THE HYPOTHESIS OF THE QUANTUM SPACE TIME-AETHER

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"The time posseses some other properties
by which it actively affects our world."
N.Kozyrev

ABSTRACT

The purpose of this paper is to state the hypothesis of the Quantum Space-Time which is based on *the unification of the physical meaning of the notions which derive either from the GRT or the QM*. A consequence of this unification is that the physical model which derives from it, has similarities as well as basic diferences with both the GRT and the QM. According to this hypothesis the Quantum Space Time is matter and therefore it can be regarded as *Aether.*

I. INTRODUCTION

The GRT and the QM have been widely applied. However, they interpret the same thing, ie. nature. For this reason many efforts have been made for their unification[1,2,3,4,5]. The hypothesis of the Quantum Space-Time (QST), ie of the Unified Space Time Matter Field, is based on *the unification of the physical meaning of the notions which derive either from the GRT or the QM*. According to the GRT, a particle field consists of a particle mass and a spacetime continuum which surrounds this mass. According to the QM, a particle field is described by means of a matter (De Broglie) wave, which includes the notion of a particle mass. Therefore, the following question arises: is an infinitesimal part of a field spacetime or is it an area which is described by a matter wave? If we want to achieve the unification mentioned, the following principles should be valid[6,7]: *Principle I. "Any infinitesimal spacetime can be regarded as a matter wave". Principle II*: "*In the whole extent of a particle field only those consequences of the GRT, which are compatible with principle I, are valid".* Principle II constitutes a restriction but not a clearly defined principle. A consequence of the GRT, which is compatible with Principle I, is that the energy of any oscillating infinitesimal spacetime is equivalent to its internal time, where as internal time is defined a time τ of a phenomenon of comparison. Thus, the following principle III has been proposed[7]. *Principle III. "The energy of any oscillating infinitesimal spacetime is equivalent to its internal time".* This principle will be discussed later in the introduction. Principle I leads to the following statements: *Statement I:* "*A particle field can be described through a spacetime wave function which is identical to the particle wave function of the field". Statement II:* "*Any physical magnitude can be expressed equivalently in a coordinate system of a euclidean space-time of reference, both as a spacetime and as a quantum - particle magnitude".* From principle I derives the following corollary[6]: *Corollary I*: *"The existence or the non existence of energy implies the existence or the non existence of spacetime, and consequently the existence or the non existence of any geometry".*

Principles I, III imply modifications in the QM since, according to these principles, the notion of a particle exists only as a spacetime entity. In order that the QST is valid the QM should describe a Hypothetical Measuring Field (HMF), because according to the QM it is considered that there does not exist any spacetime deformity; the HMF is defined in that part of the introduction which is dedicated to definitions.

A purpose of this paper is to show that the QST can be defined through principles I and III. Principle III can be regarded as deriving from the GRT but it can be extended to non relativistic forms when it is related to a stochastic matter spacetime. However, the question is raised on how spacetime can be regarded as a stochastic magnitude.

In the case that space and time are considered to correspond to the deeper reasons of reality, a scientific formalism only is insufficient and a philosophical quest is needed. According to the process through which Goedel's theorem is proved[8], two contradictory statements are valid at the same time. This leads to the following statement "A": "There exists no system of axioms, those of logic included, represented in Peano's arithmetic , which will not lead into contradiction." This statement does not constitute expression of any of Goedel's theorems which are based on the hypothesis that all axioms are consistent; this Goedel's hypothesis of course is arbitrary. A basic axiom of Peano's arithmetic declares the existence of time since it claims the existence of "next" ie. of "earlier" and "posterior". Time, however, implies space, since time must exist somewhere; if time "exists" nowhere it cannot be found, ie it is impossible to exist and to be measured. Inversely, space implies time, since space must be measurable; if I say "10 meters", I mean the existence of 1, 2, 3,....10, ie the existence of "earlier" and "posterior" or the existence of time. *If for reasons of communication consistency* we claim the validity of logic [9], statement "A" will constitute an application of logic in arithmetic and furthermore an application of logic in statements concerning *every spacetime.* This means that spacetime is characterized by uncertainty; therefore it can be regarded as a stochastic phenomenon, and , according to the gained experience through the QM, it behaves like matter ie. like ***aether.***

As far as principle III is concerned, it expresses a deep relationship between energy and time. According to corollary I, the existence of energy dE of a spacetime dÙ is the condition in order that dÙ exists. However, as it has been mentioned, the condition for a spacetime to exist is the existence of "earlier" and "posterior". Thus, the energy dE can be regarded as the ability of dÙ to produce the "next". If a "next" stops to exist, dÙ stops to exist too; therefore, energy can be regarded as the permanent ability of dÙ to produce the "next". However, the quantitative expression of energy dE measures the ability of dÙ to produce "one next" e.g. the ability of an interval between two successive hits of a clock connected to dÙ to exist; therefore, we may assume that dE measures the duration between these two successive hits. This duration can be measured with respect to the reference spacetime. If dÙ had energy 2dE the duration of these two successive hits would be twice as many and so on. Thus , we could assume that:

$$dE \sim \delta t \tag{1}$$

where δt is the internal time of dÙ, ie the time of a phenomenon of comparison e.g. the duration between two successive hits of a clock in dÙ meassured in the reference spacetime. This result, according to what was mentioned, expresses principle III. It is noted that for $\delta t \to 0$ eqn(1) can be valid for any changing infinitesimal spacetime element.

Another purpose of this paper is to explain -through the physical model which derives from this hypothesis- basic physical phenomena and laws; the explanations are exposed in chapter III. It is noted that efforts have been made to connect matter with space and time [10,11,12] and that large number of experiments are related to Kozyrev's ideas[10,13,14]. Kozyrev stated that "The time possesses some other properties by which it actively affects our World" and called these properties physical or active, in contrast to the geometric (passive) property of duration[10].

It is also noted that there is a large argumentation and experimental work (Casimir effect) related to the Zero Point Energy (ZPE) [5]. According to this concept the vacuum can be a source of energy, gravity and inertia; these phenomena can be held through changes of the vacuum. The same are valid according to this paper; we can have radiation through spacetime expansion (see chapter III sections 1,5) and force creation through lowering the relative time behind a body (see chapter III section 2). Thus the question is raised: *Is matter something different from spacetime or is quantum spacetime itself matter ?* According to what was mentioned, a purpose of this paper is to support the point of view that matter is the quantum spacetime itself .

For the purposes of this paper the following definitions are useful:

i. *As reference spacetime we define a euclidean spacetime to which, through transformations of deformity, any field can correspond.* This reference spacetime is not only a geometrical notion because, according to the present hypothesis, it is also matter. Any magnitude of it will be denoted by the subscript $_0$. According to what was mentioned in the introduction, due to uncertainty, it is impossible to have euclidean spacetime. However, for the purposes of this paper, we assume that there exists hypothetical euclidean spacetime. This is compatible with the spirit of this paper, as it will be shown in chapter II section 2. In practice, we can have euclidean spacetime in areas of low energy density; e.g. the space in which we live with a great approximation can be regarded as euclidean. A point A_0 of the reference spacetime occupies by the action of the field a position $A \neq A_0$

ii. *As Hypothetical Measuring Field (*HMF) it is defined *a hypothetical field, which consists of the reference spacetime, in which at every point A_0 the real characteristics of the corresponding point* A *of the real field exist.*

iii. *In a* HMF *we define as relative spacetime magnitude sr, the ratio of a real infinitesimal spacetime magnitude ds to the corresponding infinitesimal magnitude ds_0 of the reference spacetime*: i.e. $sr = ds / ds_0$. This can apply to any magnitude as follows :

a) Relative time $tr = dt / dt_0$, where dt is an infinitesimal time of comparison. b) *Relative length* in a direction $\vec{n}$ $lr_n = dl_n / dl_{n0}$ where dl_n is an infinitesimal length of comparison in a direction

$\vec{n}$. c) *Relative volume* $vr = dv/dv_0$ where dv is an infinitesimal volume of comparison. The relative spacetime magnitudes mentioned above, are denoted by SR, TR, VR, LR_n when they refer to spacetime which is connected to a moving particle. Relative spacetime magnitudes can apply either to a spacetime continuum, or to a statistical matter field. In the latter case the above magnitudes are denoted by $\overline{sr}, \overline{tr}, \overline{lr}_{n,} \overline{vr}$ where the superscript ($\overline{\ }$) denotes the local mean value.

II. THE HYPOTHETICAL MEASURING FIELD (HMF)

1. General

As it was mentioned in the introduction, in order that the hypothesis of the QST is valid, the QM should describe an HMF because in the QM it is considered that there is no spacetime deformity. Statement II states that any spacetime magnitude can be regarded as a quantum-particle magnitude. *Therefore, an equivalent particle is needed so that statement II can be applied; this equivalent particle is hypothetical because principles I and III imply that a particle field is a spacetime entity.* This equivalent particle describes the HMF through which the various spacetime magnitudes of the QST - Aether can be defined as it will be shown in section 6 of this chapter.

2. Application of Principle III

According to principle III, in the HMF we have :

$$dE/dE_0 = dt/dt_0 = tr \tag{2}$$

where dt an infinitesimal time of comparison, tr the relative time and dE , dE_0 are the energy of spacetime which correspond to each other through the transformations of deformity. Eqn (2) is relativistic since it is considered that the corresponding spacetime themselves are matter and they have energy dE , dE_0 respectively. Therefore it is valid also that[15]:

$$tr = 1/vr \tag{3}$$

However, principle III can be extended to non relativistic forms. In fact, in a stochastic space time we have from eqns (2,3):

$$\frac{d\overline{E}}{dE_0} = \frac{\overline{dt}}{dt_0} = \overline{tr} = \overline{\left(\frac{1}{vr}\right)} \neq \frac{1}{\overline{vr}} \tag{4}$$

where the superscript ($\overline{\ }$) denotes the local mean value. Thus, according to principle III, we have that $d\overline{E}/dE_0 = \overline{dt}/dt_0$, which is compatible to the relativity theory and that $\overline{tr} \neq 1/\overline{vr}$, which is non compatible.

It is noted that in a stochastic (real) spacetime - due to uncertainty - only the mean values are measurable. In the later principle III can be used only in the in the form of eqn(4); when it is used in the relativistic form of eqns (2,3) it refers only to a hypothetical matter spacetime.

For the energy expectation value of a spacetime particle field because of eqn(4) we have:

$$\begin{aligned} \langle E \rangle &= \int \overline{dE} = \int \overline{tr}(dE_0/dV_0)dV_0 = (E_0/V_0)\int \overline{tr} dV_0 = E_0\langle \overline{tr} \rangle \\ &and \quad \langle \overline{tr} \rangle = \langle E \rangle / E_0 \end{aligned} \tag{5}$$

where E_0 and V_0 are the energy and the volume of the reference spacetime respectively. From eqn(5) for an energy state E we obtain that:

$$\langle \overline{tr} \rangle_E = E/E_0 \tag{6}$$

3. Equivalent Particle Space Time Magnitudes

For an energy state E of the equivalent particle mentioned in section 1 , according to statement II, a relative time TR and a relative length in a direction $\vec{n}$ LR_n should be observed through a spacetime measuring system connected to this particle, so that:

$$TR = \langle \overline{tr} \rangle_E \quad \text{and} \quad LR_n = \langle \overline{lr}_n \rangle_E \tag{7}$$

Because of eqns (6,7) we have that $TR = E/E_0$ which means that the equivalent particle obeys the SRT on condition that this particle has rest energy equal to the energy of the reference spacetime i.e. $E_0 = m_0 c^2$.

At this point we should make the following elucidations:

1.For the purposes of this paper the SRT is applied only when it relates to the HMF and not to the real field itself which is regarded as aether.
2.*The equivalent particle and its connected spacetime measuring system do not exist in reality; they only help us to describe the spacetime magnitudes in a proper form so that they can be regarded as quantum -particle magnitudes according to statement II.*
In the connected to the equivalent particle spacetime measuring system, we can observe relative spacetime magnitudes for which the following are valid:
For the relative time with respect to the reference spacetime:

$$TR = \gamma = E / m_0 c^2 \tag{8}$$

For the relative volume:

$$VR = m_0 c^2 / E \tag{9}$$

For the relative length in a direction $\vec{n}$:

$$LR_n = \left(1 - \frac{\vec{v}_n^{\,2}}{c^2}\right)^{1/2} = \left(1 - c^2 \frac{m^2 \vec{v}_n^{\,2}}{m^2 c^4}\right)^{1/2} = \left(1 - c^2 \frac{\vec{P}_n^{\,2}}{E^2}\right)^{1/2} \tag{10}$$

Where E is the energy, $\vec{P}_n$ the momentum in a direction $\vec{n}$ and $m_0 c^2$ the rest energy of the particle. Taking into account the above mentioned and principle III, we notice that TR, VR, LR_n *behave as relative spacetime magnitudes of a hypothetical flat matter spacetime of energy E with respect to a hypothetical flat matter spacetime of energy* $E_0 = m_0 c^2$. Since the relative magnitudes TR, VR, LR_n are expressed with respect to a reference spacetime with energy $E_0 = m_0 c^2$, the question is posed on how these magnitudes are expressed with respect to a reference spacetime with $E_0 \neq m_0 c^2$. Applying principle III *to the hypothetical flat matter spacetime* of energy $E, m_0 c^2, E_0$ respectively and taking into account eqns(8,9,10) we find that the equivalent particle spacetime magnitudes TR, VR, LR_n defined with respect to a reference spacetime with $E_0 \neq m_0 c^2$ are:

$$TR = \frac{E}{E_0}, \quad VR = \frac{E_0}{E}, \quad LR_n = \left(1 - c^2 \frac{\vec{P}_n^{\,2}}{E^2}\right)^{1/2} \frac{E_0}{m_0 c^2} \tag{11}$$

4. Ψ Function and Operators of TR, VR, LR_n

Since the equivalent particle obeys the SRT (on the basis of the elucidations of section 3) it will be valid that:

$$E^2 = c^2 \vec{P}^2 + m_0^{\,2} c^4 \tag{12}$$

Taking into account the QM operators and eqn(12), the Schroendinger relativistic equation is obtained. Thus, we have:

$$-\hbar^2 \partial^2 \Psi / \partial t^2 = -\hbar^2 c^2 \nabla^2 \Psi + m_0^{\,2} c^4 \Psi \tag{13}$$

This eqn describes the HMF and a purpose of sections 4,5,6 of this chapter is to find the functions which correlate various relative spacetime magnitudes with the ψ wave function.
According to the principles of the QST, *there does not exist a potential which acts from a far distance, but an action of matter-space-time itself in the whole extent of a matter system [7].* Therefore, eqn (13) expresses the unique equation which describes the HMF of any matter system, since - according to principle I - any infinitesimal spacetime of any spacetime matter system can be regarded as a matter wave; any matter wave, however, locally describes a particle field. Thus, in a matter field, eqn (13) is valid locally and m_o is constant only in an infinitesimal neighborhood of any point (r,t) of the HMF[7].
The spacetime magnitudes TR,VR and LR_n of the equivalent particle behave as particle magnitudes and their operators are obtained by substitution of all these magnitudes by their operators in the corresponding relations ie in eqns (11).

From the QM we have that $\hat{E} = i\hbar \partial / \partial t$ and $\hat{P}_n = -i\hbar \partial / \partial x_n$ (14)

Therefore we have:

$$\hat{TR} = \frac{i\hbar}{E_0} \frac{\partial}{\partial t}, \quad \hat{VR} = \frac{-iE_0}{\hbar} \frac{1}{\partial / \partial t}, \quad \hat{LR}_n = \left(1 - c^2 \frac{\partial^2 / \partial x_n^{\,2}}{\partial^2 / \partial t^2}\right)^{1/2} \frac{E_0}{m_0 c^2} \tag{15}$$

Even though these operators are unusual (they act both through numerator and denominator), the principles of this hypothesis are adequate to show the way of their use. These will be shown in section 4 of this chapter.

5. Expectation Values of TR, VR, LR_n

As was mentioned TR,VR and LR_n are spacetime magnitudes of the equivalent particle and behave as particle magnitudes. According to this hypothesis the QM is valid on condition that it describes the HMF. According to the QM, the expectation value of a magnitude S of a particle field is given by the equation:

$$\langle S\rangle = \int \Psi^*(\hat{S}\Psi)dr^3 \qquad (16)$$

This equation is valid on the basis that $P(r,t) = \Psi^*\Psi$. Substituting in eqn(16) the term Ψ* by $P(r,t)/\Psi$, we obtain:

$$\langle S\rangle = \int \frac{P(r,t)}{\Psi}(\hat{S}\Psi)dr^3 \qquad (17)$$

Claiming that $\int P(r,t)dr^3 = 1$, ie. claiming a continuous normalization of Ψ we have :

$$\langle S\rangle = \langle S\rangle\int P(r,t)dr^3 = \int \langle S\rangle P(r,t)dr^3 \qquad (18)$$

Thus, from eqns (17, 18) we obtain that: $\hat{S}\Psi = \langle S\rangle\Psi$, ie. the substitution:

$$\langle S\rangle \to \hat{S} \qquad (19)$$

Therefore $\langle S\rangle$ behaves as an eigenvalue of S with eigenfunction Ψ.

The above mentioned function $P(r,t)$ can be derived from Schroedinger's relativistic equation because this equation(eqn 13) characterize the field we study. $\int P(r,t)dr^3$ relative to this eqn is the only integral which is intependent of time [16,17] and therefore when $P(r,t)$ derives from this equation ψ can be self normalized. The reason why this function $P(r,t)$ can be regarded as probability density will be shown in section 6 of this chapter.

According to the methodology of the QM, any equation between particle magnitudes is valid also between the operators of the same magnitudes[16,17]. However, relations (19) show that any equation between operators of particle magnitudes is valid also between the expectation values of the same magnitudes. Thus, we may state the following :

" If the Ψ wave function of a particle field is self normalized any equation between particle magnitudes is valid also between the expectation values of the same magnitudes".

Applying this statement to eqns (11) we obtain:

$$\langle TR\rangle = \langle \overline{tr}\rangle = \langle E\rangle / E_o\,,\ \langle VR\rangle = \frac{E_0}{\langle E\rangle}\,,\quad \langle LR_n\rangle = \left(1 - c^2\langle\vec{P}\rangle_n^{\,2}/\langle E\rangle^2\right)^{1/2}\frac{E_0}{m_0c^2} \qquad (20)$$

Because of relations (19) we have the substitutions:

$$\langle E\rangle^2 \to \hat{E}\hat{E} \quad \text{and} \quad \langle\vec{P}\rangle_n^{\,2} \to \hat{P}_n\hat{P}_n$$

Thus we obtain: $-(\hbar^2\partial^2\Psi/\partial t^2)/\Psi = \langle E\rangle^2,\quad -(\hbar^2\partial^2\Psi/\partial x_n^{\,2})/\Psi = \langle\vec{P}\rangle_n^{\,2}$ (21)

Taking into account eqns(20,21) and relations (19) we have:

$$\langle TR\rangle = \frac{i\hbar}{E_0\Psi}\frac{\partial\Psi}{\partial t}\,,\ \langle VR\rangle = \frac{-iE_0}{\hbar}\frac{\Psi}{\partial\Psi/\partial t}\,,\ \langle LR_n\rangle = \left(1 - c^2\frac{\partial^2\Psi/\partial x_n^{\,2}}{\partial^2\Psi/\partial t^2}\right)^{1/2}\frac{E_0}{m_0c^2} \qquad (22)$$

and $\quad \hat{TR}\Psi = \langle TR\rangle\Psi,\ \hat{VR}\Psi = \langle VR\rangle\Psi,\ \hat{LR}_n\Psi = \langle LR_n\rangle\Psi$ (23)

6. The Quantum Space Time-Aether Geometry In the HMF, for a relative spacetime magnitude $\overline{sr}$ by definition it is valid that: $\quad \langle\overline{sr}\rangle = \frac{1}{V_0}\int\overline{sr}(r,t)dr^3$

(24)

where V_0 is the volume of the reference spacetime. Because of corollary I, a space time magnitude has a probability to exist on condition that there exists energy, i.e.matter. In the HMF, by definition, the energy distribution refers to real magnitudes of energy. Thus, the probability density in the HMF equals the probability density, which is obtained according to the QM. Therefore, the probability density of a particle field describes the probability density of energy and of any spacetime magnitude to exist in the HMF. For the probability density it is valid that $\int P(r,t)dr^3 = 1$.

Thus, because of eqn (24) we will have that:

$$\int P(r,t)\ \langle\overline{sr}\rangle dr^3 = \frac{1}{V_0}\int \overline{sr}\ \ (r,t)dr^3 \ \text{ and } \ \overline{sr}(r,t) = \langle\overline{sr}\rangle V_0 P(r,t) \tag{25}$$

As was mentioned in section 5, $P(r,t)$ derives from Schroedinger's relativistic equation(13). It is noted *that $P(r,t)$ of Schroedinger's relativistic equation, according to what has been accepted, cannot be considered as probability density, because it is not always positive* [16,17]. However since eqn(12) has either a positive or a negative eigenvalues, according to principle III there exists either positive or negative time; this implies that $\overline{sr}(r,t)$, $P(r,t)$ can be either positive or negative. In general we can write: $P(r,t) = \delta_s|\Psi|^2$ (26)

where δ_s =1 for matter and δ_s =-1 for antimatter in the case of a particle($\langle\overline{sr}\rangle$>0) and δ_s =-1 for matter, δ_s =1 for antimatter in the case of an antiparticle ($\langle\overline{sr}\rangle$<0). According to eqn (26) the real axis is not perpedicular i.e its direction changes in time with respect to the imaginary one; therefore P(r,t) is not reduced to the form $\Psi^*\Psi$, but it continues to derive from $|\Psi|^2$ as it does according to the QM[6,7]. It is noted that nothing compels us to accept that the imaginary axis should be perpedicular to the real one; the physical sense of various magnitudes gives sense to the complex representation[6].

According to what was mentioned in section 4 of this chapter a matter field locally describes a particle field. Thus taking into account the way through which eqn(25) has been obtained we have:

$$\overline{sr}(r,t) = \langle\overline{sr}\rangle_i V_o P_1(r,t) = \langle\overline{sr}\rangle V_o P(r,t) \tag{27}$$

where $\langle\overline{sr}\rangle_i$, $P_i(r,t)$ refer to local particle fields and $\langle\overline{sr}\rangle$, $P(r,t)$ to the whole matter system. From Shroedinger's relativistic equation in a system with $\hbar = c = 1$ we have[16,17]:

$$P_i(r,t) = (i/2m_{i0})\left(\Psi^*\partial_t\Psi - \Psi\partial_t\Psi^*\right),\ \Box\Psi = -m_{i0}{}^2\Psi \text{ and } m_{i0} = i(\frac{\Box\Psi}{\Psi})^{1/2} \tag{28}$$

where $\Box = \partial^2/\partial t^2 - \nabla^2$.

Because of statement II, we have that $\langle\overline{sr}\rangle_i = \langle SR\rangle_i$ where $\langle SR\rangle_i$ is the corresponding to $\langle\overline{sr}\rangle_i$ particle - quantum magnitude. We obtain values of $\langle SR\rangle_i$ and more specifically of $\langle TR\rangle_i$ and $\langle LR_n\rangle_i$ from eqns(22). Thus, in the HMF, because of eqns(22,27,28) for relative time and relative length in a direction $\vec{n}$ we obtain:

$$\overline{tr}(r,t) = \frac{iV_0}{2E_0}\frac{\partial_t\Psi}{(\Psi\Box\Psi)^{1/2}}\left(\Psi^*\partial_t\Psi - \Psi\partial_t\Psi^*\right) \tag{29}$$

and
$$\overline{lr}_n(r,t) = -\frac{iE_0}{2}\frac{\Psi}{\Box\Psi}\left(1 - \frac{\partial^2\Psi/\partial x_n{}^2}{\partial^2\Psi/\partial t^2}\right)^{1/2}\left(\Psi^*\partial_t\Psi - \Psi\partial_t\Psi^*\right) \tag{30}$$

As it was mentioned, the ψ wave function of a matter system locally describes a particle field. Therefore, eqns(29,30) can be extended to a matter system in general. Eqns (29,30) describe the HMF with spacetime terms. This HMF derives from eqn (13) which describes a mass -gravitational (g) space whose gravitational acceleration is given by eqn(41) (see chapter III section 2). According to a previous work the charge space i.e. the electromagnetic (em) space is regarded as an imaginary gravitational space which coexists with the real one, the two of them being interconnected[7]. Thus, eqns (29,30) are also valid for the (em) space on condition that the ψ function corresponds to charge[7]. Taking into account the definition of $\overline{tr}$ and $\overline{lr}_n$ *the mean quantum spacetime-aether geometry can be defined through eqns(29,30) applied both to the (g) and to the (em) space.* Thus the quantum spacetime transformations of deformity can be obtained. It is noted that these transformations locally cannot be regarded as Lorentz transformations (see chapter III section 3).

III. EXPLANATIONS OF VARIOUS PHYSICAL PHENOMENA

1. Universe's Expansion and Second Law

Because of eqns(36,38) for relative time and volume it holds:

$$\overline{tr}(r,t)=\langle TR\rangle_i V_o P_i(r,t)=\frac{\langle E\rangle_i}{E_0}V_o P_i(r,t)=\langle\overline{tr}\rangle V_0 P(r,t)=\frac{\overline{E}}{E_0}V_o P(r,t)$$

$$\overline{vr}(r,t)=\langle VR\rangle_i V_o P_i(r,t)=\langle V\rangle_i P_i(r,t)=\langle\overline{vr}\rangle V_o P(r,t)=\overline{V}P(r,t) \tag{31}$$

Thus, we have $\dfrac{\langle E\rangle_i}{\langle V\rangle_i}=\dfrac{\overline{E}}{\overline{V}}$ (32)

where $\overline{E}$, $\overline{V}$, are the mean energy and mean volume of the whole matter system.

Because of the expansion of the Universe, we may assume that the mean value $\overline{V}_g$ of volume in a closed matter system of (g) space has a trend to increase. If it was valid that at any point of the HMF of the matter system the equivalent local expectation volume $\langle V_g\rangle_i$ had a trend to decrease, then we should assume that the whole matter system exists under conditions of volume contraction. Thus, in order that $\overline{V}_g\uparrow$, at least one point must exist,for which it is valid that:

$$\overline{V}_g\uparrow,\quad \langle V_g\rangle_i\uparrow \tag{33}$$

However, because of eqns(20) we have:

$$\langle TR_g\rangle_i=1/\langle VR_g\rangle_i,\quad \langle E_g\rangle_i/E_0=V_0/\langle V_g\rangle_i \quad\text{and}\quad \langle E_g\rangle_i\langle V_g\rangle_i=E_0V_0 \tag{34}$$

The product E_0V_0 has been found in prior work[6] to be equal to hc. Therefore, because of eqn(32,34) and relations(33) we have that: $\langle E_g\rangle_i\downarrow,\ \overline{E}_g\downarrow$ (35)

Applying the conservation principle for the whole matter system, we have that:

$$d(\overline{E}_g+\overline{E}_{em-g})=0 \tag{36}$$

where the subscript em-g indicates an equal amount of energy of (em) space expressed in the (g) space. Because of relation(35) and eqn(36) we have that:

$$d\overline{E}_{em-g}\geq 0 \tag{37}$$

Inequality(37) states that always energy of (g) space is converted into (em) space . Because of eqn(12), eqn(13) has either real eigenvalues which correspond to the (g) space or imaginary eigenvalues which correspond to the (em) space. For $m_0=0$ which corresponds to photons eqn(13) has both real and imaginary eigenvalues. Thus, we may assume that the (g) space can be converted into (em) space and vice-versa only through photons. Therefore in general, because of relations(35,37), energy of (g) space is converted into photons a part of which heats the whole system, while another part is converted into charge space. Thus, we can write:

$$dQ=TdS=\phi d\overline{E}_{em-g}\geq 0\quad (0\leq\phi\leq 1)\ ) \tag{38}$$

where T is the temperature of a body, whose entropy equals the entropy of the system under study, for which relations(38) are valid. From relations(38) we obtain: $dS\geq 0$

This inequality expresses the second law.

2. Gravitation and Manner of Forces' Unification

According to statement II, in the HMF, the energy of a field can be expressed both with quantum and spacetime terms. Thus, we have:

$dE=dE_0\overline{tr}(r,t)=dE_0/dV_0\overline{tr}(r,t)dV_0=DE_0\overline{tr}(r,t)dr^3=\langle E\rangle P(r,t)dr^3$ and

$$\overline{tr}(r,t)=\frac{\langle E\rangle}{DE_0}P(r,t) \tag{39}$$

where DE_0 the energy density of the reference spacetime. This eqn can be generalized for a many bodies system and in that case $P(r,t)$ represents the **matter** probability density. The energy $\langle E\rangle P(r,t)dr^3$ corresponds to a mass $d\overline{m}=\dfrac{\langle E\rangle}{c^2}P(r,t)dr^3$. In order for that mass to move in a direction x_i from the energy level $\langle E\rangle P(r,t)dr^3$ to the energy level $\langle E\rangle(P(r,t)+\dfrac{\partial P(r,t)}{\partial x_i}dx_i)dr^3$ a force $d\vec{F}=d\overline{m}\vec{g}_{xi}$ is needed so that $d\vec{F}dx_i$ equals the diference of the mentioned energy. The magnitude $\vec{g}_{xi}$ can be regarded as the component of the gravitational acceleration of the field in the direction x_i, since it represents the force which must be applied to a unit of mass in order that mass will be distributed according to a probability density. If a foreign particle enters the field, the probability density of the matter system is modified so that this particle will be taken into account. According to this analysis and eqn(39) we have that the gravitational acceleration, expressed in the HMF, is:

$$\vec{g}(r,t)=\frac{c^2}{P(r,t)}\nabla P(r,t)=\frac{c^2}{\overline{tr}(r,t)}\nabla\overline{tr}(r,t) \qquad (40)$$

Taking into account eqns(28) we obtain:

$$\vec{g}(r,t)=\frac{c^2\nabla\left(\Psi^*\partial_t\Psi-\Psi\partial_t\Psi^*\right)}{\left(\Psi^*\partial_t\Psi-\Psi\partial_t\Psi^*\right)} \qquad (41)$$

Equation (41) is valid either for (g) or (em) space, since the (em) space according to this hypothesis, is regarded as a gravitational space with imaginary magnitudes. Therefore, we have that all forces, i.e gravitational of (g) or (em) space and strong force, are based on a unified formula of gravitational acceleration. It is noted that eqn(40), under certain assumptions, is compatible with Newton's law[6].
Because of eqn (40) what is shown in Fig.1a will take place, that is the attraction on an object is attributed to the fact that the spacetime-aether under the object attracts the object more than the upper one and that $\overline{tr}_2>\overline{tr}_1$. If we reduced the energy density under the body[6,7], ie. if we succeed in having $\overline{tr'}_2<\overline{tr}_1$ then an ascending movement of the object will start as it is shown in Fig.1b. Thus, according to this hypothesis, a force like Alcubierre's force[5,18] can be also created. On the basis of the above mentioned, the Casimir effect can be also explained. The particle fields which are trapped in the very small gaps of the Casimir plates have small volume expectation values and according to eqns(6,34) they have high energy expectation values and high mean relative time; on the contrary, particle fields with high volume expectation values out of the plates are not exluded. Thus a gravitational force like the one which is described in fig1 is created resulting in the attraction of the plates. The acting relative time can be both gravitational(g) and electromagnetic(em). However a complete explanation needs more details which is out of the limits of this paper.

a.	b.
$\overline{tr}_1$	$\overline{tr}_1$
$\square \Downarrow$	$\square \Uparrow$
$\overline{tr}_2$	$\overline{tr'}_2$
$\overline{tr}_2 > \overline{tr}_1$	$\overline{tr'}_2 < \overline{tr}_1$

Fig.1

3. Contradiction between the Quantum Space Time and the GRT

Applying eqn (27) for relative time $\overline{tr}$ and relative volume $\overline{vr}$ - both of which are measurable magnitudes -and multiplying both parts we obtain: $\overline{tr}.\overline{vr}=\langle\overline{tr}\rangle\langle\overline{vr}\rangle V_0^{\,2}(P(r,t))^2$

If the GRT was valid, then we should have that $\overline{tr}.\overline{vr}=1$ and $P(r,t)=const$. Thus, we would have that: $1=\int P(r,t)dr^3=P(r,t)\int dr^3=P(r,t)V_0$ and $P(r,t)=1/V_0$

In general $P(r,t)\neq 1/V_0$. Therefore we have that $\overline{tr}.\overline{vr}\neq 1$. Thus Lorentz's transformations are non valid locally - a fact that contadicts both the GRT and the SRT. It is noted that observations related to the stellar abberation contradict the SRT [19,20].

4. **The Self Similarity of Matter Systems**

Because of eqn(27), for a relative length in a direction $\vec{n}$ in a matter system it is valid that:

$$\overline{lr}_n(r,t) = \left\langle \overline{lr}_n \right\rangle_i V_o P_i(r,t) = \left\langle \overline{lr}_n \right\rangle V_o P(r,t)$$

Applying this equation for two different directions $\vec{n}_1$ *and* $\vec{n}_2$ we obtain:

$$\frac{\overline{lr}_{n1}(r,t)}{\overline{lr}_{n2}(r,t)} = \frac{\overline{dl}_{n1}}{\overline{dl}_{n2}} = \frac{\left\langle \overline{lr}_{n1} \right\rangle}{\left\langle \overline{lr}_{n2} \right\rangle} = c_s$$

where $\overline{dl}_{n1}, \overline{dl}_{n2}$ the mean real infinitesimal lengths in the directions $\vec{n}_1$ and $\vec{n}_2$ respectively, corresponding to the same infinitesimal length of the reference spacetime, at any point in the field; c_s has the same value in the whole extent since it is equal to a ratio, which ratio refers to the whole. Thus, the above relation expresses the self similarity of the matter system at time t in the whole of its extent, a fact which is in agreement with fractal geometry, which has been applied widely in matter systems[21,22,23]. It is noted that $\overline{dl}_{n1}, \overline{dl}_{n2}$ are lengths which correspond , according to this hypothesis, to matter.

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