-DeWitt type equation in the relativistic domain (or of a Schrödinger type equation in the non-relativistic domain). Besides, this frequency is quantized, in agreement with the results of standard quantum mechanics. The energy and information which are associated with the electron are transmitted from one quantum of space to another, in the non-relativistic domain, via the symmetrized quantum potential (3) and the time of these transfers is zero.

In analogous way, a subatomic particle endowed with internal structure can be seen as the result of the interaction of a discrete quantity of energy and information with more QS and each of these QS can be described by an harmonic oscillator vibrating at an appropriate frequency given by relation (18). For example, proton will be given by the interaction of an appropriate energy with three QS which can be interpreted as harmonic oscillators vibrating at a frequency given by (18).

Conclusions

Quantum information transfer and quantum energy transfer via particles have light speed. Several experiments show that quantum information transfer and quantum energy transfer are immediate. Time of transfer is zero, speed of transfer is infinite. Therefore, it is legitimate to introduce the idea that Immediate-Timeless Transfer (ITT) of information and energy are phenomena that physically exist. ITT phenomena run directly via quanta of space. For established scientific mind it is unusual that some phenomena happen with no time passing, but experiments seem to show the opposite. ITT phenomena have experimental data and solid theoretical basis. ITT phenomena prove that time is not a fundamental, a primary physical reality in which the stream of phenomena in universe occur; at a fundamental level, time is a coordinate which merely measures the duration of material motions.

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