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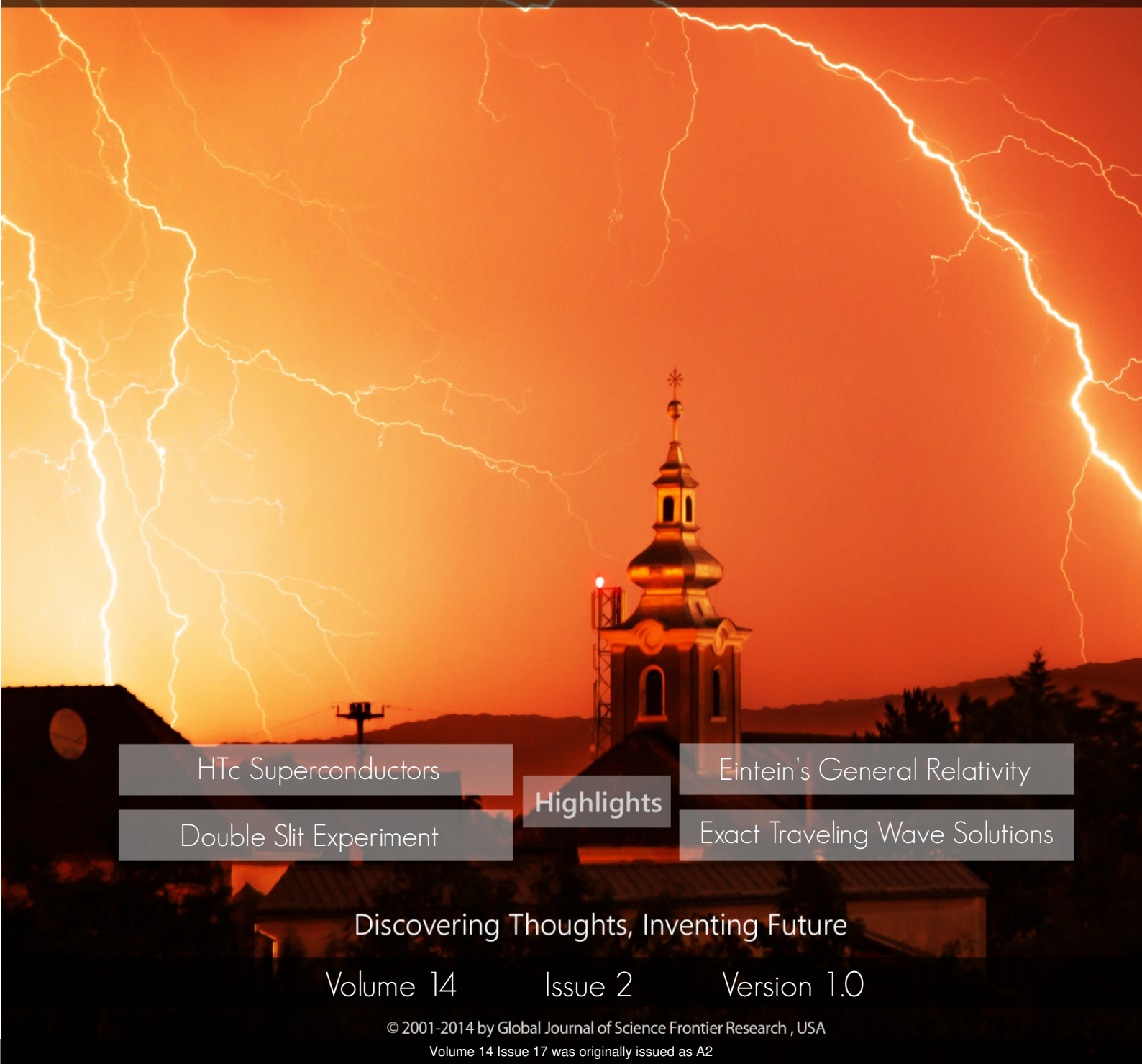

Highlights

- HTc Superconductors
- Double Slit Experiment
- Eintein's General Relativity
- Exact Traveling Wave Solutions

Discovering Thoughts, Inventing Future

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Exact Traveling Wave Solutions for the (2+1)- Dimensional ZK-BBM Equation by Exp $(-\Phi(\eta))$ - Expansion Method

By Harun-Or-Roshid, Md. Nur Alam, Mohammad Mobarak Hossain, Mohammad Safi Ullah, Rafiqul Islam & M. Ali Akbar

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Abstract- In this work, the $\exp(-\Phi(\eta))$ -expansion method is applied to solve the (2+1)-dimensional ZK-BBM equation. The traveling wave solutions are expressed in terms of the exponential functions, the hyperbolic functions, the trigonometric functions and the rational functions. The procedure is simple, direct and constructive without the help of a computer algebra system. The $\exp(-\Phi(\eta))$ –expansion method will be used in further works to establish more entirely new solutions for other kinds of nonlinear evolution equations arising in mathematical physics and engineering.

Keywords: the $\exp(-\Phi(\eta))$ -expansion method; the (2+1)-dimensional ZK-BBM equation; complixiton soliton solutions; traveling wave solutions; solitary wave solutions.

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EXACTTRAVELINGWAVESOLUTIONSFORTHE2+1DIMENSIONALZKBBMEQUATIONBYEXPEXPANSIONMETHOD

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Exact Traveling Wave Solutions for the (2+1)-Dimensional ZK-BBM Equation by Exp $(-\Phi(\eta))$ -Expansion Method

Harun-Or-Roshid [α], Md. Nur Alam [σ], Mohammad Mobarak Hossain [ρ], Mohammad Safi Ullah [ω], Rafiqul Islam [¥] & M. Ali Akbar [§]

Abstract- In this work, the exp$(-\Phi(\eta))$ -expansion method is applied to solve the (2+1)-dimensional ZK-BBM equation. The traveling wave solutions are expressed in terms of the exponential functions, the hyperbolic functions, the trigonometric functions and the rational functions. The procedure is simple, direct and constructive without the help of a computer algebra system. The exp$(-\Phi(\eta))$ -expansion method will be used in further works to establish more entirely new solutions for other kinds of nonlinear evolution equations arising in mathematical physics and engineering.

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I. Introduction

Nonlinear intricate physical phenomena are related to nonlinear partial differential equations (PDEs) which are involved in many fields of sciences, especially fluid mechanics, solid state physics, plasma physics, plasma wave and chemical physics, biology, chemistry, mechanics, etc. Searching for exact solutions of nonlinear PDEs plays an main role in the study of these physical phenomena and gradually becomes one of the most imperative and major farm duties. A huge deal of research work has been carried out during the past decades for the study of the nonlinear evolution equation. Powerful methods which make it possible to generate exact traveling wave solutions to nonlinear equations have emerged from the literatures in the past decades. Among them are the complex hyperbolic function method [1, 2], the Jacobi elliptic function expansion method [3, 4], the F-expansion method [5, 6], the (G′ / G) -expansion method [7-15], the Hirota's bilinear method [16], the Backlund transformation method [17], the Darboux transformation method [18], the homotopy perturbation method [19, 20], the exp$(-\varphi(\eta))$ -expansion method [21- 25] and soon.

The objective of this article is to put into practice the exp$(-\varphi(\eta))$ -expansion method to put up the exact solutions for nonlinear evolution equations in mathematical physics via the (2+1)-dimensional ZK-BBM equation for the first time.

The rest of the paper is organized as follows: In Section 2, we give the description of the exp$(-\varphi(\eta))$ -expansion method. In Section 3, we apply this method to the (2+1)-dimensional ZK-BBM equation. Conclusions are given in the last section.

II. Description of the Exp$(-\Phi(\eta))$-Expansion Method

Let us consider a general nonlinear PDE in the form

$$F(u,u_t,u_x,u_{xx},u_{tt},u_{tx},\ldots), \tag{1}$$

where $u = u(x, t)$ is an unknown function, F is a polynomial in $u(x,t)$ and its derivatives in which highest order derivatives and nonlinear terms are involved and the subscripts stand for the partial derivatives. In the following, we give the main steps of this method:

Step 1: We combine the real variables x and t by a complex variable η

$$u(x,t)=u(\eta), \qquad \eta = x \pm V t, \tag{2}$$

where V is the speed of the traveling wave. The traveling wave transformation (2) converts Eq. (1) into an ordinary differential equation (ODE) for $u = u(\eta)$:

$$\Re(u,u',u'',u''',\cdots), \tag{3}$$

where $\Re$ is a polynomial of u and its derivatives and the superscripts indicate the ordinary derivatives with respect to η .

Step 2: Suppose the traveling wave solution of Eq. (3) can be expressed as follows:

$$u(\eta)=\sum_{i=0}^{N} A_i(\exp(-\Phi(\eta)))^i, \tag{4}$$

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where A_i $(0 \le i \le N)$ are constants to be determined, such that $A_N \neq 0$ and $\Phi = \Phi(\eta)$ satisfies the following ordinary differential equation:

$$\Phi'(\eta) = \exp(-\Phi(\eta)) + \mu \exp(\Phi(\eta)) + \lambda, \tag{5}$$

Eq. (5) gives the following solutions:

Family 1: When $\mu \neq 0$, $\lambda^2 - 4\mu > 0$,

$$\Phi(\eta) = \ln\left(\frac{-\sqrt{(\lambda^2 - 4\mu)}\tanh\left(\frac{\sqrt{(\lambda^2 - 4\mu)}}{2}(\eta + E)\right) - \lambda}{2\mu}\right) \tag{6}$$

Family 2 : When $\mu \neq 0$, $\lambda^2 - 4\mu < 0$,

$$\Phi(\eta) = \ln\left(\frac{\sqrt{(4\mu - \lambda^2)}\tan\left(\frac{\sqrt{(4\mu - \lambda^2)}}{2}(\eta + E)\right) - \lambda}{2\mu}\right) \tag{7}$$

Family 3 : When $\mu = 0$, $\lambda \neq 0$, and $\lambda^2 - 4\mu > 0$,

$$\Phi(\eta) = -\ln\left(\frac{\lambda}{\exp(\lambda(\eta + E)) - 1}\right) \tag{8}$$

Family 4 : When $\mu \neq 0$, $\lambda \neq 0$, and $\lambda^2 - 4\mu = 0$,

$$\Phi(\eta) = \ln\left(-\frac{2(\lambda(\eta + E) + 2)}{\lambda^2(\eta + E)}\right) \tag{9}$$

Family 5 : When $\mu = 0$, $\lambda = 0$, and $\lambda^2 - 4\mu = 0$,

$$\Phi(\eta) = \ln(\eta + E) \tag{10}$$

$A_N, \ldots\ldots, V, \lambda, \mu$ are constants to be determined latter, $A_N \neq 0$, the positive integer N can be determined by considering the homogeneous balance between the highest order derivatives and the nonlinear terms appearing in Eq. (3).

Step 3: We substitute Eq. (4) into Eq. (3) and then we account the function $\exp(-\Phi(\eta))$. As a result of this substitution, we get a polynomial of $\exp(-\Phi(\eta))$. We equate all the coefficients of same power of $\exp(-\Phi(\eta))$ to zero. This procedure yields a system of algebraic equations whichever can be solved to find $A_N, \ldots\ldots V, \lambda, \mu$. Substituting the values of $A_N, \ldots\ldots V, \lambda, \mu$ into Eq. (4) along with general solutions of Eq. (5) completes the determination of the solution of Eq. (1).

III. Applications of the Method

In this section, we will apply the $\exp(-\Phi(\eta))$ -expansion method to make the exact solutions and then the solitary wave solutions of the (2+1)-dimensional ZK-BBM equation. Let us consider the generalized form of the (2+1)-dimensional ZK-BBM equation,

$$u_t - u_x - a(u^2)_x + (bu_{xt} - ku_{yt})_x = 0. \tag{11}$$

where a, b and k are arbitrary constants. It arises as a description of gravity water waves in the long-wave regime.

We apply of the traveling wave variable $u(\eta) = u(x, y, t)$, $\eta = x + y - ct$, Eq. (11) is carried to an ODE

$$u'(1 - c) - 2auu' + cu'''(b - k) = 0. \tag{12}$$

Eq. (12) is integrable, therefore, integrating twice with respect to η once yields:

$$P + u(1 - c) - au^2 + cu''(b - k) = 0, \tag{13}$$

where P is an integration constant that is to be determined later.

Proceeding in a similar manner as in the above section and considering the homogeneous balance between u^2 and u'' in Eq. (13), we obtain $N = 2$. Therefore, the solution of Eq. (13) is of the form:

$$u(\eta) = A_0 + A_1(\exp(-\Phi(\eta))) + A_2(\exp(-\Phi(\eta)))^2, \tag{14}$$

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Where A_0, A_1, A_2 are constants to be determined such that $A_N \neq 0$, while λ, μ are arbitrary constants. Substituting Eq. (14) into Eq. (13) and then equating the coefficients of $\exp(-\Phi(\eta))$ to zero, we obtain

$$-6cA_2k+6cA_2b-aA_2^{\ 2}=0, \tag{15}$$

$$10cA_2\lambda b-2aA_1A_2-10cA_2\lambda k+2cA_1b-2cA_1k=0, \tag{16}$$

$$-3cA_1\lambda k+A_2-2aA_0A_2-8cA_2\mu k+3cA_1\lambda b-A_2c-4cA_2\lambda^2k-aA_1^{\ 2}+8cA_2\mu b+4cA_2\lambda^2b=0, \tag{17}$$

$$-A_1c+2cA_1\mu b-6cA_2\mu\lambda k+A_1+6cA_2\mu\lambda b-cA_1\lambda^2k-2cA_1\mu k-2aA_0A_1+cA_1\lambda^2b=0, \tag{18}$$

$$A_0+cA_1\lambda\mu b+P+2cA_2\mu^2b-2cA_2\mu^2k-aA_0^{\ 2}-cA_1\lambda\mu k-A_0c=0, \tag{19}$$

Solving the Eqs. (15)-(19) yields

$$P=\frac{1}{4a}(-c^2-1+2c+16c^2\lambda^2\mu bk+16c^2\mu^2b^2+16c^2\mu^2k^2+k^2\lambda^4c^2$$
$$+b^2\lambda^4c^2-8c^2\lambda^2\mu b^2-32c^2\mu^2bk-2b\lambda^4c^2k-8k^2\lambda^2c^2\mu),$$

$$c=c,\quad A_0=\frac{1}{2a}(b\lambda^2c+8b\mu c-k\lambda^2c-c-8k\mu c+1),\quad A_1=\frac{6c\lambda(b-k)}{a},\quad A_2=\frac{6c(b-k)}{a}.$$

Where λ, μ are arbitrary constants.

Now substituting the values of V, A_o, A_1, A_2 into Eq. (14) yields

$$u(\eta)=\frac{1}{2a}(b\lambda^2c+8b\mu c-k\lambda^2c-c-8k\mu c+1)$$
$$+\frac{6c\lambda(b-k)}{a}(\exp(-\Phi(\eta)))+\frac{6c(b-k)}{a}(\exp(-\Phi(\eta)))^2, \tag{20}$$

Where $\eta=x-ct$.

Now substituting Eqs. (6)-(10) into Eq. (20) respectively, we get the following five traveling wave solutions of the (2+1)-dimensional ZK-BBM equation.

When $\mu\neq 0$, $\lambda^2-4\mu<0$,

$$u_1(\eta)=\frac{1}{2a}(b\lambda^2c+8b\mu c-k\lambda^2c-c-8k\mu c+1)-\frac{6c\lambda(b-k)}{a}\left(\frac{2\mu}{\sqrt{\lambda^2-4\mu}\tanh(\frac{\sqrt{\lambda^2-4\mu}}{2}(\eta+E))+\lambda}\right)$$
$$+\frac{6c\lambda(b-k)}{a}\left(\frac{2\mu}{\sqrt{\lambda^2-4\mu}\tanh(\frac{\sqrt{\lambda^2-4\mu}}{2}(\eta+E))+\lambda}\right)^2.$$

where $\eta=x-ct$ and E is an arbitrary constant.

When $\mu\neq 0$, $\lambda^2-4\mu<0$,

$$u_2(\eta)=\frac{1}{2a}(b\lambda^2c+8b\mu c-k\lambda^2c-c-8k\mu c+1)+\frac{6c\lambda(b-k)}{a}\left(\frac{2\mu}{\sqrt{4\mu-\lambda^2}\tan(\frac{\sqrt{4\mu-\lambda^2}}{2}(\eta+E))-\lambda}\right)$$
$$+\frac{6c\lambda(b-k)}{a}\left(\frac{2\mu}{\sqrt{4\mu-\lambda^2}\tan(\frac{\sqrt{4\mu-\lambda^2}}{2}(\eta+E))-\lambda}\right)^2.$$

where $\eta=x-ct$ and E is an arbitrary constant.

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When $\mu = 0$, $\lambda \neq 0$, and $\lambda^2 - 4\mu > 0$,

$$u_3(\eta) = \frac{1}{2a}(b\lambda^2 c + 8b\mu c - k\lambda^2 c - c - 8k\mu c + 1) + \frac{6c\lambda(b-k)}{a}\left(\frac{\lambda}{\exp(\lambda(\eta+E))-1}\right) + \frac{6c\lambda(b-k)}{a}\left(\frac{\lambda}{\exp(\lambda(\eta+E))-1}\right)^2.$$

where $\eta = x - ct$ and E is an arbitrary constant.
When $\mu \neq 0$, $\lambda \neq 0$, and $\lambda^2 - 4\mu = 0$,

$$u_4(\eta) = \frac{1}{2a}(b\lambda^2 c + 8b\mu c - k\lambda^2 c - c - 8k\mu c + 1) + \frac{6c\lambda(b-k)}{a}\left(\frac{\lambda^2(\eta+E)}{2(\lambda(\eta+E))+2)}\right) + \frac{6c\lambda(b-k)}{a}\left(\frac{\lambda^2(\eta+E)}{2(\lambda(\eta+E))+2)}\right)^2.$$

where $\eta = x - ct$ and E is an arbitrary constant.
When $\mu = 0$, $\lambda = 0$, and $\lambda^2 - 4\mu = 0$,

$$u_5(\eta) = \frac{1}{2a}(b\lambda^2 c + 8b\mu c - k\lambda^2 c - c - 8k\mu c + 1) + \frac{6c\lambda(b-k)}{a}\frac{1}{(\eta+E)} + \frac{6c\lambda(b-k)}{a}\left(\frac{1}{(\eta+E)}\right)^2.$$

where $\eta = x - ct$ and E is an arbitrary constant.

IV. Conclusion

In this paper, the traveling wave solutions of the (2+1)-dimensional ZK-BBM equation is found successfully through the use of the exp(−Φ(η)) -expansion method, which includes the exponential functions solutions, the hyperbolic functions solutions, the trigonometric functions solutions and the rational functions solutions. It is shown that the exp(−Φ(η)) -expansion method provides a very effective and powerful mathematical tool for solving nonlinear equations in mathematical physics and engineering.

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The Question of $E = mc^2$ and Rectification of Einstein's General Relativity

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Abstract- The formula $E = mc^2$ is a speculation that was confirmed by Nuclear fission and fusion, but is not valid for the electromagnetic energy alone because the electromagnetic energy-stress tensor is traceless. On the other hand, for the light rays satisfying $E = mc^2$ necessitates the existence of a photonic tensor with an anti-gravity coupling added to the Einstein equation with the source of an electromagnetic wave. This is consistent with the massive dynamic case that the Einstein equation must be rectified to the Lorentz-Levi-Einstein equation. Moreover, because the couplings in the Einstein equation must have different signs for the dynamic case that involves gravitational waves, the space-time singularity theorems of Hawking and Penrose actually are irrelevant to physics. The misinterpretation of $E = mc^2$ as generally valid, is responsible for overlooking the charge-mass interaction, which is crucial for the unification of gravitation and electromagnetism. General validity of $E = mc^2$ is also in disagreement with experiments. It is pointed out that the interpretations of E = mc^2 of both Nobel Laureates, 't Hooft and Wilczek, just like many others, are also incorrect.

Keywords: *einstein's equivalence principle; dynamic solution; gravitational wave; $E = mc^2$.*

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The Question of $E = mc^2$ and Rectification of Einstein's General Relativity

C. Y. Lo

Abstract- The formula $E = mc^2$ is a speculation that was confirmed by Nuclear fission and fusion, but is not valid for the electromagnetic energy alone because the electromagnetic energy-stress tensor is traceless. On the other hand, for the light rays satisfying $E = mc^2$ necessitates the existence of a photonic tensor with an anti-gravity coupling added to the Einstein equation with the source of an electromagnetic wave. This is consistent with the massive dynamic case that the Einstein equation must be rectified to the Lorentz-Levi-Einstein equation. Moreover, because the couplings in the Einstein equation must have different signs for the dynamic case that involves gravitational waves, the space-time singularity theorems of Hawking and Penrose actually are irrelevant to physics. The misinterpretation of $E = mc^2$ as generally valid, is responsible for overlooking the charge-mass interaction, which is crucial for the unification of gravitation and electromagnetism. General validity of $E = mc^2$ is also in disagreement with experiments. It is pointed out that the interpretations of E = mc^2 of both Nobel Laureates, 't Hooft and Wilczek, just like many others, are also incorrect.

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I. Introduction

The formula $E = mc^2$ can be traced back to special relativity, which suggested a rest inertial mass m_0 of a particle that has the rest energy of m_0c^2. This is supported by the nuclear fissions (or fusions) with $\Delta E = \Delta mc^2$, where Δm is the mass difference after the fission (or fusion) and ΔE the total energy created and is usually a combination of different types of energy. However, the general validity of the formula $E = mc^2$ is only a speculation that has never been verified [1]. In fact, Einstein had tried very hard for years (1905-1909) to prove this formula to be generally valid, but failed [2].

Experimentally, it has been observed that the particle π^0 meson decays into two photons (i.e.,$\pi^0 \rightarrow \gamma + \gamma$). This was mistakenly considered as evidence that the electromagnetic energy is equivalent to mass. However, there would be a conflict if a photon includes only electromagnetic energy since the electromagnetic energy-stress tensor is traceless. Therefore, this experiment means only that the photons must consist of non-electromagnetic energy.

Some define an electromagnetic mass for a photon in terms of $m = E/c^2$. However, in physics, a definition must be supported with experiments. Thus, it would be necessary to show that the electromagnetic mass can generate the same gravity that would have been generated by the inertial mass. However, when Einstein proposed the notion of photon [2; p. 177], Einstein had not yet conceived general relativity then. Moreover, according to general relativity, such a claim is incorrect for electromagnetic energy. The Einstein field equation [3, 4] is,

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = -K T_{\mu\nu} , \qquad (1)$$

where the energy stress tensor $T_{\mu\nu}$ is the sum of any type of energy-stress tensor. The electromagnetic energy-stress tensor, being traceless, cannot affect R in eq. (1). Therefore, the electromagnetic energy is not equivalent to mass.

Nevertheless, since Hawking and Penrose claimed that general relativity was not applicable in microscopic scale [5],[1)] the possibility of including gravitational energy in photons was ignored. It will be shown that Hawking and Penrose are incorrect (see section 2). Moreover, the energy of photons is, indeed, the sum of the energies of the electromagnetic wave component and that of the gravitational wave component [6]. Since a charged particle has mass, it is natural that the non-electromagnetic energy is the gravitational energy.

From the Reissner-Nordstrom Metric [7], it is clear that the electromagnetic energy is not equivalent to mass [1]. However, because of the misinterpretation of $E = mc^2$ as generally valid, the charge-mass interaction [8] that can lead to prove the non-equivalence between mass and electromagnetic energy experimentally was overlooked for more than 80 years.

It will be shown the fact that $E = mc^2$ demands a photonic Energy-Stress Tensor, is also required by general relativity. On the other hand, it can be shown also that $E = mc^2$ is not generally valid experimentally. However, theorists including some Nobel Laureates (see Section 4), still misinterpreted this formula as unconditional.

II. Necessity of a Photonic Energy-Stress Tensor and the Anti-Gravity Coupling

To have a solution of gravity for an electromagnetic wave, it turns out that the Einstein equation

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$G_{\mu\nu} = -K\,T(E)_{\mu\nu}$ is inadequate because it is impossible to have a meaningful solution in physics (see section 2.1). Then, the calculation for the bending of light could be invalid since it was implicitly assumed that the gravity due to the light is negligible [3].

To have a meaningful solution, it is necessary to modify the Einstein equation [6] to

$$G_{\mu\nu} = -K\,[T(E)_{\mu\nu} - T(P)]_{\mu\nu} = Kt(g)_{\mu\nu}, \qquad (2)$$

where $T(E)_{\mu\nu}$ is the energy-stress tensor of the electromagnetic wave, and $T(P)_{\mu\nu}$ is the photonic energy-stress tensor. Thus, the existence of the photonic energy-stress tensor is a necessary result of general relativity, that is consistent with $E = mc^2$. Moreover, the necessity of the anti-gravity coupling is not limited to the case that involves an electromagnetic wave. The anti-gravity coupling is necessary when the gravitational wave is involved [9]. To have a physical solution for massive sources, it has been shown that a gravitational energy-stress tensor with an anti-gravity coupling sign must be added [10-12], i.e., the massive Einstein equation must be modified to the Lorentz-Levi-Einstein equation,[2)]

$$G_{\mu\nu} = -K\,[T(m)_{\mu\nu} - t(g)]_{\mu\nu} \qquad (3)$$

where $T(m)_{\mu\nu}$ is the massive energy-stress tensor, and $t(g)_{\mu\nu}$ is gravitational energy-stress tensor.

It should be noted that the linearized equation in general relativity is a valid linearization of the Lorentz-Levi-Einstein equation [13], but is not a valid linearization of the Einstein equation that has no bounded dynamic solution.

In short, for the dynamic case when gravitational wave is involved, Einstein was wrong. However, Gullstrand [14], Chairman (1922-1929) of the Nobel Committee for Physics is right. Thus, the long dispute on Einstein's calculation on the perihelion is settled as invalid because it is not possible to derive his calculation from a many-body problem although the results are correct [9]. In conclusion, general relativity is incomplete although it has a good start. Nevertheless, Einstein is a winner because his conjecture, the unification of electromagnetism and gravitation is confirmed [15].

a) Physical Gravitational Solutions for Electromagnetic Plane-Waves

Analysis indicates that an electromagnetic wave would generate an accompanying gravitational wave [7, 16, 17]. The calculation of the bending of light assumes that such gravitational waves are very weak and negligible [3, 4]. To verify this, one should calculate such a gravitational wave with the Einstein equation that has the electromagnetic wave as the source. For this case, Einstein [18] believed the field equation is

$$G_{ab} = -KT(E)_{ab} \text{ where } T(E)_{ab} = -g^{mn}F_{ma}F_{nb} + (1/4)g_{ab}F^{mn}F_{mn} \qquad (4)$$

and F_{ab} is the electromagnetic field tensor. Thus, $R = 0$ since the trace of $T(E)_{ab}$ is zero.

Now, let us consider a ray of uniform electromagnetic waves (i.e. a laser beam) propagating in the z-direction. Within the ray, one can assume that the wave amplitude is independent of x and y (see also [7, 17]). Thus, the electromagnetic potentials are plane-waves, and in the unit that the light velocity $c = 1$,

$$A_k(x, y, z, t) = A_k(t - z), \text{ where } k = x, y, z, \text{ or } t\,. \qquad (5)$$

Due to the principle of causality [10], the metric g_{ab} is functions of u (= $t - z$), i.e.,

$$g_{ab}(x, y, z, t) = g_{ab}(u)\,, \quad \text{where } a, b = x, y, z, \text{ or } t\,. \qquad (6)$$

Let P^k be the momentum of a photon. Then, one obtains the conditions,

$$P^z = P^t,\ P^x = P^y = 0, \text{ and } P^m g_{mk} = P_k = 0\,, \text{ for } k = x, y, \text{ or } v, \qquad (7a)$$

where $v \equiv t + z$. Compatibility with weak gravity is used [17] in deriving eq. (7a) which is equivalent to

$$g_{xt} + g_{xz} = 0\,,\ g_{yt} + g_{yz} = 0\,, \text{ and } g_{tt} + 2g_{tz} + g_{zz} = 0\,, \qquad (7b)$$

or

$$g^{xt} - g^{xz} = 0\,,\ g^{yt} - g^{yz} = 0\,, \text{ and } g^{tt} - 2g^{zt} + g^{zz} = 0\,. \qquad (7c)$$

Note that eq. (7) implies that the harmonic gauge may not be valid. The wave transversality implies

$$P^m A_m = 0\,, \quad \text{or equivalently} \quad A_z + A_t = 0\,. \qquad (8)$$

Eqs. (6) to (8) imply that not only the geodesic equation, the Lorentz gauge, but also Maxwell's equation are satisfied. Moreover, the Lorentz gauge becomes equivalent to a covariant expression.

The above analysis suggests that an electromagnetic plane-wave can be an exact solution in a non-flat manifold. In a coordinate system where P_m are constants, the scalar $\int P_m\,dx^m$ would equal to $P_m x^m$. Moreover,

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$$R_{tt} = - R_{tz} = R_{zz} , \tag{9a}$$

because $F^{mn}F_{mn} = 0$ due to eq. (7). The other components give eq. (7), and are zero [8]. Then, we have

$$R_{tt} \equiv -\partial\Gamma^m{}_{tt}/\partial x^m + \partial\Gamma^m{}_{mt}/\partial t - \Gamma^m{}_{mn}\Gamma^n{}_{tt} + \Gamma^m{}_{nt}\Gamma^n{}_{mt} = -KT(E)_{tt} = K\, g^{mn}F_{mt}F_{nt}. \tag{9b}$$

After some lengthy algebra [17], eq. (9b) is simplified to a differential equation of u as follows:

$$G'' - g_{xx}'g_{yy}' + (g_{xy}')^2 - G'(g'/2g) = 2K\,(F_{xt}^2 g_{yy} + F_{yt}^2 g_{xx} - 2F_{xt}F_{yt}\, g_{xy}) \tag{10}$$

$$= 2GR_{tt}, \quad \text{where} \quad G \equiv g_{xx}\, g_{yy} - g_{xy}^2, \text{ and } g = |g_{ab}|$$

is the determinant of the metric. The metric elements are connected by the following relation:

$$- g = G\, g_t^2, \text{ where } g_t \equiv g_{tt} + g_{tz}; \tag{11}$$

and

$$g^{xx} = g_{yy}/G, \quad g^{yy} = g_{xx}/G, \quad \text{and} \quad g^{xy} = -g_{xy}/G \tag{12}$$

Note that eqs. (35.31) and (35.44) in reference [7] and eq. (2.8) in reference [19] are special cases of eq. (10). However, their solutions are unbounded [17]. On the other hand, compatibility with Einstein's notion of weak gravity is required by the light bending calculation and is implied by the equivalence principle [11].

Equations (5), (6), (8), and (9) allow A_t, g_{xt}, g_{yt}, and g_{zt} to be set to zero. In any case, these assigned values have little effect in subsequent calculations. For the remaining metric elements (g_{xx}, g_{xy}, g_{yy}, and g_{tt}), it will be shown, however, eq. (10) is sufficient to show that there is no physical solution for an Einstein equation. In other words, in contrast to Einstein's belief [18], the difficulty of this equation is not limited to mathematics.

Now, let us consider a circularly polarized monochromatic electromagnetic plane-wave,

$$A_x = (1/\sqrt{2})\, A_0 \cos\, \omega u, \text{ and } A_y = (1/\sqrt{2})\, A_0 \sin \omega\, u\, . \tag{13}$$

Then $P_t = \omega$ (since h = 1). The rotational invariants with respect to the z-axis are constants. These invariants are: R_{tt}, $T(E)_{tt}$, G , $(g_{xx} + g_{yy})$, g_{tz} , g_{tt} , g , and etc. Let us assume the invariant,

$$g_{xx} + g_{yy} = -2 - 2C, \text{ then } g_{xx} = -1 - C + B\, , \text{ and } g_{yy} = -1 - C - B. \tag{14}$$

Thus,

$$B^2 + g_{xy}^2 = (1+C)^2 - G\, , \text{ and } (B')^2 + (g_{xy}')^2 = 2GR_{tt} \geq 0 \tag{15}$$

obtained from $G = g_{xx}\, g_{yy} - g_{xy}^2$ and eq. (10), are constants. It follows that eq. (15) implies

$$B = B_\alpha \cos(\omega_1 u + \alpha), \quad \text{and} \quad g_{xy} = \pm B_\alpha \sin(\omega_1 u + \alpha)\, , \tag{16a}$$

where

$$\omega_1^2 = 2R_{tt}\, G/B_\alpha^2\, , \quad \text{and} \quad B_\alpha^2 = (1+C)^2 - G \geq 0. \tag{16b}$$

Thus, it is proven that the metric is a periodic function. Also, as implied by causality, the metric is not an invariant under a rotation (since a transverse electromagnetic wave is not such an invariant).

On the other hand, since $T(E)_{tt}$ is a constant, it is necessary to have

$$\omega_1 = 2\omega\, , \quad \text{and} \quad T(E)_{tt} = (1/2G)\, \omega^2 A_0^2\, (1 + C - B_\alpha \cos \alpha) > 0. \tag{16c}$$

Eq. (16a) implies that the metric is a circularly polarized wave with the same direction of polarization as the electromagnetic wave (13). However, it is not possible to satisfy Einstein's equation because both $T(E)_{tt}$ and R_{tt} have the same sign. Thus, there is no possibility, within the current theory, to construct an acceptable metric representing the accompanying gravitational wave for a circular polarized electromagnetic plane-wave.

Now, consider also a wave linearly polarized in the x-direction,

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$$A_x = A_0 \cos \omega(t - z) . \tag{17a}$$

Then, one has

$$T_{tt} = - (g_{yy}/2G)\omega^2 A_0^2[1 - \cos 2\omega(t - z)] . \tag{17b}$$

If a circularly polarized electromagnetic plane-wave results in a circularly polarized gravitational wave, one may expect that a linearly polarized electromagnetic plane-wave results in a linearly polarized gravitational wave. From the viewpoint of physics, the principle of causality would require that, for an x-directional polarization, gravitational components related to the y-direction, remains the same. In other words,

$$g_{xy} = 0 , \text{ and } g_{yy} = -1 . \tag{18}$$

Mathematically, condition (18) is compatible with semi-unitary (i.e., g is a constant).
Equation (18) means that the gravitational wave is also linearly polarized. It follows that equation (10) becomes

$$G'' = - 2 K G T_{tt} \quad \text{and} \quad G = - g_{xx}. \tag{19}$$

Then, different from the circular polarization, eq. (19) would have a solution

$$-g_{xx} = 1 + C_1 - (K/4) A_0^2\{2\omega^2(t - z)^2 + \cos [2\omega (t - z)]\} + C_2(t - z) , \tag{20}$$

where C_1 and C_2 are constants. However, (20) is invalid in physics since $(t - z)^2$ grows very large as time goes by.

On the other hand, since physical influences can be propagated at most with a light speed, the influence of an electromagnetic wave on its accompanying gravitational wave would essentially be spatially local. This means that the electromagnetic plane-wave, a well-tested spatial local idealization, is a valid physical modeling for gravity. Thus, if general relativity is fundamentally valid, there must be a way in physics to modify the equation such that a physical solution can be obtained for a plane-wave. Otherwise, general relativity would not be a valid theory in physics.

The formula $E = mc^2$ gives us a clear suggestion. Since the Einstein tensor is supported by causality, it would be sufficient to modify the source tensor [6]. The additional energy term should be a constant of different sign, and is larger in absolute value. Moreover, calculation shows that a physical solution requires that in the flat metric approximation, an electromagnetic wave energy tensor and the unknown tensor with an antigravity coupling carry, on the average, the same energy-momentum [6]. This is expected for a photonic energy tensor, according to experiments.

Thus, physics requires that the unknown tensor must be the energy-stress tensor of photons. Given that an electromagnetic wave moving with the velocity of light, its gravitational influence must be moving along according to special relativity. This means that the photonic energy-stress tensor would be the sum of the electromagnetic energy-stress tensor and the gravitational energy-stress tensor, i.e., $T(P)_{ab} = T(E)_{ab} + T(g)_{ab}$.

b) A Photonic Energy-Stress Tensor and the Anti-Gravity Coupling

As required by the bending of light, one must show that a valid modification can be obtained with a photonic energy-stress tensor, i.e. it would also lead to a physical solution and generate a geodesic equation for photons. From the previous analysis, the appropriate Einstein equation would be

$$G_{ab} = -K[T(E)_{ab} - T(p)_{ab}], \quad \text{and} \quad T_{ab} = - T(g)_{ab} = T(E)_{ab} - T(P)_{ab} , \tag{21}$$

where $T(E)_{ab}$ and $T(P)_{ab}$ are the energy-stress tensors for the electromagnetic wave and the related photons.

Note that the energy-stress tensor of photons has an anti-gravity coupling. Since both $T(E)_{ab}$ and $T(g)_{ab}$ (due to $\nabla^c G_{cb} \equiv 0$ and eq. [7a]) are divergence free and traceless, $T(P)_{ab}$ must also be divergence free and traceless.

Given that a photonic energy tensor should produce a geodesic equation, for a monochromatic wave, the tensor form should be similar to that of massive matter. Observationally, there is very little interaction, if any, among photons of the same ray. Theoretically, since photons travel at the velocity of light, there should not be any interaction among them. Therefore, the photonic energy tensor should be dust-like as follows:

$$T^{ab}(P) = \rho P^a P^b, \tag{22a}$$

where ρ is a scalar which, according to causality, is a function of u. The geodesic equation, $P^c \nabla_c P^b = 0$, is implied by $\nabla c(\rho P^c) = 0$, and $\nabla c\, T(P)^{cb} = 0$. ρ (u) should be a non-zero function of the electromagnetic potentials and/or fields. This implies $\rho = \lambda A_m g^{mn} A_n$, where λ is a scalar constant to be determined.

Since light intensity is proportional to the square of the wave amplitude, ρ can be considered as the density function of photons if $\lambda = -1$. Due to $R = 0$ and

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eqs. (5) and (6) remain valid, $\rho(u)$ is Lorentz gauge invariant. Then, one obtains

$$T_{ab} = T(E)_{ab} - T(P)_{ab} = T(E)_{ab} - \lambda A_m g^{mn} A_n P_a P_b . \tag{22b}$$

Thus, a photonic energy tensor changes nothing in calculation, but gives another term for eq. (10) only. To determine λ, let us consider a circularly polarized monochromatic wave (10). Then, we have,

$$T_{tt} = (1/2G)\, \omega^2 A_0^2 [(1 + C)(1 + \lambda) - (1 - \lambda) B_\alpha \cos\alpha] \leq 0 \tag{23}$$

since $P_t = \omega$ (in the units c = h = 1) and eq. (16b) requires R_{tt} to be of second order and positive. Eq. (23) requires that $\lambda \leq -1$ because the constants C and B_α are much smaller than 1. Causality requires that, in a flat metric approximation, the time average of T_{tt} is zero. This implies that, as expected,

$$\lambda = -1, \quad T_{ab} = T(E)_{ab} - T(P)_{ab} = T(E)_{ab} + A^m g^{mn} A_n P_a P_b$$

and

$$T_{tt} = -(1/G)\, \omega^2 A_0^2 B_\alpha \cos\alpha \leq 0, \quad \text{since} \quad B_\alpha = (K/2)\, A_0^2 \cos\alpha . \tag{24}$$

Thus, the energy density of the photonic energy tensor is indeed larger than that of the electromagnetic wave. Then, (16a) and (16b) are valid for eq. (10). Note that, pure electromagnetic waves can exist since $\cos\alpha = 0$ is possible.

To confirm the general validity of $\lambda = -1$, consider also the wave linearly polarized in the x-direction,

$$A_x = A_0 \cos\omega(t - z) . \tag{17a}$$

Then, one has

$$T_{tt} = (g_{yy}/2G)\, \omega^2 A_0^2 (-\lambda - 1) + (1 - \lambda)\cos[2\omega(t - z)] . \tag{25a}$$

Thus, the flat metric approximation again requires that $\lambda = -1$. Then,

$$T_{tt} = (g_{yy}/G)\, \omega^2 A_0^2 \cos[2\omega(t - z)] . \tag{25b}$$

Eq. (25b) implies $(g_{xx} + g_{yy})'$ to be of first order [8], and therefore its polarization has to be different. Note that T_{tt} is allowed to be positive, since the gravitational component is not an independent wave. Then the solution is

$$-g_{xx} = 1 + C_1 - (K/2)\, A_0^2 \cos[2\omega(t - z)], \text{ and } g_{tt} = -g_{zz} = (g/g_{xx})^{1/2}, \tag{26}$$

where C_1 is a constant. The frequency ratio is the same as the other case and, as expected, the average of T_{tt} is negative.

Thus, T_{ab} (P) has been derived from the electromagnetic wave. In spite of the demanding physical requirements, a photonic energy tensor has been obtained. Note that the photonic energy tensor of Misner et al. [7, Section 22], is an approximation of the time-average of $T_{ab}(P)$. For a circularly polarized electromagnetic wave, the phase difference controls the amplitude of the gravitational wave (see eq. [24]), and the amplitude of the electromagnetic wave gives an upper bound. This is different from the case of linearly polarized waves for which the amplitude of gravity is fixed.

Most important, it is the anti-gravity coupling of the photonic energy-stress tensor that illustrates general relativity to be a viable theory. Thus, what Einstein has missed is that *the anti-gravity coupling is necessary in general relativity*. Accordingly, the space-time singularity theorems of Hawking and Penrose are actually irrelevant to physics since the physical assumption of their energy conditions will not be satisfied.

Historically, the existence of the antigravity coupling was first proposed for the gravitational energy-stress tensor $t(g)_{\mu\nu}$ [2)] by Lorentz [20] in 1916 and Levi-Civita [21] in 1917. However, Einstein [22] incorrectly rejected their proposal on the ground that $t(g)_{\mu\nu} = 0$ in his equation. In 1995, Lorentz and Levi-Civita are proven right [10-12]

III. The Reissner-Nordstrom Metric and the Repulsive Effect

A problem of the above analysis is that it is difficult to verify experimentally. In this section, we shall discuss the experimental verification of the non-equivalence between mass and electromagnetic energy.

General relativity makes it explicit that the gravity generated by mass and that by the electromagnetic energy are different, as shown by the existence of repulsive effect in the Riessner-Nordstrom metric [15],

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$$ds^2 = \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)dt^2 - \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)^{-1} dr^2 - r^2 d\Omega^2, \tag{27}$$

where q and M are the charge and mass of a particle and r is the radial distance, in terms of the Euclidean-like structure [23] from the particle center.

In metric (27), the gravitational components generated by electricity have not only a very different radial coordinate dependence but also a different sign that makes it a new repulsive gravity [1].

Some argued that the effective mass in metric (27) is M - $q^2/2r$ (in the units, the light speed $c = 1$) since the total electric energy outside a sphere of radius r is $q^2/2r$. However, from metric (27), the gravitational force is different from the force created by the "effective mass" $M - q^2/2r$ because

$$-\frac{1}{2}\frac{\partial}{\partial r}\left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right) = -\left(\frac{M}{r^2} - \frac{q^2}{r^3}\right) > -\frac{1}{r^2}\left(M - \frac{q^2}{2r}\right). \tag{28}$$

They achieved only exposing further an inadequate understanding in the theory of relativity. Some theorists claimed that M should include the electric energy, and this exposes an even deeper error related to the derivation.

a) Derivation of the Reissner-Nordstrom Metric

It seems that mass M in (2) as a "total mass" that includes the electric energy, would be allowed if you were careless. However, a close examination shows that this is invalid.

According to Einstein, for the Reissner-Nordstrom metric, the static field equation includes at least the massive energy-stress tensor and the electromagnetic energy-stress tensor. They differ by that the electromagnetic energy-stress tensor is traceless whereas the massive energy-stress tensor is not.

If one assumes that the metric has the following form,

$$ds^2 = f\,dt^2 - h dr^2 - r^2(d\theta^2 + \sin\theta^2 d\phi^2), \tag{29}$$

then, as shown by Wald [5], at the region outside the particle ($r > r_0$) we have

$$-R_{00} = \frac{1}{2}(fh)^{-1/2}\frac{d}{dr}\left[(fh)^{-1/2} f'\right] + (fhr)^{-1} f', \tag{30a}$$

$$-R_{11} = -\frac{1}{2}(fh)^{-1/2}\frac{d}{dr}\left[(fh)^{-1/2} f'\right] + (h^2 r)^{-1} h', \tag{30b}$$

$$-R_{22} = -\frac{1}{2}(rfh)^{-1} f' + \frac{1}{2}(h^2 r)^{-1} h' + r^{-2}(1 - h^{-1}) \tag{30c}$$

Moreover, outside the particle we have

$$T(m)_{\mu\nu} = 0 \qquad \text{for} \qquad r > r_0 \tag{31a}$$

But

$$T(m)_{00} = \rho(r), \quad T(m)_{11} = T(m)_{22} = T(m)_{33} = P(r), \quad \text{when } r < r_0 \tag{31b}$$

where P(r) is the pressure of the perfect fluid model.

Because the electric energy-stress tensor $T(E)_{\mu\nu}$ is traceless, we also have, for $r > r_0$,

$$R_{00} = -R_{11} = R_{22} = -E^2, \text{ where } \vec{E} = \frac{q}{r^3}\vec{r} \tag{32}$$

is the electric field, according to Misner et al. [7; p. 841]. If $h = 1/f$ in metric (29), then (30) is reduced to

$$-R_{00} = R_{11} = \frac{1}{2} f'' + r^{-1} f' = E^2 \tag{33a}$$

And

$$-R_{22} = -r^{-1} f' + r^{-2}(1 - f) = E^2 \tag{33b}$$

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Moreover, if $f = \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)$ as in metric (27), then we have, in consistent with (32),

$$\frac{q^2}{r^2} = r^2 E^2 \tag{34}$$

Thus, it might seem there is no restriction on the mass M of metric (29). However, from (32), it is clear that M in metric (29) cannot include the electric energy (outside the particle) since it has been represented in (32).

b) Misinterpretations of the Reissner-Nordstrom Metric

Nevertheless, Herrera, Santos, & Skea [24], argued that M in (27) involves the electric energy. They follow the error of Whittaker [25] and Tolman [26]. They defined the active gravitational mass density μ with the electromagnetic energy tensor $E^{\alpha}{}_{\beta}$ as $\mu = E_0^0 - E_i^i$ and the active mass in a volume V_a is given by

$$m_a(r) = \int_{V_a} \mu(-g)^{1/2} dx^1 dx^2 dx^3, \tag{35}$$

where g is the determinant of the metric $g_{\mu\nu}$. It thus follows that, for a particle with charge Q, one has

$$m_a(\infty) - m_a(r) = \int_r^{\infty} \frac{Q^2}{r^2} dr, \text{ and } m_a(r) = M - \frac{Q^2}{r}, \text{ where } m_a(\infty) = M \tag{36}$$

Thus $m_a(r)$ would be in agreement with that the total force is proportion to

$$\frac{1}{2}\frac{\partial}{\partial r}\left(1 - \frac{2M}{r} + \frac{Q^2}{r^2}\right) = (M - \frac{Q^2}{r})\frac{1}{r^2} = \left(m_a(r_0) + Q^2(\frac{1}{r_0} - \frac{1}{r})\right)\frac{1}{r^2} \tag{37a}$$

$$\text{since } M = m_a(r) + Q^2/r = \left(m_a(r_0) + Q^2/r_0\right), \tag{37b}$$

where r_0 is the radius of the particle. However, (36) does not agree with (28) since

$$-2(M - \frac{Q^2}{r})\frac{1}{r} \neq \left(-\frac{2M}{r} + \frac{Q^2}{r^2}\right) \tag{37c}$$

Eq. (37a) implies that the weight of a charged metal ball would increase when the charge Q is increased. According to eq. (35), $m_a(r_0)$ would increase as the charge Q increases. Thus, no repulsive effects can be detected.

However, it should be noted that as shown in (37b), M includes energy outside the particle, in conflict with (32). On the other hand, if the mass M is the inertial mass of the particle, the weight of a charged metal ball can be reduced [27] (see Appendix). Thus, as expected [8], experiments of two metal balls [28] reject eq. (36). The repulsive force on a charged ball is an important experiment to be completed for the details *since it is a test of general relativity*.

The inertial mass of the particle should be smaller than M defined in (37b) since an acceleration of the charged particle would not immediately affect the electric energy at long distances. However, 't Hooft also claimed in his Nobel Lecture [29] that M in (37c) is the inertial mass subjected to Newton's second law. Thus, it is clear that 't Hooft is only an excellent applied mathematician, but a questionable physicist. Understandably, 't Hooft also does not understand the principle of causality adequately [30, 31]. Note that the radius r_e of an electron *e* is about a half of its classical radius e^2/m_0c^2 [32], where m_0 is its inertial mass. Thus, the electric energy e^2/r_e would be larger than m_0.

The problem started from the assumption of equivalence between mass and electric energy. Should the electric energy be considered as part of the gravitational mass of the particle? If it is, then gravitational mass and inertial mass are different. If it is not, then any electromagnetic energy should assign a mass. However, this is invalid because it is not supported by experiments. Thus, the electric energy should not be equivalent to mass. Unfortunately, 't Hooft is not alone, and Wilczek [33] also mistaken $m = E/c^2$ as unconditional in his Nobel speech (see Section 4).[3)]

The above approach is essentially the same as that of Pekeris [34], who gets a similar metric as follows:

$$ds^2 = e^{\nu} dt^2 - e^{-\nu} dR^2 - R^2 d\Omega^2 \quad \text{where } R^3 = r^3 + r_0^3 \tag{38a}$$

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$$e^{\nu} = \left(1 - \frac{2M_{mat}}{R} - \frac{2M_{em}}{R} + \frac{Q^2}{R^2}\right) = \left(1 - \frac{2M}{R} + \frac{Q^2}{R^2}\right), \quad \text{where } M_{em} = Q^2/r_0, \text{ and } M = M_{mat} + M_{em} \tag{38b}$$

The difference is due to that Pekeris [34] requires that $|g_{\mu\nu}| = g = -1$. Thus, what Herrera et al. [24] does is essentially what Pekeris had done. Apparently, theorists have run out of ways that can be used against the repulsive force.

In summary, misinterpretations of the Riessner-Nordstrom metric delay the recognition of the charge-mass interaction for more than 80 years. An experimental verification of the charge-mass repulsive interaction gives a clear statement that the electro-magnetic energy and mass are not equivalent. The charge-mass interaction leads to the necessity of unification. However, for the case of such force acting on a charged capacitor, this is beyond general relativity.

Nevertheless, the necessary existence of the anti-gravity coupling shows that the theoretical developments without the anti-gravity coupling are incorrect. This is an important development because it is beyond Einstein.

c) The Charge-mass Interaction and Five-Dimensional Theory

To show the repulsive effect, one needs to consider only g_{tt} in metric (27). According to Einstein [3, 4],

$$\frac{d^2x^{\mu}}{ds^2} + \Gamma^{\mu}{}_{\alpha\beta}\frac{dx^{\mu}}{ds}\frac{dx^{\nu}}{ds} = 0, \quad \text{where} \quad \Gamma^{\mu}{}_{\alpha\beta} = (\partial_{\alpha}g_{\nu\beta} + \partial_{\beta}g_{\nu\alpha} - \partial_{\nu}g_{\alpha\beta})g^{\mu\nu}/2 \tag{39}$$

and $ds^2 = g_{\mu\nu}dx^{\mu}dx^{\nu}$ are defined by the metric $g_{\mu\nu}$. Consider the static case, $dx/ds = dy/ds = dz/ds = 0$. Thus,

$$\frac{d^2x^{\mu}}{ds^2} = -\Gamma^{\mu}{}_{tt}\frac{dct}{ds}\frac{dct}{ds}, \quad \text{where} \quad -\Gamma^{\mu}{}_{tt} = -\frac{1}{2}\left(2\frac{\partial g_{t\nu}}{\partial ct} - \frac{\partial g_{tt}}{\partial x^{\nu}}\right)g^{\mu\nu} = \frac{1}{2}\frac{\partial g_{tt}}{\partial x^{\nu}}g^{\mu\nu} \tag{40}$$

since $g_{\mu\nu}$ would also be static. (Note that the gauge affects only the second order approximation of g_{tt} [35].) For a particle P with mass m at **r**, the force on P is

$$-m\frac{M}{r^2} + m\frac{q^2}{r^3} \tag{41}$$

in the first order approximation since $g^{rr} \cong -1$. Thus, the second term is a repulsive force.
If the particles are at rest, then the force acts on the charged particle Q has the same magnitude

$$\left(m\frac{M}{r^2} - m\frac{q^2}{r^3}\right)\hat{r}, \quad \text{where } \hat{r} \text{ is a unit vector} \tag{42}$$

since the action and reaction forces are equal and in the opposite directions. However, for the motion of the charged particle with mass M, if one calculates the metric according to the particle P of mass m, only the first term is obtained. Thus, the geodesic equation is inadequate for the equation of motion. Moreover, it is necessary to have a repulsive force with the coupling q^2 to the charged particle Q in a gravitational field generated by masses. In conclusion, force (42) to particle Q is beyond current theoretical framework of gravitation + electromagnetism.

However, this problem would be solved in a five-dimension theory [36], where the geodesic equation would include the coupling of q^2. The geodesic is

$$\frac{d}{ds}\left(g_{ik}\frac{dx^k}{ds}\right) = \frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{ds}\frac{dx^l}{ds} + \left(\frac{\partial g_{5k}}{\partial x^i} - \frac{\partial g_{5i}}{\partial x^k}\right)\frac{dx^5}{ds}\frac{dx^k}{ds} - \Gamma_{i,55}\frac{dx^5}{ds}\frac{dx^5}{ds} - g_{i5}\frac{d^2x^5}{ds^2} \tag{43a}$$

$$\frac{d}{ds}\left(g_{5k}\frac{dx^k}{ds} + \frac{1}{2}g_{55}\frac{dx^5}{ds}\right) = \Gamma_{k,55}\frac{dx^5}{ds}\frac{dx^k}{ds} - \frac{1}{2}g_{55}\frac{d^2x^5}{ds^2} + \frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{ds}\frac{dx^k}{ds}, \tag{43b}$$

where $ds^2 = g_{\mu\nu}dx^{\mu}dx^{\nu}$, $\mu, \nu = 0, 1, 2, 3, 5$ $\quad (d\tau^2 = g_{kl}dx^k dx^l;\ k, l = 0, 1, 2, 3)$.

If instead of s, τ is used in (43), the Lorentz force suggests

$$\frac{q}{Mc^2}\left(\frac{\partial A_i}{\partial x^k} - \frac{\partial A_k}{\partial x^i}\right) = \left(\frac{\partial g_{i5}}{\partial x^k} - \frac{\partial g_{k5}}{\partial x^i}\right)\frac{dx^5}{d\tau}$$

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Thus,

$$\frac{dx^5}{d\tau}=\frac{q}{Mc^2}\frac{1}{K}, \qquad K\left(\frac{\partial A_i}{\partial x^k}-\frac{\partial A_k}{\partial x^i}\right)=\left(\frac{\partial g_{i5}}{\partial x^k}-\frac{\partial g_{k5}}{\partial x^i}\right) \quad \text{and} \quad \frac{d^2x^5}{d\tau^2}=0 \tag{44}$$

where K is a constant. It thus follows that

$$\frac{d}{d\tau}\left(g_{ik}\frac{dx^k}{d\tau}\right)=\frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{d\tau}\frac{dx^l}{d\tau}+\left(\frac{\partial A_k}{\partial x^i}-\frac{\partial A_i}{\partial x^k}\right)\frac{q}{Mc^2}\frac{dx^k}{d\tau}-\Gamma_{i,55}\left(\frac{q}{Mc^2}\right)^2\frac{1}{K^2} \tag{45a}$$

$$\frac{d}{d\tau}\left(g_{5k}\frac{dx^k}{d\tau}+\frac{1}{2}g_{55}\frac{q}{KMc^2}\right)=\Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau}+\frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{d\tau}\frac{dx^k}{d\tau}。 \tag{45b}$$

One may ask what the physical meaning of the fifth dimension is. Some claim that those higher dimensions are curl up. Our position is, however, that the physical meaning the fifth dimension is not yet very clear, except some physical meaning is given in equation (44). The fifth dimension is assumed as part of the physical reality, and the metric signature is (+,-,-,-,-). However, our approach is to find out the full physical meaning of the fifth dimension as our understanding gets deeper. Unlike mathematics, in physics things are not defined right at the beginning. For example, it took us a long time to understand the physical meaning of energy-momentum conservation.

For a static case, it follows (42) and (45) that the forces on the charged particle Q in the ρ -direction are

$$-\frac{mM}{\rho^2}\approx\frac{Mc^2}{2}\frac{\partial g_{tt}}{\partial\rho}\frac{dct}{d\tau}\frac{dct}{d\tau}g^{\rho\rho}, \text{ and } \frac{mq^2}{\rho^3}\approx-\Gamma_{\rho,55}\frac{1}{K^2}\frac{q^2}{Mc^2}g^{\rho\rho} \tag{46a}$$

and

$$\Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau}=0, \qquad \text{where} \qquad \Gamma_{k,55}\equiv\frac{\partial g_{i5}}{\partial x^5}-\frac{1}{2}\frac{\partial g_{55}}{\partial x^k}=-\frac{1}{2}\frac{\partial g_{55}}{\partial x^k} \tag{46b}$$

in the (-*r*)-direction. Here particle P is at the origin of spatial coordinate system (ρ, θ', φ'). The meaning of (46b) is the energy momentum conservation. Thus,

$$g_{tt}=1-\frac{2m}{\rho c^2}, \quad \text{and} \quad g_{55}=\frac{mMc^2}{\rho^2}K^2+\text{constant}。 \tag{47}$$

In other words, g_{55} is a repulsive potential. Since g_{55} depends on M, it is a function of local property, and thus is difficult to calculate. This is different from the metric element g_{tt} that depends on a distant source of mass m.

Since g_{55} is independent of q, $(\partial g_{55}/\partial\rho)/M$ depends only on the distant source with mass m. Thus, this force, though acting on a charged particle, would penetrate electromagnetic screening. This would make such a force easier to be identified. From (47), it is possible that a charge-mass repulsive potential would exist for a metric based on the mass M of the charged particle Q. However, since P is neutral, there is no charge-mass repulsion force (from $\Gamma_{k,55}$) on P.

In terms of physics, since the static repulsive force is independent of the charge sign, it should not be subjected to electromagnetic screening. From the viewpoint of the five-dimensional theory, the charge would create an independent field to react with the mass. To test this, one should observe whether there is a repulsive force from a charged capacitor to a mass particle since a capacitor would screen out the electromagnetic field outside the capacitor in current theories. Experimentally, such a force is observed since a charge capacitor reduces its weight [37-40].

It should be noted that Einstein and Pauli [41] had investigated the five-dimensional relativity. However, they failed because they did not recognize the emerging of new interactions as Maxwell did. Thus they failed to see the existence of a coupling with the charge square from the metric element g_{55}.

IV. Conclusions and Discussions

In physics, the most famous formula is probably E = mc². Ironically, it is also this formula that many physicists do not understand properly. This formula means that there is an energy related to a mass, but it does not necessarily mean that, for any type of energy, there is a related mass. It is interesting that E = mc² demands that the light must include non-

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electromagnetic energy. On the other hand, general relativity naturally requires that a photonic energy-stress tensor, which is different from the electromagnetic energy-stress tensor, must have an anti-gravity coupling.

An anti-gravity coupling implies that the energy-conditions in the singularity theorems of Penrose and Hawking are invalid, and thus these theorems are irrelevant in physics. The existence of anti-gravity coupling is crucial in general relativity. For this is a major problem that many theorists overlooked. In fact, the existence of the antigravity coupling was first proposed by Lorenz [20] and Levi-Civita [21]. However, Einstein incorrectly rejected their proposal, and Einstein was wrong in his claim on the existence of dynamic solutions [10-12].

Because of the blind faith on Einstein, Misner et al. [7] claimed to have an explicit bounded wave solution and supported their errors with invalid mathematics [9]. Wald [5] claimed to be able to solve a second order equation, but without any solution. Christodoulou and Klainerman [42] have mistaken that they could construct the dynamic solutions [43]. Taylor [44] claimed to have a bounded dynamic solution and won a Nobel Prize [45], but failed to justify his calculation [46]. 't Hooft [30, 31] come up with an explicit solution that cannot have appropriate sources, etc. This is also why the positive mass theorem of Schoen and Yau [47] (and Witten [48]) is misleading in physics.[4)]

General relativity also makes it explicit that the gravity generated by mass and that by the electromagnetic energy are different as shown by the Riessner-Nordstrom metric. Since not every type of energy is equivalent to mass, the study of gravity must be extended beyond massive sources. It is the recognition of non-equivalence between electromagnetic energy and mass that naturally leads to unification of electromagnetism and gravitation.

It should be noted that Wilczek also misinterpreted in his Nobel lecture [33] that $m = E/c^2$ is generally valid. He claimed, "Stated as $m = E/c^2$, Einstein's law suggests the possibility of explaining mass in terms of energy. That is a good thing to do, because in modern physics energy is a more basic concept than mass. He further claimed, "In fact, the title is a question: 'Does the Inertial of a body Depend upon its energy content?' From the beginning, Einstein was thinking about the origin of mass ... Modern QCD answer Einstein's question with a resounding "Yes!" Indeed, the mass of ordinary matter derived almost entirely from energy-the energy of massless gluons and nearly massless quarks, which are the ingredients from which protons, Neutrons and atomic nuclei are made." Thus, 't Hooft is not the only Nobel Laureate who made an incorrect interpretation of $E= mc^2$.

However, the formula $E = mc^2$ has already answered Einstein's question affirmatively. The equivalence of a particular energy to mass is beyond the issue of whether the mass of a body depends on its energy contents. Wilczek was aware that there are difference between $E = mc^2$ and $m = E/c^2$, but failed to see the crucial difference. Thus, modern QCD did not answer Einstein's question, but only uses his formula as he speculated. Since electromagnetic energy is not equivalent to mass, to use the formula $m = E/c^2$ needs justifications in physics that Wilczek [33] failed to provide.

Moreover, the notion of photon is established not as an assumption, but as a necessary consequence of general relativity. Concurrently, the notion of anti-gravity coupling is naturally established. So, Einstein is still the final winner. Had Einstein known that his conjecture of unification was that close, he might have the desire to live longer [49]. Einstein was right that he should have more mathematics [49]. Einstein's weakness is that he had too much confidence on himself. His curiosity did not help him to discover his own errors. In any case, it is up to us to complete what he started.

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Appendix A

Experimental Verification of the Mass-Charge Repulsive Force

The repulsive force in metric (27) can be detected with a neutral mass. To see the repulsive effect, one must have

$$\frac{1}{2}\frac{\partial}{\partial r}\left(1-\frac{2M}{r}+\frac{q^2}{r^2}\right)=\frac{M}{r^2}-\frac{q^2}{r^3}<0 \qquad \text{(A1)}$$

Thus, repulsive gravity would be observed at $q^2/M > r$. For the electron the repulsive gravity would exist only inside the classical electron radius $r_0(= 2.817\times 10^{-13}cm)$. Thus, it would be very difficult to test a single charged particle.

However, for a charged metal ball with mass M and charge Q, the formula is similarly $0 > M/R^2 - Q^2/R^3$, where R is the distance from the center of the ball [27]. Consequently, the attractive effect in gravity is proportional to mass related to the number of electrons,

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but the repulsive effect in gravity is proportional to square of charge related to the square of the number of electrons. Thus, when the electrons are numerous enough accumulated in a metal ball, the effect of repulsive gravity will be shown in a macroscopic distance.

Consider Q and M consist of N electrons, i.e., $Q = Ne$, $M = Nm_e + M_0$, where M_0 is the mass of the metal ball, m_e and e are the mass and charge of an electron. To have sufficient electrons, the necessary condition is

$$N > \frac{R}{r_0}, \quad \text{when} \quad r_0 = \frac{e^2}{m_e c^2} = 2.817 \times 10^{-13}\,\text{cm}. \tag{A2}$$

For example, if $R = 10$ cm, then it requires $N > 3.550 \times 10^{13}$. Thus $Q = 5.683 \times 10^{-7}$ Coulomb. Then, one would see the attractive and repulsive additional forces change hands. For this case, the repulsive force is

$$\frac{Q^2 m_p}{R^3} \quad \text{where} \quad m_p \text{ is the mass of the testing particle P.} \tag{A3}$$

And the total force is

$$\left(\frac{M_0 + Nm_e}{R^2} - \frac{N^2 e^2}{R^3}\right) m_p \tag{A4}$$

When condition (A2) is satisfied for a certain R, the repulsive effect will be observed as the charge increases. The verification of this formula also disproves the equivalence between mass and electric energy. However, the majority of theorists failed gravity by following Einstein's error.

However, since the repulsive force is very small, for a large charge, the interference of electricity would be comparatively large. Thus, it would be desirable to screen the electromagnetic effects out. The modern capacitor is such a piece of simple equipment. When a capacitor is charged, it separates the electron from the atomic nucleus, but there is no change of mass due to increase of charged particles. Before such separation the effect of the charge-mass interaction is cancelled out by the current-mass interaction (see Appendix B). Thus, after charged, the capacitor would have less weight due to the charge-mass repulsive force, a nonlinear force towards charges.

One may ask whether the lighter weight of a capacitor after charged could be due to a decrease of mass. Such a speculation is ruled out. Inside a capacitor the increased energy due to being charged would not be pure electromagnetic energy such that, for the total internal energy, Einstein's formula is valid.

Thus, this simple experiment would confirm the mass-charge repulsive force, and thus the unification.

In the case of charged capacitor, the repulsive force would be proportional to the potential square, V^2 where V is the electric potential difference of the capacitor. This has been verified by the experiments of Musha [38]. However, the weigh reduction phenomenon is currently mixed up with the B-B effect which is directional to the electric field applied. However, the weight reduction effect is not directional and it stays if the potential does not change. This is verified by Liu [40], who measured the effect of weight reduction with the roll-up capacitors.

Appendix B

The Current-Mass Interaction

If the electric energy leads to a repulsive force toward a mass, the magnetic energy would lead to an attractive force from a current toward a mass [50, 51]. The existence of such a current-mass attractive force has been verified by Martin Tajmar and Clovis de Matos [52] from the European Space Agency.

They found that a spinning ring of superconducting material increases its weight much more than expected. Thus, they believed that general relativity had been proven wrong. However, according to quantum theory, spinning super-conductors should produce a weak magnetic field. Thus, they are also measuring the interaction between an electric current and the earth, i.e. an effect of the current-mass interaction!

The existence of the current-mass attractive force would solve a puzzle, i.e., why a charged capacitor exhibits the charge-mass repulsive force since a charged capacitor has no additional electric charges? In a normal situation, the charge-mass repulsive force would be cancelled by other forms of the current-mass force as Galileo, Newton and Einstein implicitly assumed. This general force is related to the static charge-mass repulsive force in a way similar to the Lorentz force is related to the Coulomb force.

One may ask what is the formula for the current-mass force? However, unlike the static charge-mass repulsive force, which can be derived from general relativity; this general force would be beyond general

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relativity since a current-mass interaction would involve the acceleration of a charge, this force would be time-dependent and generates electromagnetic radiation. Moreover, when the radiation is involved, the radiation reaction force and the variable of the fifth dimension must be considered [36].

Nevertheless, we may assume that, for a charged capacitor, the resulting force is the interaction of net macroscopic charges with the mass [52]. A spinning ring of superconducting material has the electric currents that are attractive to the earth. This also explains a predicted phenomenon, which is also reported by Liu [39] that it takes time for a capacitor to recover its weight after being discharged [53]. This was observed by Liu because his rolled-up capacitors keep heat better. A discharged capacitor needs time to dissipate the heat generated by discharging, and the motion of its charges would accordingly recover to normal. Thus, it is natural to predict that a piece of heated up metal would have reduced weight, and this has been verified by experiments [53].

Endnotes

1. Hawking in his visit (June 2006) to China, still misleadingly told his audience that his theory was based on general relativity only. The root of his problem would be that he still does not understand the formula $E = mc^2$.
2. This equation was first proposed by Lorentz [20] and later Levi-Civita [21] as a possibility in the following form,

$$\kappa t(g)_{ab} = G_{ab} + \kappa T_{ab} \qquad \text{(LL)}$$

   where $t(g)_{ab}$ is the gravitational energy-stress tensor, G_{ab} is the Einstein tensor, and T_{ab} is the sum of other massive energy-stress tensors. Then, the gravitational energy-stress tensor takes a covariant form, although they have not proved its necessity with calculations.
3. An independent evidence for the absence of a bounded dynamic solution for the Einstein equation is that the calculated gravitational radiation would depend on the approach used [54].
4. Many theorists such as Hawking & Penrose have also mistaken that $m = E/c^2$ is unconditionally valid.
5. S. T. Yau won a Fields Medal in 1982 and Witten won a Fields Medal in 1990. Their works on the positive mass (or energy) were cited as an achievement because the mathematicians do not understand the related physics [54].
6. The correct formula would be the single-directional mc^2 => E, but not necessarily E/c^2 => m.

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Investigations of the Defects Influence on I-V Curves of HTc Superconductors

By Sosnowski J.
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Abstract- Analysis of the influence of defects, created in irradiation process at nuclear accelerators or during mechanical and heat treatment of superconducting tapes in the technological process, on the current-voltage characteristics of superconducting multi-layered materials is given. New approach taking into account inter-layers interaction is proposed and results of calculations presented, which are in accordance with experiment. The magnetic field dependence of the critical current is theoretically deduced, which relation is useful then for analysis of the dynamical anomalies of the current-voltage characteristics in HTc superconductors. New solution of the magnetic diffusion equation into HTc superconductors is proposed, which predicts results concerning dynamical anomalies being in agreement with experimental data.

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Abstract- Analysis of the influence of defects, created in irradiation process at nuclear accelerators or during mechanical and heat treatment of superconducting tapes in the technological process, on the current-voltage characteristics of superconducting multi-layered materials is given. New approach taking into account inter-layers interaction is proposed and results of calculations presented, which are in accordance with experiment. The magnetic field dependence of the critical current is theoretically deduced, which relation is useful then for analysis of the dynamical anomalies of the current-voltage characteristics in HTc superconductors. New solution of the magnetic diffusion equation into HTc superconductors is proposed, which predicts results concerning dynamical anomalies being in agreement with experimental data.

I. Introduction

High temperature oxide superconductors are multi-layered materials, therefore their subtle structure is very sensitive to existence of nano-sized defects. Topic of nano-defects created by irradiation concerns especially superconductors used in the nuclear reactors [1], constructed by applying the superconducting windings as for instance it has the place in CERN and JINR in Dubna [2-3]. Neutron irradiation will appear also in the constructed ITER reactor and will influence therefore the current-voltage characteristics of using here superconducting wires and then critical current, which makes this problem very actual. The work of the HTc superconducting cables transporting current, which subject is close to the Author's scientific interests, is influenced too by the microscopic interaction of the defects with the magnetic vortices, what indicates also on relevance of this phenomenon. The multi-layered structure of HTc superconductors plays here additionally important function, what will be shown in this paper.

II. Model Presentation

Neutron irradiation created defects influence strongly properties of low dimensional superconductors, such as layered HTc materials but also they are important for low temperature superconductors of an A15 type crystal structure. Destruction of linear chains of transition metals by fast neutron or heavy ions irradiation is presented in Fig. 1, showing elementary cell of an A15 type superconductor. Materials crystalizing in this structure, as Nb3Sn are used continuously in the technology of the superconducting wires and really their superconducting properties, especially critical temperature is sensitive to heavy ions irradiation. From other side critical temperature of 3-dimensional type of conductivity NbTi materials is only slightly affected by punctual, irradiation induced defects.

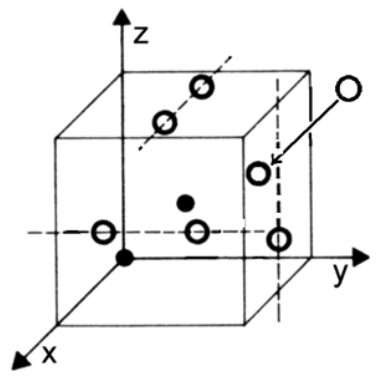

Figure 1 : Crystal structure of Nb3Sn A15 type superconductor, with shown linear chains of (O) transition metals, (•) positions of Sn atoms. The irradiation caused damage of the linear chain is also presented

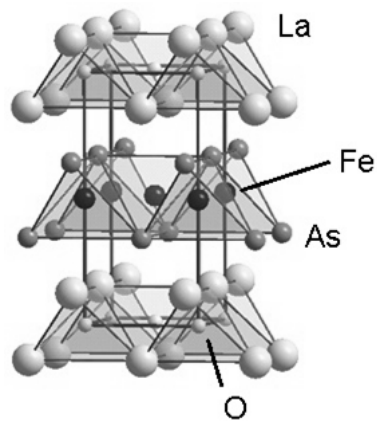

Figure 2 : Crystal structure of HTc iron superconductor LaFeAsO of the critical temperature above 40K

The multi-layered structure of HTc superconductors is shown in Fig. 2 for LaFeAsO material, while Fig. 3 presents such multi-layered structure for YBaCuO and BiSrCaCuO composition with CuO_2 planes responsible for superconductivity.

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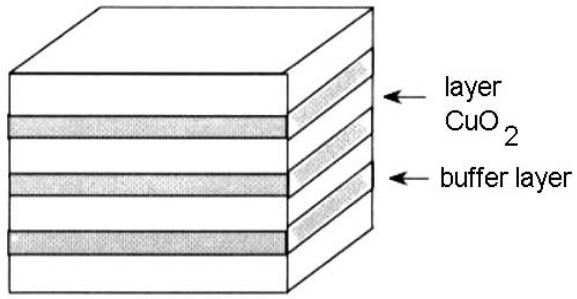

Figure 3 : Schematic structure of the multi-layered HTc superconductor with shown CuO_2 planes in YBaCuO or BiSrCaCuO compound

This structure is very sensitive therefore to the nano-defects appearance and on the other hand to the interplane interaction. Model of the capturing interaction has been elaborated for 2D layered HTc superconductors, in which pancake shape vortices are formed. Change of the free energy of the Ginzburg-Landau type has been analysed for an arrangement of the vortices captured on the regularly ordered nano-defects, acting as the pinning centers, in the function of vortex deflection from initial, equilibrium position. Shift of the vortex from this position causes an increase in the normal energy of the system. The energy barrier arises, which is function of the vortex displacement, according to the notation of Fig. 4 given by:

$$\Delta U_2(x) = \frac{\mu_o H_c^{\,2} l dx}{2} \tag{1}$$

for $x<x_c$, where x_c is any critical distance, dependent on ratio $d/2\xi$. In opposite case appears relation:

$$\Delta U_3(x) = \frac{\mu_o H_c^{\,2} l \xi^2}{2}\left[\arcsin\frac{x}{\xi} - \frac{\pi}{2} + \arcsin\frac{d}{2\xi} + \frac{x}{\xi}\sqrt{1-\left(\frac{x}{\xi}\right)^2} + \frac{d}{2\xi}\sqrt{1-\left(\frac{d}{2\xi}\right)^2}\right] \tag{2}$$

H_c denotes in Eqs. 1-2 thermodynamic critical magnetic field, μ_0 is magnetic permeability, while parameter x shown in Fig. 4 describes the deflection of the vortex core against the pinning center formed by the nano-defect of the width d. ξ is coherence length and describes the radius of the core of the vortex, while l is the thickness of the pancake type vortex, equal to the thickness of the superconducting layer in oxide HTc superconductor. In the paper has been considered an initial captured vortex position on the depth of the coherence length inside the pinning center, which is favorable from the point of view of the shielding current

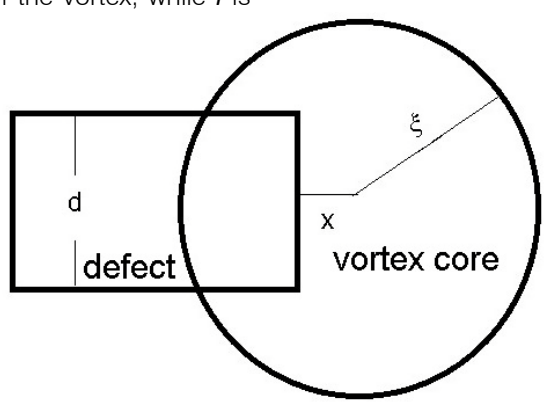

Figure 4 : Schematic view of the vortex captured on the depth (ξ - x) inside the nano-defect

distribution, however other configurations can be also regarded. While taking into account the Lorentz forces as well as elasticity energy of the vortex lattice expressed by the coefficient α an energy barrier height ΔU is received in the current representation as follows:

$$\Delta U = \frac{\mu_o H_c^2 l \xi^2}{2}\left[-\arcsin\ i + \arcsin\frac{d}{2\xi} + \frac{d}{2\xi}\sqrt{1-\left(\frac{d}{2\xi}\right)^2} - i\sqrt{1-i^2}\right] + \alpha\xi^2\sqrt{1-i^2}\left(\sqrt{1-i^2}-2\right) \tag{3}$$

Tilting of the potential energy wells is caused by the current flow of the reduced density $i = j/j_c$, where j_c is received in the present model critical current density, expressing the transition between flux creep and flux flow states. S in Eq. 4 denotes the defect cross-section, while a lattice constant of regularly arranged defects:

$$j_c = \frac{\mu_0 H_c^2}{\pi\xi\ B}\cdot\frac{S(1-S/a^2)}{a^2} \tag{4}$$

In the present paper interaction between the neighboring superconducting planes shown in Fig. 3

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has been taken into account. Results of preliminary calculations of the influence of number of interacting planes on the current-voltage characteristics, performed inserting the scaling coefficient, connected with shielding effects in individual planes, is shown in Fig. 5. Above described model predicts too the magnetic field dependence of the current-voltage characteristics of the HTc superconductors. The results of calculations are shown in Fig. 6 and are in qualitative agreement with the experimental data measured on $Bi_2Sr_2Ca_2Cu_3O_x$ superconductor at liquid nitrogen temperature in external magnetic field, presented in Fig. 7.

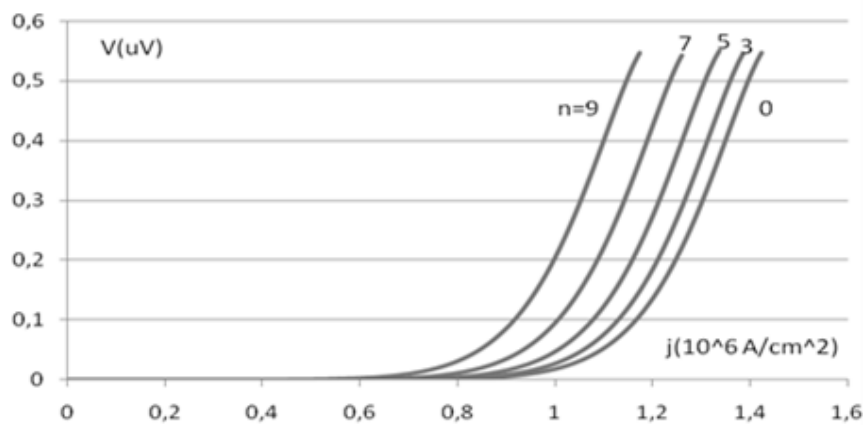

Figure 5 : Influence of the number of interacting planes (n) in HTc multilayered superconductor on the current-voltage characteristics of the irradiation defected sample n=0, 1, 3, 7, 9.

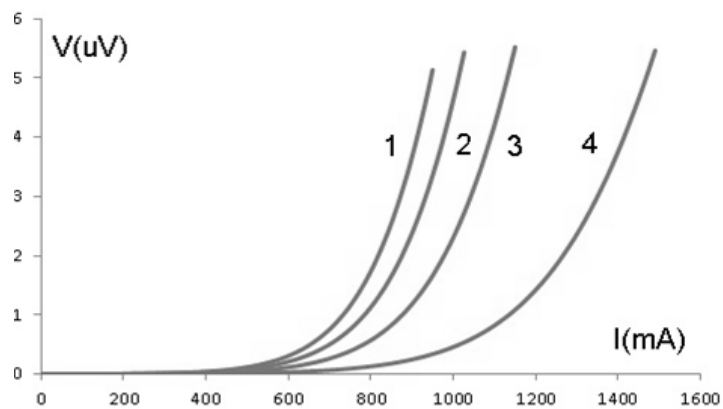

Figure 6 : Theoretically calculated current-voltage characteristics of HTc superconductor in static magnetic field: (1) B=35 mT, (2) 33 mT, (3) 30 mT, (4) 24 mT

Experimental magnetic field dependence of the critical current for that sample is shown in Fig. 8 and really confirms significant influence of magnetic induction on this parameter, as predicts theoretically Eq. 4.

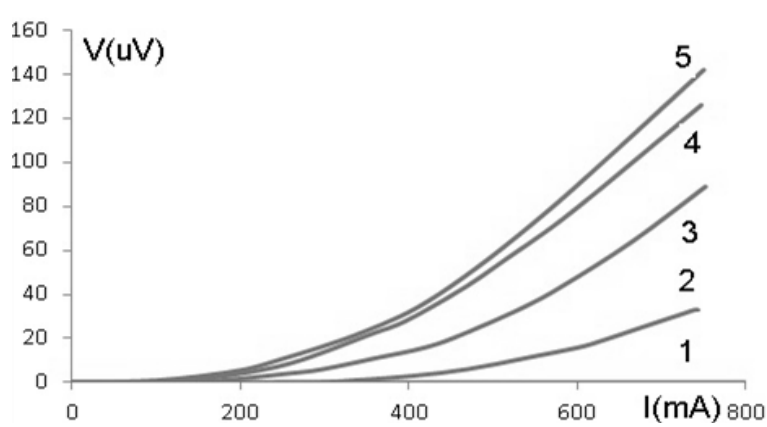

Figure 7 : Experimental current-voltage characteristics for $Bi_2Sr_2Ca_2Cu_3O_x$ superconductor in liquid nitrogen temperature for various magnetic fields: (1) B=0, (2) 13,5 mT, (3) 24 mT, (4) 33 mT, (5) 35 mT.

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Figure 8 presents the experimental critical current dependence on the magnetic induction in the liquid nitrogen temperature basing on experimental data of Fig. 7.

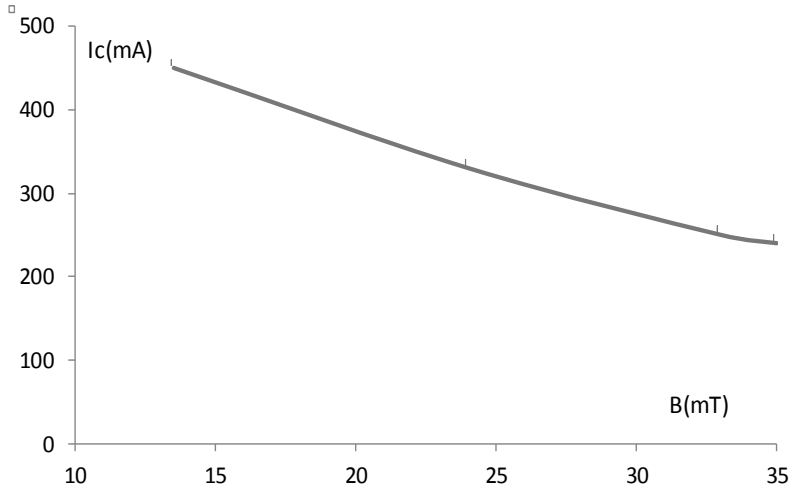

Figure 8 : Critical current magnetic field dependence for BiSrCaCuO ceramic superconductor in 77 K.

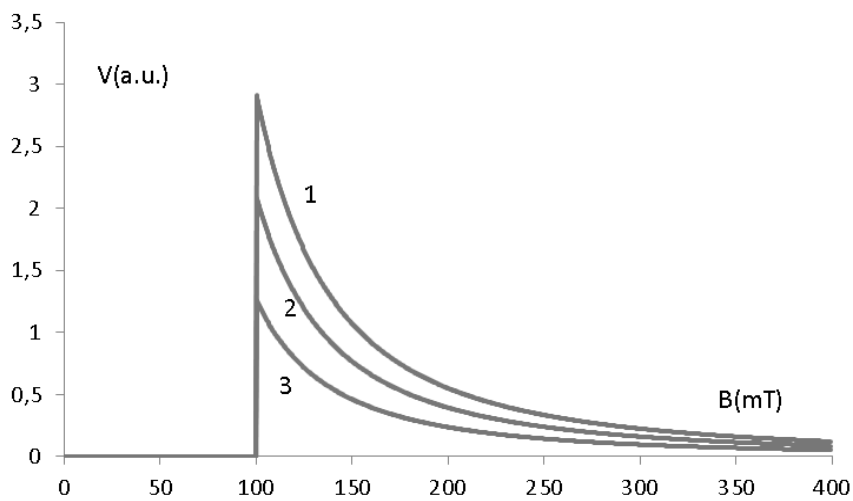

Figure 9 : Theoretically calculated dynamical anomalies of the current-voltage characteristics of HTc superconductor in slowly varying magnetic field 10 mT/s for transport current: (1) I=350 mA, (2) 250 mA, (3) 150 mA.

Elaborated model leading to the inverse magnetic field dependence of the critical current density given by Eq. 4 describes too, observed us experimentally dynamical anomalies of the current-voltage characteristics of the HTc superconductors, in slowly varying external magnetic field, which are also the subject of present investigations. New model of this phenomenon has been deduced basing on the solution of the magnetic diffusion equation. This new solution in the polynomial form, with additional constrains appropriate to description of superconductivity phenomenon, has been applied for analysis of the current-voltage characteristics in dynamically varying magnetic field. Some results of calculations are given in Fig. 9 and indicate on sensitivity of anomalies to the transport current, which makes them promising new tool for detecting current amplitude, as well as other electromagnetic quantities. Similar behavior has been measured us previously and shows the dependence of anomalies on such electromagnetic quantities as magnetic field sweep rate, current amplitude and frequency, temperature and generally superconducting sample quality.

III. Conclusions

Performed investigations are devoted to the phenomenon of the transport current flow through the HTc ceramic, multi-layered superconductors with nano-defects, especially under point of view of analysis their current-voltage characteristics. This topic is related to the issue of applications of HTc superconductors in such electric devices as coils and cryocables, which are in the scope of author scientific interest. The relevance from the point of view of applied superconductivity, of the interaction of defects with pancake vortices is indicated, especially taking into account its influence on

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the critical current of HTc superconductors. The interplane interaction in these multilayered superconductors was investigated too in the paper and comparison of the theoretical model with experimental data is enclosed. It have been predicted theoretically dynamical anomalies of the current-voltage characteristics in varying magnetic field basing on new polynomial type solution of magnetic diffusion equation, which gives results in accordance with experimental data.

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Rethinking the Double Slit Experiment

By Ke Xiao

Abstract- The wave-particle duality relate to the space-time property of matter by Planck constant. The fine structure constant is linked to the double-slit and the uncertainty principle in Quantum Mechanics. Compton scattering and interference of doubleslit is established by the cross-linked angle $T_1 = T_c \cos(\theta_2)$, and vice versa. The single-slit diffraction is described by Sinc-function which could combine the classical diffraction and quantum interference effect in the same experiment. This space-time model explain the experimental mystery of the double-slit.

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I. Introduction

The interference of Young's double-slit experiments is the "central paradox" of Quantum Mechanics. [3] The quanta exhibit strange behavior after passing through the double-slits: (a) There is a definite symmetric interference pattern for the multi-quanta (photon or electron), regardless of whether they all come together or one at a time; (b) The individual quanta has a random path and target point; (c) There is a white background noise, a photon can be found even at the node; and (d) No interference for single-slit. There are many controversies surrounding wave-particle duality, determinative, causality, localization. Beyond the Copenhagen interpretation, other interpretations include Path-Integral, Hidden Variable, de Broglie-Bohm, etc, each with its own compromises. The fine-structure constant α is deeply involved in the Quantum theory. [1,2] Pauli considered quantum mechanics to be inconclusive without understanding of the fine structure constant. [2] Feynman also said that nobody understands quantum mechanics. [3] As a new approach, this paper discuss a fine structure constant interpretation of double-slit. [4]

II. Wavefunction and Wave-Particle Duality

A plane wave function $\Psi(\mathbf{r},t)$ and the Born probability density $|\Psi(\mathbf{r},t)|^2$ are [6]

$$\begin{aligned} \Psi(\mathbf{r},t) &= Ae^{-\frac{i}{\hbar}(\mathbf{p}\cdot\mathbf{r}-Et)} = Ae^{-\frac{i}{\hbar}Et}\psi(\mathbf{r}) = f(t)\psi(\mathbf{r}) \\ |\Psi(\mathbf{r},t)|^2 &= \Psi\Psi^* = [Ae^{-\frac{i}{\hbar}Et}\psi(\mathbf{r})][Ae^{-\frac{i}{\hbar}Et}\psi(\mathbf{r})]^* \\ &= Ae^{-\frac{i}{\hbar}Et}\psi(\mathbf{r})\cdot Ae^{\frac{i}{\hbar}Et}\psi^*(\mathbf{r}) = A^2|\psi(\mathbf{r})|^2 \end{aligned} \tag{1}$$

The fine structure constant can be defined as the conservation of angular momentum related to the same dimensional $\mathbf{p}\cdot\mathbf{r}-Et$

$$\frac{\mathbf{e}^2}{c} = \pm\alpha\hbar = \mathbf{p}\cdot\mathbf{r}-Et \tag{2}$$

The wavefunction had an entropy format $S = k\ln\Psi$ for $\hat{\boldsymbol{H}}\Psi = \boldsymbol{E}\Psi$ in the first paper of Schrödinger in 1926. [5,12] The Boltzmann constant k is linked to α by the dimensionless blackbody radiation constant α_R and primes $\alpha_R = \mathbf{e}^2(\frac{4\sigma}{ck^4})^{1/3} = (\prod\frac{\mathbf{p}^2}{\mathbf{p}^2+1})^{1/3}\alpha = 0.86976680\alpha = \frac{1}{157.555}$. [7] The Einstein/de Broglie **wave-particle duality is linked to the reciprocal space-time properties of matter**. [8,9] Note that period $T = 1/\nu$ [T] and wavelength $\lambda = 1/k$ [L], the property of *particle-wave* is defined by the spin over *time-space*.

$$\begin{aligned} E &= \hbar\omega \quad \text{i.e.} \quad E = h\nu = h/T \qquad \text{(spin/time)} \\ \mathbf{p} &= \hbar\mathbf{k} \quad \text{i.e.} \quad \mathbf{p} = hk = h/\lambda \qquad \text{(spin/space)} \end{aligned} \tag{3}$$

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where the conservation of angular momentum in the reduced Planck (Dirac) constant $h = ET = \mathbf{p}\lambda$ (i.e., $\hbar = E/\omega = \mathbf{p}/\mathbf{k}$), and the electron spin $\hbar/2$ can only be interpreted by the 4-dimensional space-time of the relativistic Dirac equation. [10, 11]

III. Compton Scattering and Interference

In **Fig. 1** (a), the 2D double-slit plane is illustrated so that the slits 1 and 2 are at $\frac{d}{2}$ and $-\frac{d}{2}$, with the slit width δ, a moving target receiver at the point X, with distance Y between the double-slit and target, $L_1 = [Y^2 + (X + \frac{d}{2})^2]^{1/2}$ and $L_2 = [Y^2 + (X - \frac{d}{2})^2]^{1/2}$. Note that the experimental condition requests $Y \gg X \gg |d| \gg \lambda$, so $\triangle L \cong aX$ is linear.

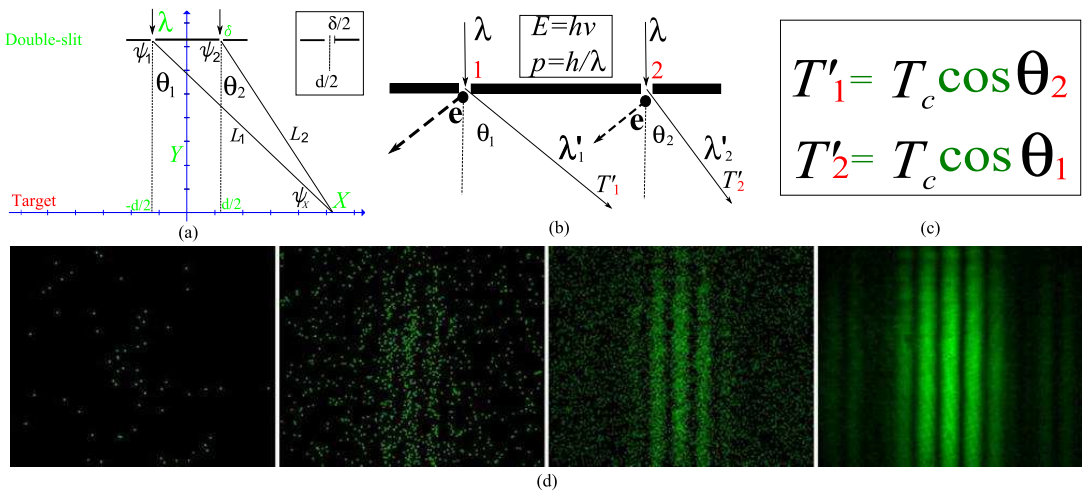

Figure 1 : The 2D illustration of Double-slit (a), the cross-linked photon scattering (b), (c), and (d) the experimental data recorded by Antoine Weis in 2003.

Since the phase velocity $c = \nu\lambda = \omega\lambda\!\!\!^{-} = \omega/k$ and $T = \omega^{-1}$, from Compton scattering $\lambda\!\!\!^{-}{}' - \lambda\!\!\!^{-} = \lambda\!\!\!^{-}_c(1 - \cos\theta)$ (i.e., $\frac{c}{\omega'} - \frac{c}{\omega} = \frac{c}{\omega_c}(1 - \cos\theta)$), we have $T' - T = T_c(1 - \cos\theta)$ in **Fig. 1** (b). [13] For the each slit in **Fig. 1** (c)

$$\begin{aligned} T_1' - T &= T_c[1 - \cos(\theta_1)] \qquad (1) \\ T_2' - T &= T_c[1 - \cos(\theta_2)] \qquad (2) \end{aligned} \tag{4}$$

Let (4-2) subtract (4-1), and $T_c = \lambda\!\!\!^{-}_c/c = \hbar/m_e c^2 = 1.288 \times 10^{-21}$[sec], then

$$\triangle T = T_2' - T_1' = T_c[\cos(\theta_1) - \cos(\theta_2)] \tag{5}$$

(5) establishes ***the cross-linked angle for the double-slit***

$$\text{If} \quad T_1' = T_c\cos(\theta_2) \quad \text{then} \quad T_2' = T_c\cos(\theta_1) \tag{6}$$

where the T_1' on the slit-1 is related to the scattering angle θ_2 on the slit-2, and *vice versa*. It is a random variable for each particle noted as $\triangle T = \delta T$, and the experimental data shows in **Fig. 1** (d).

Assuming $\psi_1 = A_1 e^{-i\omega T_1'}$ and $\psi_2 = A_2 e^{-i\omega T_2'}$ after the photon scattering for slits 1 and 2, where $|A| \simeq |A_1| \simeq |A_2|$ is real number. The target wavefunction at X is $\psi_X = Ae^{-i\omega T_1'}e^{ikL_1} + Ae^{-i\omega T_2'}e^{ikL_2} = \psi_1 e^{i2\pi L_1/\lambda} + \psi_2 e^{i2\pi L_2/\lambda}$, where λ is the wavelength of the quanta (photon or electron). The probability given for the quanta at the target point X is the same as (1) in the exponential form

$$|\psi_X|^2 = (Ae^{-i\omega T_1'}e^{ikL_1} + Ae^{-i\omega T_2'}e^{ikL_2})(Ae^{i\omega T_1'}e^{-ikL_1} + Ae^{i\omega T_2'}e^{-ikL_2})$$

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$$
\begin{aligned}
&= |A|^2 \cdot [1 + 1 + e^{i(kL_1 - \omega T_1' - kL_2 + \omega T_2')} + e^{-i(kL_1 - \omega T_1' - kL_2 + \omega T_2')}] \\
&= |A|^2 \{ \underset{\text{White noise}}{2} + \underset{\text{Wave interference}}{2\cos[k(L_1 - L_2)} - \underset{\text{Particle scattering}}{\omega(T_1' - T_2')]} \} \\
&= 2|A|^2 [1 + \cos(\underset{\text{space}}{k\triangle L} - \underset{\text{time}}{\omega\delta T'})]
\end{aligned}
\tag{7}
$$

The angle term in (7) is same as $\frac{1}{\hbar}(\mathbf{p}\cdot\mathbf{r} - Et) = (\mathbf{k}\cdot\mathbf{r} - \omega t) = \mathbf{k}(\mathbf{r} - ct)$ in (1), i.e., related to the fine structure constant in (2). It is $\lambda\!\!\!^{-}_c = \alpha a_0 = \frac{\alpha^2}{4\pi R_\infty} = \frac{r_e}{\alpha}$ for the free electron and $\frac{\hbar}{m_i c} = \frac{m_p}{m_i}\frac{\alpha}{\beta}a_0 = \frac{m_p}{m_i}\frac{\alpha^2}{\beta}\frac{1}{4\pi R_\infty}$ for the atomic bonding electron in the Compton scattering. (7) clearly show that the wave-particle duality by the wave-vector k and the photon-frequency ω linked separately to the space $\triangle L$ and time $\delta T'$.

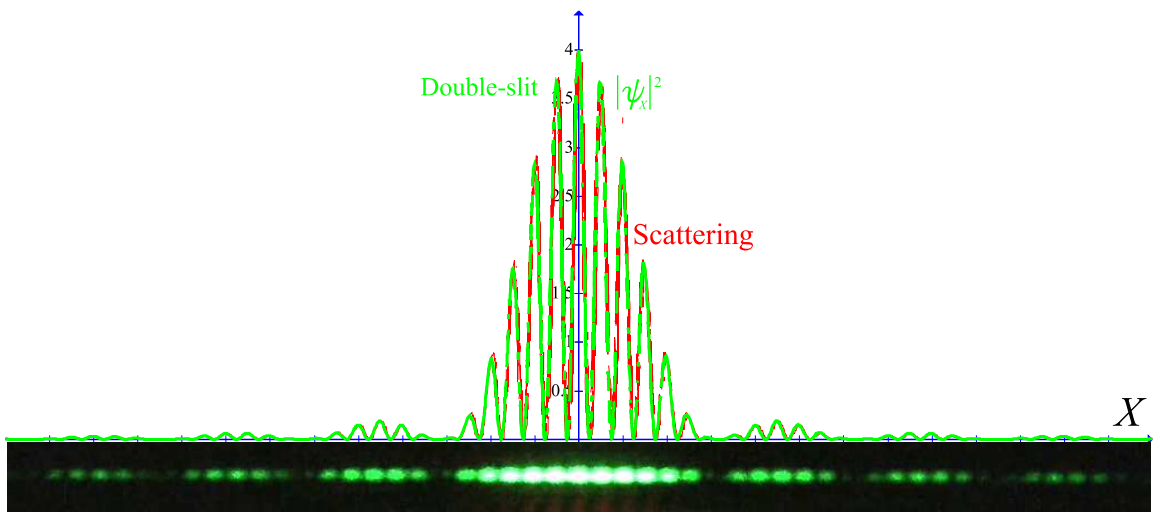

Figure 2 : The scatter graph of the probability density $|\psi_X|^2_{DS}$ in (7) by author (top); and the Laser double-slit experimental data for the *far* target from MIT (bottom).

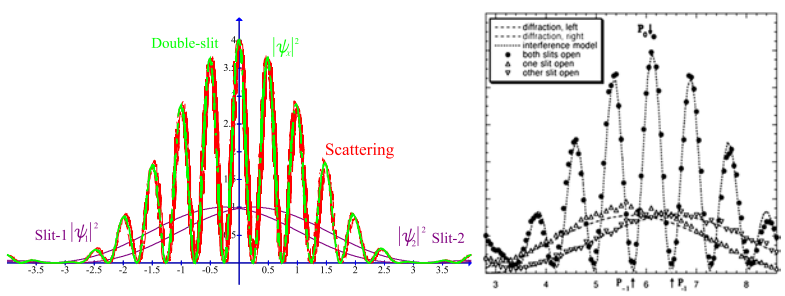

Figure 3 : The scatter graph of $|\psi_X|^2_{DS}$, $|\psi 1|^2$ and $|\psi_2|^2$ in (7) by author (left); and the "one photon at a time" double-slit experimental data for the *near* target from Teachspin (right)

The visible photon-frequency is about $\omega \sim 10^{14}[Hz]$. The term of $\omega\delta T'$ are random and small effect on the visible-light scattering by the tightly bound electron ($m_i \gg m_e$). Therefore, the term $\frac{2\pi}{\lambda}(L_1 - L_2) = akX$ is the major-variable in control. The cosine term becomes $\{-1, 0, 1\}$ when $\frac{2\pi}{\lambda}(L_1 - L_2) - \omega(T_1 - T_2) = akX - \omega\delta T' = \{(2n \pm 1)\pi, (n + \frac{1}{2})\pi, 2n\pi\}$ where $k = \frac{2\pi}{\lambda}$, $n = 0, \pm 1, \pm 2, \cdots$, and let $|\psi_X|^2 = \{0, 2, 4)\}|A|^2$. The continued distribution is changes into a quantum interference pattern during coherence and cross-correlation. [14] Assuming $A = \text{sinc}[k\triangle L]$ and $A_{1,2} = \text{sinc}[k(\triangle L \pm \frac{d}{2})]$, the graph of (7) matches perfectly with experimental data from MIT for the *far* target using lasers (**Fig.**

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2),[1] and Teachspin for the *near* target with "one photon at a time" (**Fig. 3**).[2] The scatter graph in **Fig. 2** and **Fig. 3** clearly show that the interference pattern with the random scattering effect as the individual particle of "one photon at a time."

(7) indicates that the double-slit experiment has the interference pattern (a) with a random quantum scatting (b) and a background white noise (c). Notice that the cosine function is an even function responsible for making the symmetric interference pattern appearing on the target plate. It also shows that there is no interference pattern for the *narrow* single-slit (d), since $|\psi_j e^{i2\pi L_j/\lambda}|^2 = (A_j e^{-i\omega t_j} e^{ikL_j})(A_j e^{i\omega t_j} e^{-ikL_j}) = |A_j|^2$ where $j = 1, 2$ (**Fig. 3**).

IV. Diffraction and Interference of N-Slits

As an exception, a slit which is wider than a wavelength produces Fraunhofer diffraction similar to the *weak* interference, due to the slit-edge electron-photon scattering effect. The probability for the diffraction of a *wide* single-slit at the target point X can be derived as a Taylor-Maclaurin series or Euler-Viete infinite product,

$$\begin{aligned} |\psi_X|^2_{SS} &= |A|^2 = |\mathrm{sinc}(akX)|^2 = [\sum_{n=1}^{\infty}(-1)^n \tfrac{(akX)^{2n}}{(2n+1)!}]^2 \\ &= \{\prod_{n=1}^{\infty}[1-(\tfrac{akX}{n\pi})^2]\}^2 = [\prod_{n=1}^{\infty}\cos(\tfrac{akX}{2^n})]^2 \end{aligned} \tag{8}$$

where $akX = \frac{\pi d}{\lambda}\sin\theta$ and slit width d. Unlike θ in the Fraunhofer approximation for the *far* field limitation, X can be measured directly regardless *far* or *near* target. (8) looks like but is not Gaussian distribution. **Fig. 4** shows the graph of (8) compared with the single-slit diffraction experimental data using laser and adjustable slit-width.

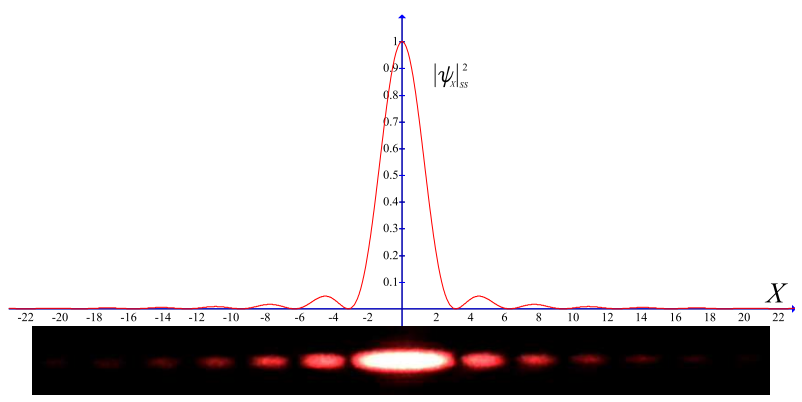

Figure 4: The graph of the probability density $|\psi_X|^2_{SS}$ in (8) by author (top); and the single-slit diffraction experimental data from MIT (bottom)

Therefore, the double-slit equation is simply the diffraction of two *narrow* single-slits with wave interference and photon scattering. This is supported by the experimental result of very narrow but widely separated double-slit, i.e., moving two single-slits closer, in the double-slit experiment of electron. [15] From (7) and (8), the double-slit equation is

$$\begin{aligned} |\psi_X|^2_{DS} &= \underbrace{2}_{\text{two}} \cdot \underbrace{|\mathrm{sinc}(a'kX)|^2}_{\text{diffraction}}[1+\cos(\underbrace{akX}_{\text{interference}} - \underbrace{\omega\delta T'}_{\text{scattering}})] \\ &= \{2\cdot\mathrm{sinc}(a'kX)\cdot\cos[(akX-\omega\delta T')/2]\}^2 \end{aligned} \tag{9}$$

[1] http://scripts.mit.edu/_tsg/www/demo.php?letnum=P%2010 (2011)
[2] http://www.teachspin.com/instruments/two_slit/experiments.shtml (2011)

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where $a'kX = \frac{\pi\delta}{\lambda}\sin\theta$ and δ is the narrow slit width; $akX = \frac{\pi d}{\lambda}\sin\theta$ ($d > \delta$ in **Fig. 2-3**). The total number of fringes are $N = 2m - 1$, where $m = d/\delta = a/a'$ equal to the ratio of the width of two-slits d divides the slit width δ. The double-slit experiment is a combination of the diffraction, scattering, and interference processes.

The same principle can be applied to *N-narrow* slit experiments (**Fig. 5**). [15]

$$\begin{aligned} \psi_X &= \sum_{n=0}^{N/2}\psi_{\pm n} = A\sum_{n=1}^{N/2}\cos(akX - \omega\delta T') \\ &= A\frac{\sin[N(akX+\omega\delta T')/2]}{\sin[(akX+\omega\delta T')/2]} \end{aligned} \tag{10}$$

The probability for the diffraction grating of *N-narrow* slits at the target point X is

$$\begin{aligned} |\psi_X|^2_{NS} &= \mathrm{sinc}^2(a'kX)\{\frac{\sin[N(akX-\omega\delta T')/2]}{\sin[(akX-\omega\delta T')/2]}\}^2 \\ &= \frac{1-\cos(2a'kX)}{2(a'kX)^2}\cdot\frac{1-\cos[N(akX-\omega\delta T')]}{1-\cos(akX-\omega\delta T')]} \end{aligned} \tag{11}$$

If $N = 2$, $\left[\frac{\sin(2\phi/2)}{\sin(\phi/2)}\right]^2 = [2\cos(\phi/2)]^2 = 2(1+\cos(\phi)) = 4\cos^2(\phi/2)$, (11) go back the double-slit equation (9). Unfortunately, the wave pattern is so attractive in the classical grating equation, and the particle scattering is ignored. (11) contains a particle scattering term $\omega\delta T'$, and its scatter graph compare with experiment from UTPD is shown in **Fig. 5** [3]

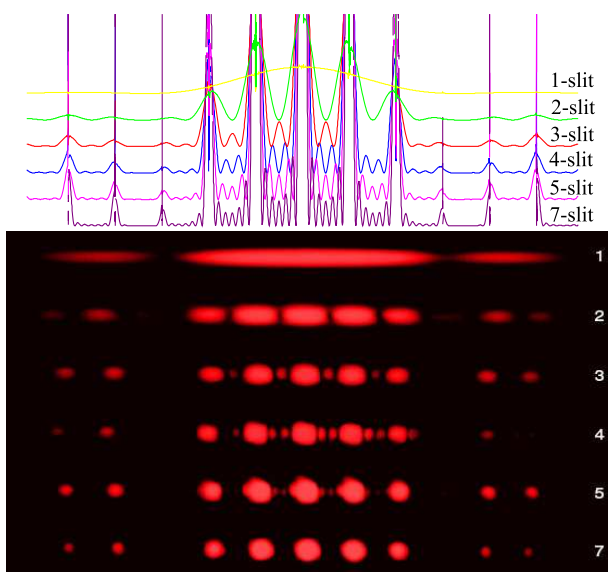

Figure 5: The scatter graph of the probability density $|\psi_X|^2_{1,2,3,4,5,7}$ in (11) by author (top); and the *N-narrow* slits (1, 2, 3, 4, 5, 7) diffraction data from UTPD (bottom)

V. Combination of Quantum and Classical Slit

In this model, the slit-edge electron-photon scattering plays a hidden role (each slit has two edges), which is linked to the fine structure constant. [7] Compton scattering creating redshift has been confirmed by sunlight. The fine structure constant must also play critical rule in the double-slit experiment of electron, neutron, He-atoms, and C-60 molecules.

[3] http://electron9.phys.utk.edu/phys136d/modules/m9/diff.htm (2011)

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Fig. 6 shows that there is a classical distribution (or de-coherent) if the quanta-slit interaction is weak (e.g., the double-slit experiment for neutron, C-60 and other heavy atoms). Other types of quantum scattering (e.g., Møller) may be involved. The Neutron double-slit data can be described as [16]

$$|\psi_X|^2_{NDS} = [2\mathrm{sinc}(a'kX)\cos(akX - \omega\delta T")]^2 + \sum|\mathrm{sinc}[a'k(X \pm x))]|^2 \tag{12}$$

Fig. 6 shows that many quanta have passed the slit without interaction (leaking), they are not taking place in the interference. This is also true for the photon-recoil atomic interferometry, and the light-quanta passing a widely separated double-slit. [16] **Fig. 7** shows the Young's interference patterns of synchrotron radiation. The photon energy is fixed at 180 eV, while the spacing of the double slit is changed from 30 to 200 µm. [17]

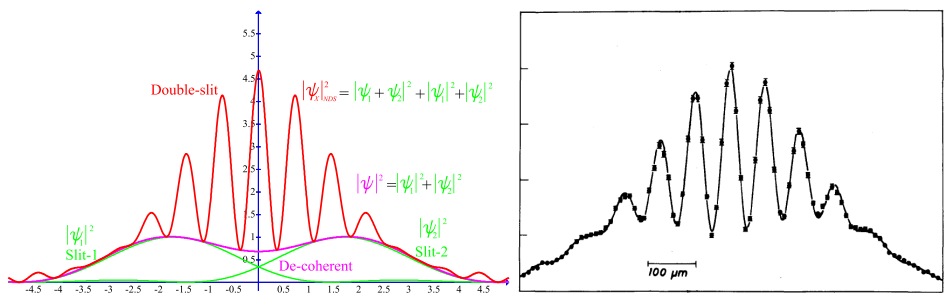

Figure 6 : The scatter graph of the probability density $|\psi_X|^2_{NDS} = |\psi_1+\psi_2|^2 + |\psi_1|^2 + |\psi_2|^2$ in (12) by author (left); and the Neutron double-slit data (right) [16]

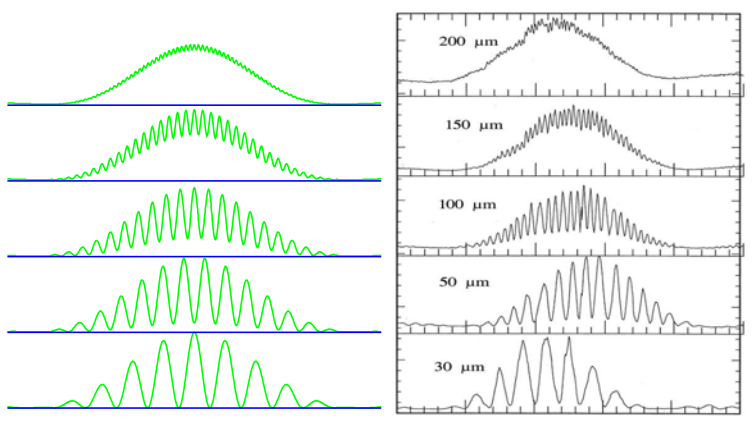

Figure 7 : The graphic $|\Psi|^2$ in (12) by author (left) compare to the Young's interference patterns of synchrotron radiation (right), $h\nu = 180eV$, the spacing of the double slit d is changed from 30 to 200 µm. [17]

VI. Space-Time 3D Model of Double-Slit

Applying the time evolution $e^{-kct} = e^{-bY}$ to the diffraction, interference and scattering in (12), the 3D expression of the double-slit is

$$\begin{aligned} |\psi_X|^2 &= (1 - e^{-kct}) \cdot |\psi_X|^2_{DS} + e^{-kct} \cdot \left\{|\psi_{X+d/2}|^2_{SS} + |\psi_{X-d/2}|^2_{SS}\right\} \\ &= (1 - e^{-bY})[2\mathrm{sinc}(a'kX)\cos(akX - \omega\delta T")]^2 + e^{-bY}\sum|\mathrm{sinc}[a'k(X \pm \tfrac{d}{2})]|^2 \end{aligned} \tag{13}$$

where $aX = [Y^2+(X+\frac{d}{2})^2]^{0.5} - [Y^2+(X-\frac{d}{2})^2]^{0.5}$ and $\delta T" = T_c\{[1+(\frac{X+d/2}{Y})^2]^{-0.5} - [1+(\frac{X-d/2}{Y})^2]^{-0.5}\}$. The contour map of (13) compare with the He-atom, and the 3D graph of (13) with the weak measurement are shown in **Fig. 8**. [18]

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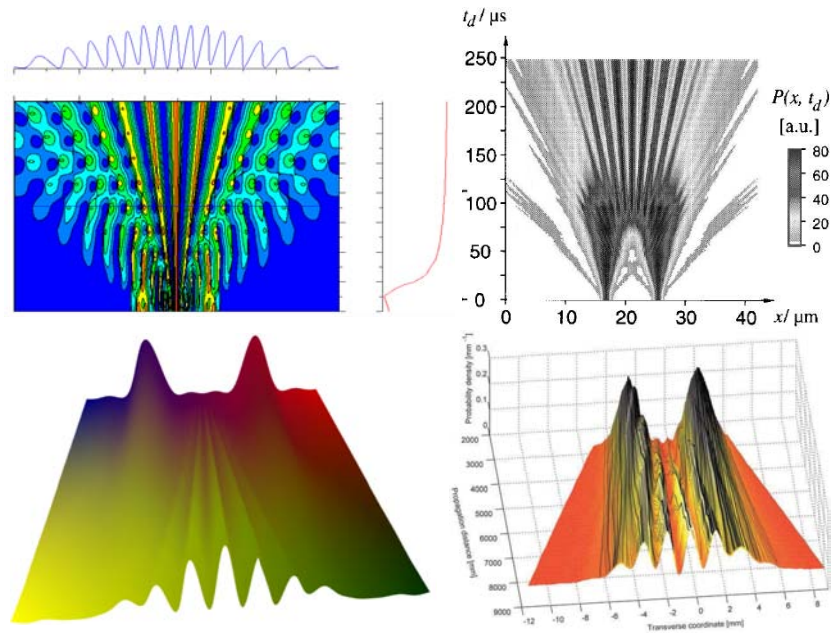

Figure 8 : The contour map and 3D graph of $|\Psi|^2$ in (13) by author (left) to compare with the He-atom and the weak measurement (right), originally explored by Wigner function and Bohmian trajectories. [18]

In (13), the wave-particle $\mathbf{P}\cdot\mathbf{r}-Et = akX-\omega\delta T' = k(aX-c\delta T')$ link to the space-time, and the X-enlarge distorted 3D graph shows in **Fig. 9**.

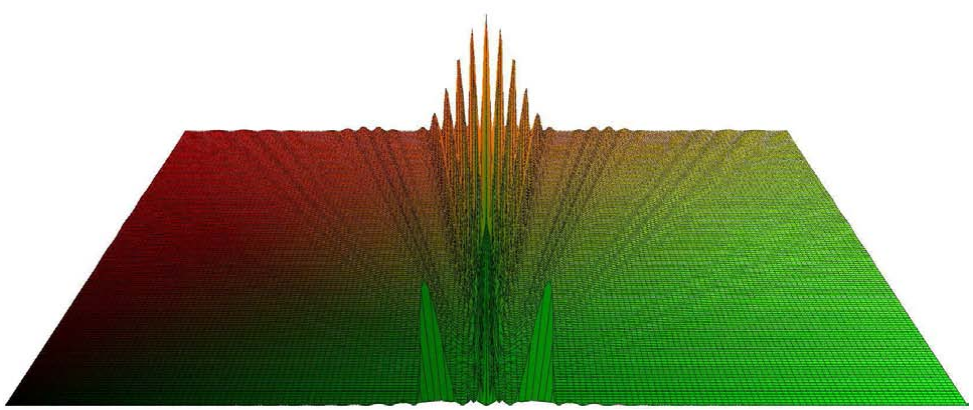

Figure 9 : The double-slit distorted 3D graph of $|\Psi|^2_{3D}$ in (13) by author

The experiment for which-way also show the de-coherent by the secondary scattering after the quanta passed slit. [19] It further prove that the quantum scattering is a critical issue behind the geometric parameters for the wave-pattern. In other word, ***there will be no interference if without relativistic quantum scattering.*** The fine structure constant is the magic hand behind the double-slit experiment. This model clearly displays the particle-wave duality by particle scattering and wave-interference. The quanta can be counted as one *particle* at a *time*, and the multi-quantas are displaced as the cosine-type *wave*-pattern in *space*. The electromagnetic wave frequency is in the region of $\omega = kc = 10^0 \sim 10^{24}$[Hz]. Since $T_c = 1.288\times10^{-21}$[sec], the double-slit wave interference can be tested from soft-X-ray (10^{18}[Hz]) to microwave (10^8[Hz]). The visible light ($\sim 10^{14}$[Hz]) is a *wave*-like rather than the *particle*-like, and the γ-ray (10^{20-24}[Hz]) is a *particle*-like rather than the *wave*-like. This physical reality was obscured by the trigonometric identities, however, there are many different versions of the classical grating equations. The quantum physical principle is the same and independent of the mathematical expression and coordinate system.

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VII. Conclusion

The wave-particle duality relate to the space-time property of matter by Planck constant. The fine structure constant is linked to the double-slit and the uncertainty principle in Quantum Mechanics. Compton scattering and interference of double-slit is established by the cross-linked angle $T_1^{'} = T_c \cos(\theta_2)$, and *vice versa*. The single-slit direction is described by Sinc-function which could combine the classical and quantum interference effect in the same experiment. This space-time model of double-slit explain the experimental mystery of the double-slit.

VIII. Acknowledgments

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Selfvariations Vs Standard Cosmological Model using as Criterion the Cosmological Data

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Abstract- We compare the Standard Cosmological Model with the Model of the Selfvariations, based upon the cosmological data as we collect them since the time of Hubble. We selected to examine the 14 most fundamental pieces of data. The Standard Cosmological Model can justify four of these, it can justify two additional with some further assumptions, while it cannot justify the remaining eight. The Cosmological Model of the Selfvariations justifies eleven, while the completeness of justification of the remaining two is a matter of further investigation. We did not identify any piece of cosmological data that contradicts the predictions of the Model of the Selfvariations.

Keywords: *cosmological model, SCM, selfvariations.*

GJSFR-A Classification : *FOR Code: 240101*

SELFVARIATIONSVSSTANDARDCOSMOLOGICALMODELUSINGASCRITERIONTHECOSMOLOGICALDATA

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Keywords: cosmological model, SCM, selfvariations.

I. Introduction

The Standard Cosmological Model prevailed over other models mostly because it justifies the redshift of distant astronomical objects, the Cosmic Microwave Background Radiation, and the nucleosynthesis of the elements. This success of the model, attenuated the strictness of the scientific community resulting in the introduction of many hypotheses into the model in an attempt to justify the ever increasing amount of cosmological data, ranging from the hypothesis of Cosmic Inflation in the 1980's, up to the most recent hypothesis of Dark Matter to justify the increased luminosity distances of type Ia supernovae. At the same time, many similar cosmological models were developed, which, at their core, justified the redshift by the expansion of the Universe. Finally we came to the anisotropies recorded by the Planck satellite, the temperature difference between the Northern and Southern hemisphere of the Universe, the recording of the variation of the fine structure constant, the Sloan Great Wall, and to the extremely large extent of the 73 quasars structure, the Huge-LQC group, which was recently observed. These recent data are in complete opposition to the Standard Cosmological Model. The same holds for the luminosity distances of type Ia supernova. The Dark Energy hypothesis momentarily justifies these distances by alluding to a Universe that expands at an accelerating rate. But in combination with the fact that we know, from successive measurements by the COBE, WMAP and Planck satellites, that the Universe is flat, there arises an insurmountable problem: the time required for the electromagnetic radiation we observe from astronomical objects with a redshift z>1 to reach the Earth, is greater than the age of the Universe predicted by the Standard Cosmological Model.

The correlation of redshift with the distance of far distant astronomical objects, as conducted by Edwin Hubble at the begin of the past century, leads to a certain conclusion: one, or more physical quantities from these considered as constant, vary within the universe. To SCM justifies the redshift with macroscopic causes via the expansion of the universe. However the redshift can be perfectly justified with microscopic causes. From a slight continuous increase of the rest mass and a slight continuous increase/ decrease of the electric charge of material particles. This increase/ decrease is expressed by the law of selfvariations.

Actually Hubble himself had serious doubts about the interpretation of reshifts as 'recession' velocities. As expressed by Hubble and Humason in the most influential paper [1,2]:

"The interpretation of redshifts as actual velocities, however, does not command the same confidence, and the term 'velocity' will be used for the present in the sense of 'apparent' velocity, without prejudice as to its ultimate significance… The writers are constrained to describe the 'apparent velocities – displacements' without venturing on the interpretation and its cosmological significance."

According to Allan Sandage [3]:

"Hubble believed that his count data gave a more reasonable result concerning spatial curvature if the redshift correction was made assuming *no recession.* To the very end of his writings he maintained this position, favouring (or at the very least keeping open) the model where no true expansion exists, and therefore that the redshift *"represents a hitherto unrecognized principle of nature"."*

The model of selfvariations predicts and justifies all of the cosmological data. Some of the predictions of the model demand further investigation as to their completeness, which is natural for a new model. There is no cosmological observation that contradicts the predictions of the model. Essentially, the totality of cosmological data is contained as information in a single equation for the rest mass of material particles and an analogous equation for the electric charge that express the law of selfvariations in the macrocosm. The consequences of the selfvariations at the scale of the

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Universe, are recorded in the most direct way in the cosmological data.

The redshift and the increased distance brightnesses of distant astronomical objects, the microwave background radiation and the flatness of the universe are mainly due to the selfvariation of the rest mass and less to that of the of the electric charge. The fluctuations of the CMBR temperature and the fine stracture parameter, the temperature difference of the northern and southern hemispheres of the universe and the absence of antimatter in the universe are solely due to the selfvariation of the electric charge. The Dark Matter relates both to the selfvariation of the electrical charge and the original form of the universe.

In the distant past, the equations predict that the original form of the universe differs only minimally from the vacuum. The ionization energy of atoms and the synthesizing energy of nucleons tend to zero as we go backwards in time. The universe went through a phase of ionized atoms when the nucleosynthesis of the elements could be made at temperatures near 0 K.

The law of selfvariations incorporates the arrow of time in the macrocosm and predicts that there is no arrow of time in the microcosm. Starting from a situation that differed only minimally from the vacuum the universe has evolved over the years because of the selfvariations, to the form we observe today. Nevetheless the universe remains consistent with its origin since at every stage of its evolution, at any time, the total energy content is zero. The law of the selfvariations expresses the unique relationship between matter and vacuum .

The equations of the model of the selfvariations allow us to go back in time as far as we want. The period considered as the age of the universe by the SCM is only the recent time period where matter has taken the form we observe today. According to the law of the selfvariations, beyond the limits of the universe we observe today there is no Big Bang, but an immense period of time evolution of the universe. This evolution is determined by the selfvariations.

II. The Fundamental Cosmological Data and the Predictions of the Two Models

We list the main cosmological data and the corresponding prediction of each model.

a) The redshift of distant astronomical objects

The Standard Cosmological Model justifies the redshift macroscopically, as a result of the expansion [4] of the Universe. On the contrary, in the model of selfvariations the redshift results from microscopic causes, as a consequence of the decrease of the rest masses of material particles [5, 6] at distant astronomical objects.

b) The Cosmic Microwave Background Radiation

The Standard Cosmological Model predicts the Cosmic Microwave Background Radiation as a remnant of the Big Bang [7]. The Model of the selfvariations predicts the Cosmic Microwave Background Radiation as the consequence of the enormous, theoretically infinite, values of the Thomson and Klein-Nishina scattering coefficients in the very early Universe. The enormous values of the scattering coefficients render the very early Universe opaque at a temperature close to OK [5, 6].

c) The increased luminosity distances of type Ia supernovae

In order to justify the increased luminosity distances of type Ia supernovae, the Standard Cosmological Model has to introduce further hypotheses, such as the one of dark energy [8, 9]. Knowing from observational data that the Universe is flat, the great distances measured for these supernovae constitute an insurmountable problem for the Standard Cosmological Model, as we shall see in the following subparagraph d.

In the model of the selfvariations the luminosity distances are predicted to be greater than the real distances for all distant astronomical objects. Because of the selfvariations, the energy generated by fusion, and by any conversion of rest mass into energy, is less at distant astronomical objects compared to the corresponding laboratory amount. The mass of distant supernovae is smaller than the mass of the prototype "standard candle" supernova. After performing the relevant calculations we obtain the correct relation between the luminosity distance and the redshift of astronomical objects [5, 6].

The model of the selfvariations predicts that at distant astronomical objects, the degree of opacity of the stellar surfaces increases, but at the same time the degree of atomic ionization also increases. These two factors affect the luminosity of distant astronomical objects for large values of the redshift z. It is important that for small values of the redshift, where we only measure the consequences of the selfvariation of the rest masses, the prediction of the law of the selfvariations is exactly confirmed.

d) The Flatness of the Universe

The COBE, WMAP and Planck satellites have successively confirmed that the Universe is flat. Since the Universe is flat for the time interval $T(z)$ required for the electromagnetic radiation to reach Earth from a distant astronomical object with redshift z, it holds that [5].

$$T(z) > \frac{z}{H} .$$

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For $z > 1$ we get $T(z) > \frac{1}{H}$, that is, the time interval $T(z)$ is greater than the age of the Universe predicted by the Standard Cosmological Model. The problem created by the combination of the flatness of the Universe and the increased luminosity distances of the supernovae, for the time interval $T(z)$, has been completely silenced. Since the Universe is flat, the hypothesis of Dark Energy is not enough to render the supernovae luminosity distances compatible with the Standard Cosmological Model. We remind that the initial measurements [8, 9] were conducted in order to confirm that the luminosity distances are smaller than those given by Hubble's law, since that was predicted by the Standard Cosmological Model. To this insurmountable problem for the Standard Model we have to add the case of star HD140283, which seems to have an age greater than the age of the Universe [10]. We come to the conclusion, mainly because of the first reason, that the Standard Cosmological Model is not in accordance with the observed flatness of the Universe.

The model of the selfvariations predicts that the total energy content of the Universe is zero and, therefore, the Universe is flat.

e) The Nucleosynthesis of the Chemical Elements

The Standard Cosmological Model predicts the nucleosynthesis of the chemical elements [11]. The very high temperatures in the very early Universe result in the decomposition of particles into their partial, constituent particles. As the Universe expands and cools, the phases of nucleosynthesis are predicted in detail.

The model of the selfvariations predicts [5, 6] that the binding energies of elementary particles for the formation of complex particles decrease at distant astronomical objects down to the value $\Delta m_0 c^2 (1-A)$. Regarding parameter we know that $A \to 1^-$, while $\Delta m_0 c^2$ is the laboratory value of the binding energy. Therefore, nucleosynthesis can take place at very low temperatures, close to $0K$, which are predicted by the model in the very early Universe.

Nucleosynthesis can take place in two distinctly different phases during the evolution of the Universe, as predicted by the model of the selfvariations: in the very early Universe, at a temperature close to 0K, but also during the accumulation of matter for the formation of the large scale structures in the Universe. The decreased binding energies of the material particles during the phase of accumulation of matter allow for the nucleosynthesis of heavy elements at temperatures at which, until today, nucleosynthesis was considered impossible. Thus, we can justify the existence of heavy elements in the Sun and other stars.

The model predicts that with the passage of time the selfvariations strengthen the binding energies of the particles, resulting in the enormous cohesion energies we measure in the laboratory today. The model is self-consistent, but a complete study is demanded as far as the completeness of the prediction is concerned.

f) The ionization of atoms in the very early Universe

The Standard Cosmological Model predicts that the Universe underwent a phase of atomic ionization [4], because of the high temperatures after the Big Bang.

The model of the selfvariations predicts [5, 6] a decrease in the values of atomic ionization energies at distant astronomical objects, down to value $X_n(1-A)$, where X_n is the laboratory value of the ionization energy of an atom. Taking into consideration that $A \to 1^-$, the ionization of atoms in the very early Universe follows.

g) The Sloan Great Wall

During the recent measurements for the large - scale structures of matter in the Universe, the Sloan Digital Sky Survey [12] recorded huge structures of matter followed by enormous voids. The largest recorded structure, the Sloan Great Wall, spans a length of $1.38 \times 10^9\ ly$, while it is estimated that its formation requires about $80 \times 10^9\ yr$. The size of the Sloan Great Wall introduces an issue of anisotropy of the Universe for the Standard Cosmological Model. Furthermore, the time needed for its formation exceeds the age of the Universe predicted by the model.

The equations of the model of the selfvariations are compatible with the condition $r \to \infty$ [5, 6], which means that we can go back in time as much as we want. Therefore, the size, and the time interval needed for the formation of the Sloan Great Wall, are compatible with the model of the selfvariations.

h) The Variation of the Fine Structure Constant

In the Standard Cosmological Model the fine structure constant has to actually be constant. As we have already mentioned, the Standard Cosmological Model explains the main cosmological data based on macroscopic and not microscopic causes.

The cosmological model of the selfvariations predicts a slight variation of the electric charge [5, 6]. Indeed, this variation can take place in two directions, either towards the increase, or towards the decrease of the absolute value of the electric charge. This potential for the evolution of the selfvariation of the electric charge in two directions is due to the fact that the electric charge exists in the Universe in the form of pairs of opposite quantities. Such a potential does not exist for the rest mass, which evolves only the direction of increase. The fine structure constant depends on the

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electric charge and is, therefore, affected by the selfvariations.

Recent measurements [13-27] have recorded a slight variation of the fine structure constant. Indeed, the measurements have shown that in the Northern hemisphere of the sky the fine structure constant had in the past a smaller than laboratory value, and in the Southern hemisphere a greater one. The Standard Cosmological Model cannot explain such results, while they don't pose a problem for the model of the selfvariations.

i) The Temperature Difference between the North and the South Hemisphere of the Universe

Recently, the Planck satellite confirmed the initial measurements of WMAP, according to which the temperature of the Northern hemisphere of the Universe is slightly lower than the temperature of the Southern hemisphere. According to the Standard Cosmological Model this temperature difference should not exist.

The difference in the value of the fine structure constant between the two hemispheres, as we already mentioned in the previous subparagraph, is due to the difference in the value of the electric charge [5, 6]. This difference in the electric charge is responsible also for the difference in temperature between the two hemispheres of the Universe. In the regions of the Universe where we measure a smaller fine structure constant, therefore a smaller value of the electric charge, it is predicted that the Universe will have a lower temperature [28]. We propose the measurement of the value of the fine structure constant in the direction of the cold spot identified by the Planck satellite in the Northern hemisphere. We predict that the value of the fine structure constant measured along this direction will be smaller than its laboratory value.

j) The Anisotropies in the Distribution of Quasars

The model of the selfvariations predicts an important factor as the main cause of the anisotropies that are already recorded in the observable Universe. According to the model, we only observe a small part [5, 6] of the Universe. The more our observational instruments improve, the more detailed our observations become, the larger the observed anisotropies due to this factor are going to be.

The recent observation [29] of a group of 73 quasars, the Huge-LQC group, which spans a distance of $4\times10^{9}\ yr$, is just such an anisotropy. The size of this group exceeds by far the limits set by the Standard Cosmological Model. This anisotropy is recorded in the cosmological data exactly because we only observe a small part of the Universe. According to the Model of the Selfvariations, the Universe is isotropic at larger distances, far larger than the part of the Universe we observe today.

k) Dark Matter

The existence of Dark Matter is known since the beginning of the last century from its contribution to the cohesion of galaxies. However, recent measurements [30] by modern, improved observational instruments have shown that Dark Matter does not behave as expected based on the Standard Cosmological Model. Of course we could, to some degree, assume that the observations are not problematic for the model, but expose our ignorance about the nature of Dark Matter.

The Model of the Selfvariations predicts that in the initial phase of the evolution of the Universe, part of the matter accumulates and creates the large-scale structures of the Universe at high temperatures. The rest of the matter remains permanently [5, 6] at a temperature close to $0K$. The different conditions in which the selfvariations evolve, could lead to the creation of particles with different properties. Additionally the equations of the model predict that the antimatter which existed in the early universe is converted to Dark Matter particles with the passage of time. Of course, further investigation is necessary, in order to evaluate the completeness of the prediction.

l) The temperature fluctuations of the CMBR

The SCM can only make some assumptions about the causes of fluctuations in the CMBR. It cannot provide a clear theoretical prediction.

The model of the selfvariations in detail provides for the temperature fluctuations in the CMBR with accurate theoretical predictions [6]. This is a consequence of the selfvariation of the electric charge.

m) The absence of antimatter in the universe.

The SCM can not justify the absence of antimatter in the universe. The quantity of matter and antimatter should be equal.

The model of the selfvariations predicts that over time antimatter is converted to neutral particles of Dark Matter. This is a consequence of the evolution of the selfvariation of the electric charge [6].

n) The Horizon problem

From the observational data we know that different regions of the universe located billions of light years from each other have interacted in the past. This fact is referred in Cosmology as the "Horizon problem".

In order to solve the Horizon problem, the hypothesis of cosmic inflation is introduced into Standard Cosmological Model (SCM), according to which the universe expands exponentially during a tiny fraction of a second just after the Bing Bang. With this hypothesis the SCM justifies further the flatness of the universe, while it bypasses the fact that immediately after the Bing Bang the universe shall collapse again to a point. During the 1970s we already knew the density of matter of the universe and that the equations of General Theory of Relativity lead to this catastrophic result for the

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SCM. Without the cosmic inflationary hypothesis the SCM cannot survive the consequences of the Big Bang.

The equations of the Cosmological Model of the Selfvariations predict that the rest masses, as well as the velocity of material particles tend to vanish towards the very early universe. Therefore the uncertainty of the momentum ΔP of each material particle tends to zero, $\Delta P \to 0$.This in turn implies by the Uncertainty Principle of Heisenberg that the uncertainty of the position of each material particle towards the very early universe tends to infinity, $\Delta x \to \infty$. The early particles tend to occupy the whole extant spacetime which means that the universe literally 'emerges from everywhere'. The consequences from this phase of evolution of the universe are recorded in our times by the observational instruments. The Horizon problem does not arise as 'a problem', within the Cosmological Model of the Selfvariations. The article, with the analytical predictions and the mathematical calculations about this issue, has been accepted for publication in the Journal 'Physics International'. The article also contains additional information such as the dependence of the rest mass and the volume of the white dwarfs and the neutron stars on redshift. Also the redshift decelerates the rate of evolution of certain phenomena, such as the process of excitation and de-excitation of atoms.

III. Discussion

Based on the physical theories of the past century, the only reliable justification of the redshift of the far distant astronomical objects can be accomplished by the expansion of the universe. This had resulted in the SCM. As we go back in time we are leaded towards a singularity of infinite density and temperature. Thus, we are led to the Bing Bang hypothesis. Immediately after the Bing Bang the material particles are completely decomposed to constituent particles, due to the extremely high temperatures. As the universe expands and cools down, the synthesis of particles takes place while the CMBR remains as a remnant.

The improvement of the observational instruments and the accretion of cosmological data for almost a century, led to the introduction of several fundamental hypotheses into the SCM, in order for this model to remain in accordance with the cosmological data. The main hypotheses refer to the introduction of cosmic inflation and Dark Energy. However current cosmological data is not anymore in accordance with the predictions of the SCM. The fine structure parameter variation, the temperature difference between the Northern and the Southern hemispheres of the universe, the estimated immense age of the Sloan Great Wall, the enormous structure of 73 quasars discovered in 2013 and the existence of galaxies in proximity to the Bing Bang, are some examples. There is currently no single hypothesis which can justify these data within the framework of the SCM. If we attempt for example to justify theoretically the fine structure parameter variation, we are led to a theory analogous to the Theory of Selfvariations and finally to the justification of redshift within a static and not within an expanding universe.

During the 1990s the luminosity distances of the Ia supernovae have been measured with the target to verify that these luminosity distances were smaller than those provided by the Hubble law, in accordance to the prediction of the SCM. Today we know that the luminosity distances of the type Ia supernovae are not only larger than those predicted by Hubble's law, but they seemed unrealistic for the framework of the SCM. The difficulty of the introduction of the Dark Energy hypothesis, in order for the SCM to remain in accordance with the available data, can not go unnoticed. This remark does not refer to the researchers who introduced this hypothesis and who have contributed largely and obtained excellent work as pioneers for the exploration of the universe. The origin of the Dark Energy hypothesis lies in the physical theories of the past century and is based on the wrong assumption that these theories have the necessary completeness in order to justify the cosmological data.

There are many reasons which lead to the assumption that the fundamental physical theories of the past century are not complete. We shall refer only to one, the ignorance about the cause of the quantum phenomena. Einstein insisted on this subject up to the end of his life. The Theory of Selfvariations sets the foundations of a common cause for the quantum and the cosmological phenomena. Especially the cosmological data are included as information and are justified by the Law of the Selfvariations on cosmological scales.

The Law of Selfvariations predicts that the state of the very early universe only slightly differs from the state of vacuum at a temperature close to OK. The evolution of the selfvariations with the passage of time leads the universe from its initial state to the state we observe it today. During each phase of evolution, the universe remains consistent with its origin, since its total energy content remains zero. The Law of Selfvariations does not answer to the question posed by Leibniz "why does something exist rather than nothing?". Nevertheless it provides us with the unique relation between matter and the vacuum.

As we go backwards in time, the binding energies of the nucleons, the ionization energies and the excitation energies of the atoms, as well as the gravitational energy are reduced, until they vanish. The material particles are totally decomposed into constituent particles. With the passage of time and the evolution of the selfvariations, the synthesis of particles

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takes place. The CMBR is predicted to originate from the whole space of the universe i.e. it originates 'from everywhere'.

The Law of Selfvariations justifies the totality of the current cosmological data. As we observe the universe as it was in the past, the consequences of the selfvariations are recorded within the cosmological data. The parameters appearing in Astrophysics, in Thermodynamics and in Quantum Mechanics, as well as the conclusions derived by their propositions, are affected by the selfvariations. It is these consequences that are recorded by the observational instruments in the cosmological data.

IV. Results

The evidence presented in the previous paragraph results in the following table. The table shows a clear superiority of the Cosmological Model of the Selfvariations over the Standard Cosmological Model.

Cosmological Data	Standard Cosmological Model	Cosmological Model of The Selfvariations
Redshift	direct consequence of the expansion of the Universe	direct consequence of the selfvariations
Cosmic Microwave Background Radiation	remnant of the Big Bang	consequence of the enormous values of the Thomson and Klein-Nishina scattering coefficients in the early Universe
increased luminosity distances of type Ia supernova	not in agreement	direct consequence of the selfvariations
flatness of the Universe	not in agreement	the total energy content of the Universe is predicted to be zero, therefore the Universe is flat
nucleosynthesis of the chemical elements	predicted	predicted, further investigation of completeness of the prediction is required
ionization of atoms in the early Universe	predicted as a consequence of the high temperatures after the Big Bang	direct consequence of the selfvariations
size and age of the Sloan Great Wall	not predicted	predicted
variation of the fine structure constant	not predicted	direct consequence of the selfvariation of the electric charge
temperature difference between the Northern and Southern hemisphere of the Universe	not predicted	direct consequence of the selfvariation of the electric charge
anisotropies in the distribution of quasars	not predicted	predicted
Dark Matter	further investigation required, mainly due to recent observations	predicted, further investigation of completeness of the prediction is required
temperature fluctuations of the CMBR	not predicted	direct consequence of the selfvariation of the electric charge
absence of antimatter in the universe	not predicted	direct consequence of the selfvariation of the electric charge
the Horizon problem	the introduction of the inflationary hypothesis is demanded	it is included as information within the equations of the model

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A Stocastic Explination of Newton's Law and Coulombs' Law

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Abstract- Assuming that a particle follows the discrete Bernoulli process with a step size proportional to one over twice its mass and that the vacuum is made up of particles with the reduced Planck mass, one can derive both Newton's Law of Gravitation and Coulomb's Law of Electric Force using slightly different parameters of the process. Two classes of experiments, which could affirm the hypothesis, would indicate a preferred reference frame.

Keywords: discrete space, discrete time, discrete vacuum, dark particle, black hole, diffusion, quantum gravity, stochastic process, bernoulli process, coulomb's law, newton's law, preferred reference frame, absolute velocity.

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ASTOCASTICEXPLINATIONOFNEWTONSLAWANDCOULOMBSLAW

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A Stocastic Explination of Newton's Law and Coulombs' Law

John Laurence Haller Jr.

Abstract- Assuming that a particle follows the discrete Bernoulli process with a step size proportional to one over twice its mass and that the vacuum is made up of particles with the reduced Planck mass, one can derive both Newton's Law of Gravitation and Coulomb's Law of Electric Force using slightly different parameters of the process. Two classes of experiments, which could affirm the hypothesis, would indicate a preferred reference frame.

Keywords: discrete space, discrete time, discrete vacuum, dark particle, black hole, diffusion, quantum gravity, stochastic process, bernoulli process, coulomb's law, newton's law, preferred reference frame, absolute velocity.

I. Introduction

If one assumes that the information in the Universe is finite, one should conclude that space-time is discrete because not enough information exists to describe a variable or an observable to a continuous value. Haller [1] gives reasons why one would believe that the information in a system with finite energy and finite time is finite.

We must also understand the length scale of the discrete step size of a particle and that of the gravity field before we can make a viable theory. Haller [2] shows that the step size of a particle is equal to one over twice the particle mass and that of the vacuum is one over twice the reduced Planck mass.

With this we can derive an understanding of how gravity and electricity work; how they are similar and how they are different.

Work is still needed to fully integrate this derived stochastic process with relativity, however clues are left which indicates that the probability a particle steps to the left or steps to the right, is a feedback between the particle's state and the curvature of space.

II. Bernoulli Process

Introducing the Bernoulli process as reviewed by Chandrasakhar and Reif [3,4], we see a stochastic process where the result of a sample of a uniform distribution between zero and one is compared against the process parameter β. If the sample is less than β, the particle steps to the right, otherwise it steps to the left.The time between steps is quantized to δt and the length of the steps is also quantized to δx.

The process can be expanded to 3+1 dimensions but for the purposes here we will forgo relativistic effects of the +1 time dimension and further align the particles on the x axis so we can focus on only the 1 spatial dimension.

a) *Step size of a particle*

Building on analysis by Kubo on the fluctuation dissipation theorem [5], we formalize the 2 time constants for a diffusing free particle: the collision time, δt and the relaxation time, τ . When the relaxation time is equal to the thermal time , $\tau = \hbar/2k_BT$, the diffusion constant becomes, $D = \hbar/2m$, [1,2,5-7] and the spatial variance is $(\Delta x(t))^2 = 2Dt = \hbar t/m$.

To derive the step size,δt , (or the collision time) we can look at the variance. The contribution to the spatial variance is balanced between drift and diffusion; when the probability parameter is ½ the variance is,

$$(\Delta x(K))^2 = \delta x^2 K + (\Delta v_K)^2(\delta t K)^2$$

Here δx is the spatial step size, K is the number of steps $t = K \cdot \delta t$ is the duration of the process and $(\Delta v_K)^2$ is the variance in velocity after K steps. From Dirac, we know that $\delta x = c \cdot \delta t$ [8] which allows us to calculate $(\Delta v_K)^2$.

When K is large, the average variance of the sum of K samples of a distribution is equal to the variance of the individual sample divided by K [9].

$$(\Delta v_K)^2 = \frac{(\Delta v_1)^2}{K} = \frac{\frac{1}{2}\left(\frac{\delta x}{\delta t}\right)^2 + \frac{1}{2}\left(\frac{-\delta x}{\delta t}\right)^2}{K} = \frac{c^2}{K}$$

Equating $(\Delta x(t))^2$ and $(\Delta x(K))^2$ which $\hbar t/m = 2\delta x^2 K$, results in,

$$\delta t = \frac{\hbar}{2mc^2}$$

Thus when the relaxation time is equal to one over twice the temperature $\tau = \hbar/2k_BT$, the collision time is one over twice the energy $\delta t = \hbar/2mc^2$, and visa versa.

b) *Gravitational scale*

I will not go into the detailed theory of dark particles as a tradeoff of simplicity overdeep insight, yet one can find that analysis here [2].

The gist is that the vacuum is made up of particles with the reduced Planck mass

$$m_p = \sqrt{\frac{\hbar c}{8\pi G}}$$

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A number of special conditions arise at this value of mass. One of these is that the quantum step, $\delta x = \hbar/2mc$, is equal to a circle's circumference with the Schwarzschild radius.

$$\ell_p = 2\pi R_S = \frac{4\pi G m_p}{c^2} = \delta x = \frac{\hbar}{2m_p c}$$

c) Electrical scale

The step size, or scale of the electric field, of a particle can be derived with the help of an old idea; namely electromagnetic mass[10,11].

Consider the electromagnetic energy, E_{em}, equal to the mass energy of the particle,

$$mc^2 = E_{em}$$

To find E_{em}, we add the electrostatic energy, E_{es}, to the Poincaré stresses, $E_{ps} = E_{es}/3$, we get the total electromagnetic energy, E_{em} [10], or

$$mc^2 = 4E_{es}/3 = 4E_{ps}$$

We can solve for r_e byusing an ansatz, such that the resulting r_e gives the correct form for Coulomb's Law. Note that appendix A gives further reason why this ansatz is reasonable.

The ansatz is that the Poincaré stresses are equal to the electrostatic energy of a spherical shell of total charge equal to the minimum quantum charge, $q_e/3$.

$$E_{ps} = \frac{(q_e/3)^2}{2(4\pi\varepsilon_0)r_e}$$

Or,

$$r_e = \frac{2{q_e}^2}{9(4\pi\varepsilon_0)mc^2}$$

However the length we are interested in is, ℓ_e, the wavelength that fits around a sphere of this radius, (just like $\ell_p = 2\pi R_S$) thus

$$\ell_e = 2\pi r_e = \frac{{q_e}^2}{9\varepsilon_0 mc^2}$$

III. Force as a Stochastic Process

a) Velocity as a probability

Going back to the Bernoulli process of motion we can see a relationship between the average velocity and the probability parameter, β.

$$\overline{x(K)} = (2\beta - 1)\delta x K$$

Where $\delta x K = c\delta t K = ct$. We know from above the relaxation time is $\tau = \hbar/2k_B T$ and is representative of how long the process stays coherent. In other words, τ is the time over which the particle forgets its state. Thus we can define the moving average velocity as

$$\bar{v} = \frac{\overline{x\left(K = \frac{\tau}{\delta t}\right)}}{\tau} = c(2\beta - 1)$$

Or,

$$\beta = \frac{\overline{x\left(K = \frac{\tau}{\delta t}\right)}}{2c\tau} + \frac{1}{2}$$

Note that the instantaneous velocity is one of the two velocity Eigen values, ±c, however $\bar{v}$ ∈[-c,c]; which is mathematically nice since $\beta \in [0,1]$.

b) Resistive Force – an aside

In the derivation of dark particles [2], one finds a resistive force for dark particles that we need to briefly consider here as it adjusts our expression for $\boldsymbol{\beta}$. The force can be derived a few ways and has the simple expression $F = -mx/\tau^2$. Haller shows that when this force is in play, it contributes to $\boldsymbol{\beta}$ an amount $\beta = -x/4c\tau + 1/2$ [2].

Thus our expression for $\boldsymbol{\beta}$ for dark particles becomes,

$$\beta - \frac{1}{2} = \frac{\overline{x\left(K = \frac{\tau}{\delta t}\right)}}{2c\tau} - \frac{\overline{x\left(K = \frac{\tau}{\delta t}\right)}}{4c\tau} = \frac{\overline{x\left(K = \frac{\tau}{\delta t}\right)}}{4c\tau}$$

c) $\boldsymbol{\beta}$ changing due to a force

With this definition of $\bar{v}$ we can consider how $\bar{v}$ and $\boldsymbol{\beta}$ (through feedback) are a function of time and thus also a function of space as it moves.

As stated above we will limit ourselves to non-relativistic particles, thus we have the relationship between the force on a particle of mass m_1 and $\boldsymbol{\beta}$

$$F = \frac{dp}{dt} = m_1\frac{d\bar{v}}{dt} = 2cm_1\frac{d\beta}{dt}$$

d) Stocastic process

Now imagine the force between two particles. For the sake of simplicity (since we assume Newton's third law), we will consider only the force on particle 1 due to interaction with particle 2. Again for simplicity we take particle 1 at the origin and particle 2 on the x axis at R.

Particle 2, like particle 1, follows the Bernoulli process. As such it accelerates between its two velocity Eigen values, ±c. As it accelerates at each step, it radiated energy δt_2. Thus $dt = \Phi\delta t_2$, or

$$dt = \Phi\frac{\hbar}{2m_2c^2}$$

Where Φ is the probability the emitted radiation from particle 2 is in the direction of particle 1 and captured (and processed).

Since the direction of the radiation wave vector is random and uniformly distributed across solid angle, Φ, is the cross section of particle 1, σ, divided by the surface area of a sphere, A, with a radius equal to the distance between particle 1 and particle 2, R.

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$$\Phi = \frac{\sigma}{A} = \frac{\sigma}{4\pi R^2}$$

Putting this together we have,

$$F = \frac{4m_1 m_2 \sigma c^3 d\beta}{4\pi R^2 \hbar}$$

e) Findingd $\boldsymbol{\beta}$

Now if particle 1 captures the emitted radiation the effect is to change the probability parameter β, by artificially (outside the Bernoulli process) stepping the particle towards or away from the direction of the radiation a distance ζ.

If particle 1 artificially steps the distance ζ, then the difference in average displacement (to first order in low velocity) between the artificial step and no artificial step is ζ.

$$\overline{x\left(\frac{\tau}{\delta t}\right)}_{extra\ step} - \overline{x\left(\frac{\tau}{\delta t}\right)}_{no\ extra\ step} = \zeta$$

IV. Gravity

Using our result above for the quantization of the gravity scale, we have the artificial step size,ζ, equal to the quantum step size of the dark particle, or

$$\zeta = \ell_p \hat{\boldsymbol{k}}$$

Where $\hat{\boldsymbol{k}}$ is in either the positive or negative direction of the vector pointing from particle 1 to particle 2.

Using our expression for β for dark particles from section 3.2, we find

$$d\beta = \frac{\zeta}{4c\tau} = \frac{\ell_p}{4c\tau}\hat{\boldsymbol{k}}$$

To find the cross section, σ, of dark particles Haller uses a modified Langevin equation that accounts for the resistive force mentioned in section 3.1 [2]. Or,

$$\sigma = (\Delta x)_p^2 = \frac{\hbar^2}{2m_p k_B T}$$

Plugging these in and reducing we have,

$$F = \frac{Gm_1 m_2}{R^2}\hat{\boldsymbol{k}}$$

We learn through empirical evidence that the artificial step of particle $1, \zeta$,is always in the direction towards particle 2, $\hat{\boldsymbol{k}} = -\hat{\boldsymbol{R}}$, thus we derive Newton's Law of Gravity,

$$F = \frac{-Gm_1 m_2}{R^2}\hat{\boldsymbol{R}}$$

V. Electricity

Using our result above for the quantization of the electric scale, we have the artificial step size,ζ, equal to the circumference, ℓ_e, of a sphere of radius, r_e.

$$\zeta = \ell_e \hat{\boldsymbol{k}} = \frac{{q_e}^2}{9\varepsilon_0 m_2 c^2}\hat{\boldsymbol{k}}$$

Using our original expression for β from section 3.1,

$$d\beta = \frac{\zeta}{2c\tau}$$

However this is not the whole picture as we must account for the charge of either particle 1 or particle 2 being a multiple ofthe minimum quantum charge, $q_e/3$. If $|q_2|/(q_e/3)$ is greater than one, then the frequency of interaction, $1/dt$, will go up by this amount since there are more charged particles which are radiating. Thus

$$\frac{1}{dt} \rightarrow \frac{3|q_2|}{q_e}\frac{1}{dt}$$

Also if $|q_1|/(q_e/3)$ is greater than one, thenζwill go up by this amount. It is as if the massive charged particle is a Turing Machine [12] that executes the following computer code:

for i = 1 to $(3|q_1|/q_e)$

$$\beta = \beta + \frac{\zeta}{2c\tau}\hat{\boldsymbol{k}}$$

The cross section will be similar to σ from section 4, in that σ equals the spatial variance. However in this case the resistive force is not in play, thus $(\Delta x)_{m1}^2$ reduces to the common expression [10].

$$\sigma = (\Delta x)_{m1}^2 = \frac{\hbar^2}{4m_1 k_B T}$$

Plugging these in and reducing we have,

$$F = \frac{|q_1||q_2|}{4\pi\varepsilon_0 R^2}\hat{\boldsymbol{k}}$$

Again through empirical evidence

$$\hat{\boldsymbol{k}} = \frac{q_1}{|q_1|}\frac{q_2}{|q_2|}\hat{\boldsymbol{R}}$$

We thus returnCoulomb's Law,

$$F = \frac{q_1 q_2}{4\pi\varepsilon_0 R^2}\hat{\boldsymbol{R}}$$

VI. Discussion

Since most experiments require many data points to find the signal of interest, we are in the realm of the weak law of large numbers; which means the mean (or measurements) approaches the expectation (or calculation) of the underlying continuous theory.

However if we look at the individual measurement we might be able to identify tell tale signs of particles being more stochastic in Nature.

Another way to find evidence of this stochastic description of motion and of force is to change the notion of evidence away from the average value to the

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value of the variance. One example comes in the nuances of an attempt to make this theory conform to special relativity.

Sparing the reader more details, the gist can be found by looking at the quantum step size , δt. If we consider δt proportional to the inverse of the relativistic energy and not the rest mass [13], we have

$$\delta t_\gamma = \frac{\hbar}{2\gamma m_0 c^2}$$

Where

$$\frac{1}{\gamma} = \sqrt{1-\left(\frac{v}{c}\right)^2}$$

Now looking at the variance of the displacement which contracts with relative velocity we have from the continuous solution

$$(\Delta x(t))^2 = \frac{2Dt}{\gamma^2} = 2Dt\left(1-\left(\frac{v}{c}\right)^2\right)$$

From the stochastic solution when $\beta \neq \frac{1}{2}$ we have

$$(\Delta x(K))^2 = 4\beta(1-\beta)(\delta x^2 K + (\Delta v_K)^2(\delta t K)^2)$$
$$= 4\beta(1-\beta)2Dt$$

Plugging in our relationship $\bar{v} = c(2\beta - 1)$

$$(\Delta x(K))^2 = 2Dt\left(1-\left(\frac{\bar{v}}{c}\right)^2\right)$$

At first one might claim success and equate $(\Delta x(K))^2$ with $(\Delta x(t))^2$. However at second glance there are two problems wrong with this. First we used, δt not δt_γ. Plugging in for δt_γ

$$(\Delta x(K))^2 = 2Dt\left(1-\left(\frac{v}{c}\right)^2\right)\left(1-\left(\frac{\bar{v}}{c}\right)^2\right)$$

We now have two factors, $\left(1-\left(\frac{\bar{v}}{c}\right)^2\right)$ and $\left(1-\left(\frac{v}{c}\right)^2\right)$.We know the later is related to the contraction of space due to special relativity. However the former has a different origin.

We can see this origin by looking at the second problem, which is that $\boldsymbol{\beta}$ is the probability the particle steps to the right. A sample of this process will have the particle step to the left or step to the right. This distinction is absolute and does not dependent on reference frame.

The conclusion is that a preferred reference frame exists and $\bar{v} = c(2\beta - 1)$ is the velocity of the particle in the preferred frame. One might find more background on what this preferred frame looks like from Lorenz's ether theory [11].

a) Experiment

I propose two classes of experiments. One class is to measure the variance of diffusion and look for the additional factor of $\left(1-\left(\frac{\bar{v}}{c}\right)^2\right)$. The other class is to determine the direction of a particle's discrete step.

i. *Variance*

Two experiments within this class are to measure the variance of a particle 1) at rest in the laboratory frame, or 2) highly relativistic.

The first will require very high precision. A good guess for the preferred reference frame is that of the cosmic microwave background which moves at $0.001c$ relative to Earth. Thus $\left(1-\left(\frac{\bar{v}}{c}\right)^2\right)$~$0.999999$ and any experiment would need to be more accurate than this.

Another experiment (which is more complicated to conduct but with a bigger signal) is measuring the variance of displacement of a relativistic particle.

If the theory proposed here is true, a measurement of $(\Delta x(t))^2$ of a relativistic particle will be

$$(\Delta x(t))^2 = 2Dt\left(1-\left(\frac{v}{c}\right)^2\right)\left(1-\left(\frac{\bar{v}}{c}\right)^2\right)$$

At high v one has $\bar{v}$~v, or

$$(\Delta x(t))^2 \sim 2Dt\left(1-\left(\frac{v}{c}\right)^2\right)^2$$

As v approaches c this will be a big difference between accepted theories. However Nature is not so easy to give away her secrets; there is also another source of variance from the Fourier diffusion [2], which grows proportional to the square of t.

ii. *Discrete step*

The other class of experiments is to determine if a particle steps to the left or steps to the right and with what probability.

One should start with two particles at rest a distance L apart. One (denoted the laboratory) will have a heavy mass and be on the left; the other (denoted the test particle) will have a mass much much lighter than the laboratory and be to the right. In this case, the laboratory will look like it has a more continuous trajectory and have smaller variance.

After the quantum step of the test particle, δt, the laboratory will drift in the perfered reference frame the amount $\bar{v}\delta t$. The test particle after one step will be displaced from the laboratory either a) $L + c\delta t - \bar{v}\delta t$ or b) $L - c\delta t - \bar{v}\delta t$.

The distinction between a) and b), should be observable at cold temperatures. Note that over many steps the displacement will be

$$\beta(L + c\delta t - \bar{v}\delta t) + (1-\beta)(L - c\delta t - \bar{v}\delta t)$$
$$= L + c(2\beta - 1)\delta t - \bar{v}\delta t = L$$

The trick will be to measure the individual step not the average. If K_x is the number of times out of K that the particle steps to the right, then the unbiased estimator of β_x isK_x/K.

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V. Acknowledgements

JLH is grateful to his wife and two boys.

Appendix A

Poincaré stresses are also known as rubber bands that hold the electron together [10]. They might be just that.

If we look at the electrostatic energy of an elementary unit of charge, E_{es}

$$E_{es} = \frac{{q_e}^2}{2(4\pi\varepsilon_0)r_{es}}$$

And consider the relationship in section 2.4,

$$mc^2 = 4E_{es}/3 = 4E_{ps}$$

One can see that $r_{es} = 3r_e$. If $2\pi r_e$ is the length of a wave that fits the boundary conditions around a quantum of charge $q_e/3$, then three wavelengths places end to end would fit the boundary condition around an electron or elementary unit of charge.

I interpret this as saying that three quantum charges fit together to wrap themselves around the electron or elementary charge to hold it together. Perhaps all mass is electrical!

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Grab Sampling and Continuous Monitoring Techniques for Radon Measurements at Controlled Environmental Conditions

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Abstract- The continuous monitoring of radon concentrations is a useful method to study the effects of ventilation on radon concentration levels. The determination of average radon concentration is preferable than the active-type. For this purpose a model chamber, of cubic shape, made of plexy glass with a volume of 0.65 m^3, is constructed.

For this purpose, two devices RDA - 200 and TRI - MET 372 are used for active-type. Devices RGM I/I and CRM- 1027 are used for continuous monitoring. The experiments are carried out at two different environmental conditions, one by using high temperature (40°C) and relative humidity (100%), the other by using low temperature (16°C) and low relative humidity (50%).

Radon calibration chamber is a good tool in testing for radon measurements to different devices and techniques, a 65m^3 plexy glass chamber is constructed to compare different detecting devices with the change of environmental conditions (temperature – relative humidity – samples concentration) as well as the use of devices inside or outside the chamber. This chamber resemble to a great extend the mines atmosphere which help in using it as a pilot plant.

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GRAB SAMPLINGANDCONTINUOUSMONITORINGTECHNIQUESFORRADONMEASUREMENTSATCONTROLLEDENVIRONMENTALCONDITIONS

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Grab Sampling and Continuous Monitoring Techniques for Radon Measurements at Controlled Environmental Conditions

Hassan S. F [α], Tawfik M. N. [σ], Shalaby M. H. [ρ], Hussien M. I. [Ѡ] & Ibrahim I. H. [¥]

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The obtained results show that: Lower stability of measurements with the change in environmental conditions, more stability for the RDA - 200 and Tri - met devices at high temperature and high humidity. From the other hand a more stability for both RGM and CRM devices clearly appeared at low temperature and low humidity conditions. This may be attributed to that the measurements depend mainly on an electronic circuit which have a higher performance at these environmental conditions.

I. Introduction

There are two main categorized measuring techniques, active *technique and passive technique.*

The Grab Sampling Techniques (Active-type): In this case, air is sampled by drawing it through a filter material, housed in an adequate filter holder by means of air sampling pump. Radioactivity counting is carried out after the sampling period.

i) In case of Rn-gas measurements. The examined air sample is collected by filling a container, either previously evacuated or by a flow-through type in the sampling area and releasing the container. The radon from the sample is then later (may be days later) transferred to a measuring chamber, which may be ionization chamber or scintillation cell Lucas, (1957).

An integrated count method has been described (Jonassen, N. and Clements, W. E., (1974)., where the counting of radon activity may start at any time after filling the cell with daughter-free air. The accuracy of the method is shown to depend on the counting period rather than upon the time elapsed since filling. Another active method for measuring radon concentration using a metal cylinder and two filters (two filter method). In this case air is drawn through a cylinder fitted with a filter on either end. The front filter will remove all daughters in the air sampled, and the second filter will collect those daughters' products being produced by decaying of radon in the air, while it passes through the cylinder. The alpha activity from the filter at the end of sampling is then a measure of the radon concentration in the sampled air. (Fontan et al, (1962), Jacobi, (1964), Thomas and Le Clare, (1970)).

The measurement of radon daughters is often used not only for the determination of individual daughter concentrations but also for measurement (or estimation) of the potential alpha energy concentration of these daughters (WL). All methods used for both types of measurements are based on the analysis of the activity from a filter (or detector) on which the daughters have been deposited. The daughter's activity from the filter may be counted during and/or after sampling. Evans, (1969). If the air is drown through a filter, and the gross alpha activity is counted after a waiting a certain period for one time this called one count method [Kusntez, (1956)] and Rolle [Rolle, (1972)] methods, which differ only in the choice of sampling, waiting and counting times.

To overcome the low accuracy in the one count methods a lengthy operating procedure uses two uncorrelated counts. The most common two-count method is the Hill Method [Hill, (1975)]. The total alpha activity is integrated over two counting periods of two minutes after the end of sampling with the integrated counts I_0 and I_1 respectively. Using a special relation including this ratio and detector efficiency, the (PAEC) can be calculated. Methods for three uncorrected counts during and /or after sampling is called three-count methods, there are two techniques for the three count methods:

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a) Alpha gross count method, where the sum of RaA and RaĆ activities is measured. The most commonly used α-gross count method was developed by Tsivoglou [Tsivoglou, et al, (1953)] in which the activity from a filter is measured at three intervals after sampling. The amount of air sampled is about 50 liters. Because count rates are used instead of integrated counts, even at high concentrations (tens of thousands Bq/m^3), the reproducibility may only be good within 20-30 percent. By integrating the alpha activity over time intervals instead of measuring the rate at three times, it is possible to reduce the uncertainty of the Tsivoglou method considerably as proposed by Thomas [Thomas, (1972)].

The uncertainty is usually high for RaA, especially if the atmosphere is near radioactive equilibrium. From three different gross-alpha count rates it is possible to calculate the concentrations of RaA (Po-218), RaB (Pb-214) and RaC (Bi-214), by solving a system of three Bateman linear differential equations with three unknowns [Evans, (1969)].

b) Alpha spectroscopy methods, where RaA and RaC activities are measured individually. In these methods, the alpha particles from radon daughters can be counted separately and the daughter concentration can be obtained by distinguishing between the 6-MeV and 7.69 MeV alpha particles energy groups. A method employing only alpha radiation has been developed by Martz et al [Martz et al, (1969)].

In case of Continuous Monitoring Techniques: air samples are taken on a continuous basis lasting typically from several days to several weeks. Counting of radioactivity is conducted by the same instrument and concurrently with air sampling. Hence, the radioactivity count, or activity is being "integrated" by the instrument. Also, the continuous monitoring of radon concentrations is the most useful method for studying the effects of ventilation on radon concentration levels and determination of average radon concentration.

In continuous monitoring of radon daughters, the air is sampled continuously and the alpha and/or beta activities are integrated over intervals ranging from minutes to hours. [Dalu, G. A. and Dalu, G., (1971), Thomas, (1977), McVey et al, (1977) and Wrenn et al, (1975)].

In radon daughter measurement systems, the daughters are collected on a filter, which is placed in front of a detector. A common calibration procedure uses an essentially mono-energetic alpha emitter, americium-241, uniformly deposited on a metal disc as pseudo radon daughter calibration source. An absolute method for calibration of radon daughter system has been developed by Falk [Falk, (1982)]. Beckman [Beckman, (1975)] described calibration of air sampling equipment and counting equipment including field checks, calibration equipment and data treatment. For radon daughter calibration, Thomas (Modified Tsivoglou) and alpha spectrometric methods have been suggested as the most suitable primary counting methods [Lawrence Berkeley Laboratory, (1981)].

II. Experimental Techniques

a) Calibration chamber and samples

The chamber is made of (0.5 cm thick) plexy glass sheets. It is of cubic shape with volume of 0.65 m^3. On top, a removable ceiling contains four wholes of (1 cm in diameter) each. Two wholes are used for the intake of samples from the chamber, the other two are used for the electricity cables needed for the devices inside the chamber. It has also the possibility for use active techniques for radon and its daughter's detection (Tawfik, M. N 2011).

Figure 1 : Radon calibration chamber

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Five different samples were selected from Gattar Mountain (Hurghada, Red Sea, Egypt). The uranium content of these samples was experimentally measured in the NMA. Laboratories (Salem, 2008). The chosen samples are nearly equal weight, size, and physical state (solid rocks) with no fractures or any crushing to smaller grains. The samples are labelled from one to five according to their uranium ppm measurements as follows: Sample 1 (35 ppm), sample 2 (200 ppm), sample 3 (330 ppm), sample 4 (470 ppm), sample 5 (850 ppm).

b) Devices and methods

A total of four devices are used, two of them (RDA - 200 and TRI - MET 372 for the grab sampling (active) techniques

i. *RDA – 200:* It is designed to measure alpha activity originated from radon and its daughters. The alpha particles register on the ZnS (Ag) phosphor coating of the scintillator cell or tray in the form of light flashes. Each flash of light, as seen by the high gain photomultiplier tube, is transformed into an electrical impulse. These impulses are accumulated, counted and then digitally displayed on a five digit, seven segments L.E.D. digital display, after a preset counting time has been completed. The device weight is about 3 kg. (EDA Instruments INC).

ii. *TRI-MET 372:* It is designed as an alpha counter, equipped with a foil type open Zinc Sulphide detector. The instrument is manufactured by (Tri-Met Instruments LTD). This type of detector is inexpensive, readily obtainable and is easily replaced. The sample holders can accommodate membrane filter samples of 25 mm, 37 mm. and 47 mm diameter. The device weight is about 2.5 kg, the Tri-Met was used for measuring (WL) by Roll – method. (Tri-Met instruments LTD).

The second category is for continuous radon gas monitoring

i. Portable Radioactive Gas Monitor type RGM I/I is a self-contained instrument for measuring the concentration of radioactive gases in air, it is calibrated for Tritiated Water Vapour (HTO) in air, for direct radon gas determination; a single portable, battery operated device is used to monitor radon gas. The device is of weight (14.5Kg). (Nuclear Enterprises Ltd) .

ii. Professional continuous radon monitor model 1027 is a patented electronic detecting device using a diffused-Junction photodiode sensor to measure the concentration of radon gas. The unit is operated from standard line power and includes a 9-volt battery which provides backup power. For continuous radon monitoring; a single fixed, electricity operated device is used for monitoring of radon gas. It has an internal detector for measuring radon gas and it is equipped with a digital screen for displaying of results. It has a weight of (1 Kg). (Sun Nuclear Corporation).

c) Measuring procedures

The experiment is done according to the variable factors, the plan can be divided into two parts: one using high temperature (40°C) and relative humidity (100%) conditions and the other by using low temperature (16°C) and low relative humidity (50%).

Each sample is put separately inside the radon chamber and the measurements started from zero time till 168 hours (one week), the measurements are taken for all devices at the same time every four hours resulting in 42 measurements for each device. The temperature is adjusted to reach 40 °C and a by using a water bath as water source to ensure a relative humidity level of 100 % (Tawfik, M. N 2011).

The procedures are done as follows:

i. For the total potential alpha energy concentration expressed as working level PAEC. Rolle method is used, using a portable air sampler to withdraw up to 5 l/min of air through a filter paper.

Radon daughters are collected on a high-efficiency filter paper for 10 minutes and then alpha-counted with either a rate meter or scalar after a prescribed delay of about 5 to 10 minutes. (Rolle, 1968).

The working level is calculated by the following formula (Safety Series No. 43, (1979)]:

$$WL = \frac{R - B}{EvtF} \quad (1)$$

Where:
R = Count rate at T minutes from the end of sampling (in counts/min)
B = Count rate due to background measurement
E = Counting efficiency, decimal fraction
v = Volumetric sampling rate in L/min
t = Sampling time in minutes
F = Conversion factor =212 for sampling periods of from 1 to 20 min

ii. For direct radon gas measurement using RGM I/I: The technique starts by withdrawing a sample of air by the air pump followed by a direct measurement by the ionization chamber detector to obtain the result of the measurements in a few seconds from sampling. (Grossi, 2001).

iii. For continuous radon monitoring: A sensitive semiconductor detector is exposed to radon to start the measuring processes, by this way the radon can be continuously monitored. These values are stored using a small internal memory for future revision.

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III. The Annual Dose Conversion Factors were Done as Follows

1) For the data information from (RDA - 200 and TRI-MET 372) instruments .The total working hours per one year will be two thousand (2000) hours per year. The ICRP-31 (1980) (International Commission for Radiation Protection) submits a conversion factor (CF)) for the calculation of annual dose from the WLM to be five times greater, so according to the previous information the final formula can be written as:

$$\text{Annual dose (mSv/y)} = \frac{(WL)X(2000h)X(5CF)}{(170h)} \quad (2)$$

2) The calculation of annual dose using the data information from the RGM 1/1 (Radioactive Gas Monitor) which gives the data in μCi/m^3.

$$\text{Annual dose (mSv/y)} = \frac{(\mu Ci/m^3)X(1000UC)X(0.2331CF)}{(1000DUC)} \quad (3)$$

3) The calculation of annual dose using the data information from the CRM -1027 (Continuous Radon Monitoring) which gives the data in pCi/l.

$$\text{Annual dose (mSv/y)} = (pCi/l)X(0.2331CF) \quad (4)$$

Where :

UC: is the unit conversion from μCi/m^3 to pCi/l.

DUC: is the device conversion factor from Tritiated Water Vapour (HTO) in air to μCi/m^3.

IV. Results and Discussion

a) Active techniques (grab sampling) one count method

i. *At High Temperature and Humidity*

For the Tri-Met 372, figure (1) shows the experimental results of the calculated annual doses using equation (2) with the five samples, a low annual doses (mSv/y) are reported for low sample concentrations and minimum time period (4-20 h) while high values for annual doses (mSv/y) are reported for maximum sample concentrations and maximum time periods (140-164 h)

At low samples concentrations a smoothly increasing in the calculated values are observed which may indicate that the instrument was able to discriminate between small concentrations at the harsh environmental conditions. At a high samples concentrations a high ability for the discrimination between high and low concentrations epically at the harsh environmental conditions was observed

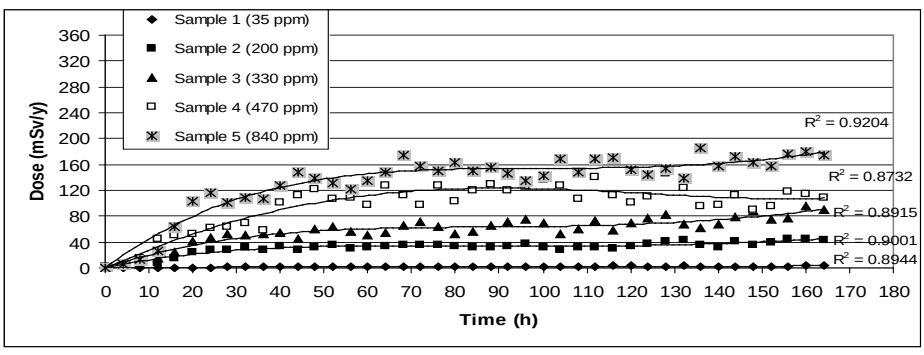

Figure 1 : Calculated annual dose (mSv/y) using the measurements of Tri-met device for all samples at high relative humidity and temperature versus time (h).

For RDA 200, figure (2) shows experimental results of the calculated annual doses using equation (2) with the five samples the time interval.

It is obvious, low annual doses (mSv/y) were reported for low sample concentrations and minimum time period (4 – 20 h) While high values for annual doses (mSv/y) was reported for maximum sample concentrations maximum time periods (140 – 163 h).

At low samples concentrations a smooth variation are observed which may indicate that the instrument is able to discriminate between small concentrations at the harsh environmental conditions. Also it is shown that at high samples concentrations a complete separation between the measured values, which means that the instrument has the ability to discriminate between high and low concentrations at harsh environmental conditions that may gives it advantages for using in such cases.

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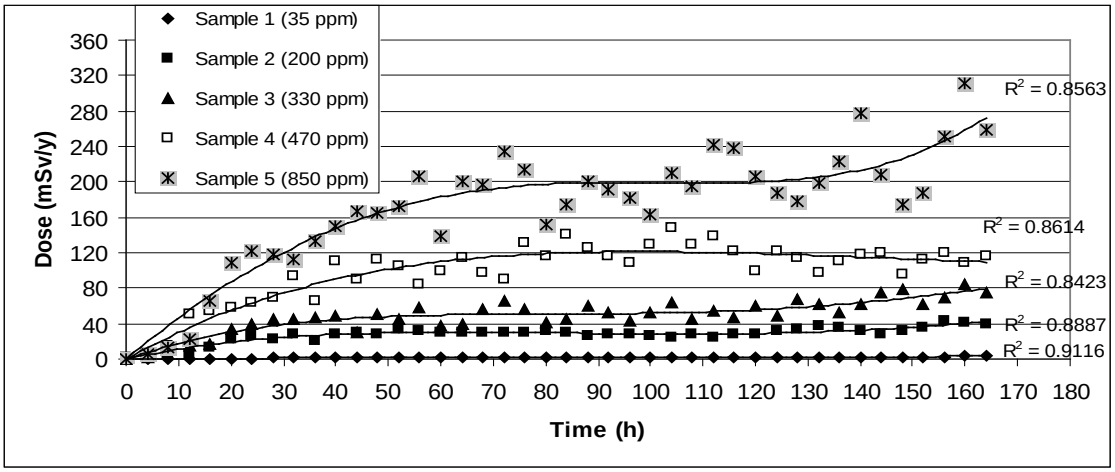

Figure 2 : Calculated annual dose (mSv/y) using the measurements of RDA 200 device for all samples at high relative humidity and temperature versus time (h).

ii. *At Low Temperature and Humidity*

For the Tri-Met 372, figure (3) shows that low annual doses (mSv/y) are reported for low sample concentrations and minimum time period (4 – 20 h), while high values for annual doses (mSv/y) are reported for maximum sample concentrations maximum period (140 – 164 h).

From the table also we can get that, an increase in the calculated annual doses with time when using different samples from sample (1) to sample (5). A nearly closed data appears for sample (2) and sample (3) also a slight overlap appears for sample (4) and sample (5).

There is some coincidence in some measured values in case of high and low samples concentrations where there is a complete difference between the two groups, which means that the instrument does not have the ability to discriminate between high and low samples concentrations at normal environmental conditions.

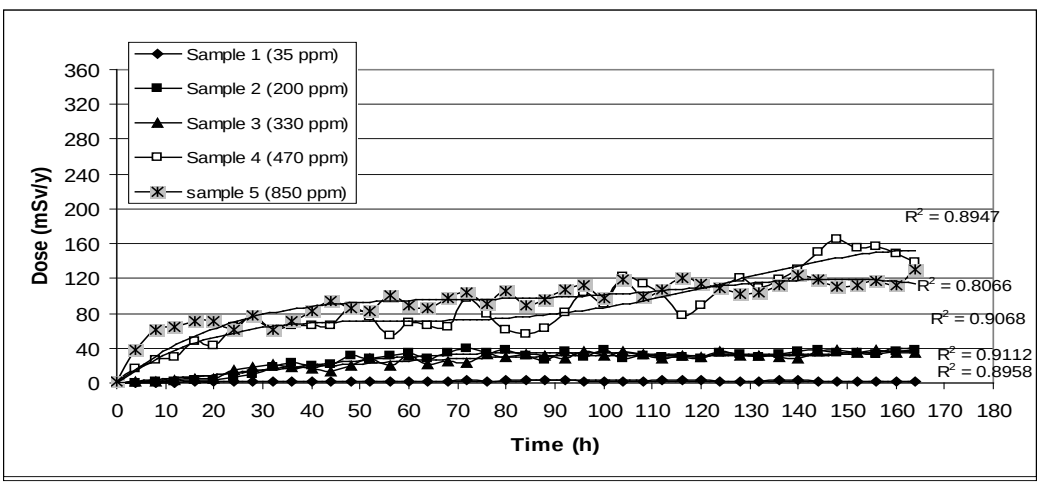

Figure 3 : Calculated annual dose (mSv/y) using the measurements of Trimet device for all samples at low relative humidity and temperature versus time (h).

For RDA 200, figure (4) shows that low annual doses (mSv/y) are reported for low sample concentrations and minimum time period (4 – 20 h). While high values for annual doses (mSv/y) was reported for maximum sample concentrations maximum period (140 – 164 h)

An increase in the calculated annual doses with time when using different samples, from sample (1) to sample (5). A slight overlap appears for sample (4) and sample (5).

At low samples concentrations a normally increases in the calculated annual dose with time.

There is an overlap in some measured values in case of high and low samples concentrations where there is a complete separation between the two groups, which means that the instrument does not have the ability to discriminate between high and low samples concentrations at normal environmental conditions.

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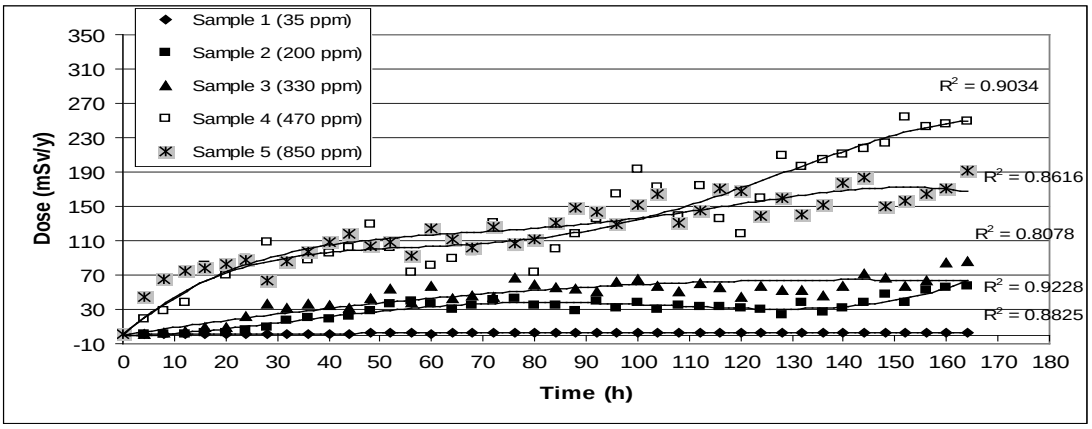

Figure 4 : Calculated annual dose (mSv/y) using the measurements of RDA 200 device for all samples at low relative humidity and temperature versus time (h).

b) Continuous radon monitoring

i. *At High Temperature and Humidity*

For the RGM 1/1, figure (5) shows experimental results of the calculated annual doses using equation (3) with the five samples

It is obvious that there is a gradually increase in the annual doses measured in (mSv/y) goes from low sample concentrations and minimum time period (4 – 20 h) to maximum sample concentrations maximum period (140 – 164 h).

At low samples concentrations a highly nearly closed values are observed while in the measured annual dose values for the most high two samples concentrations, there is a completely difference between them especially at high one (850ppm), which indicate a low performance for this instrument as it could not discriminate between high and low sample concentrations at harsh environmental conditions that may gives it disadvantages for using in such cases.

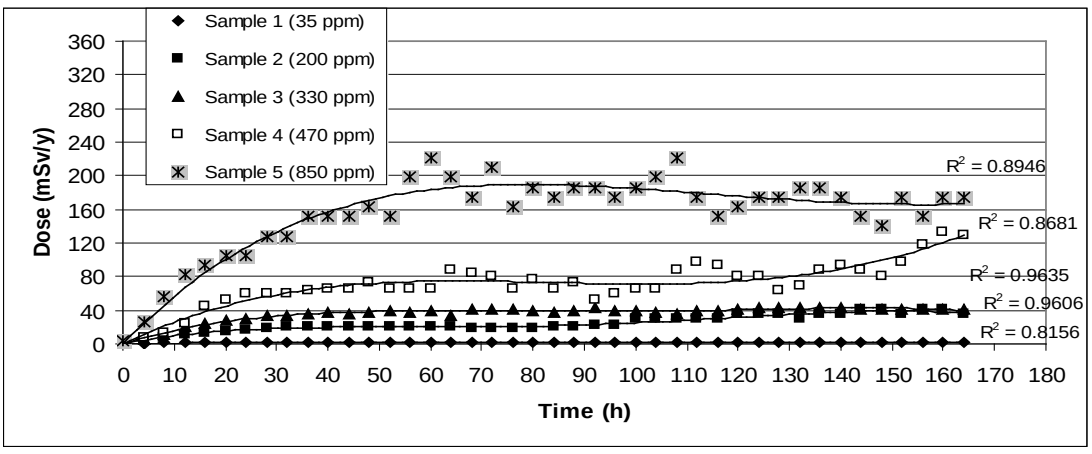

Figure 5 : Calculated annual dose (mSv/y) using the measurements of RGM device for all samples at high relative humidity and temperature versus time (h).

For the CRM- 1027, figure (6) shows experimental results of the calculated annual doses using equation (4) with the five samples

It is obvious that there is a gradually increase in the annual doses measured in (mSv/y) goes from low sample concentrations and minimum time period (4 – 20 h) to maximum sample concentrations maximum period (140 – 164 h).

From the data we can get that: At low samples concentrations a highly closed values with small resolution and discrimination at these low concentration values. While for the high samples concentrations there is a close separation with small over lapping at small time intervals, which indicate a slightly confusion in the performance of the instrument at high and low concentrations at harsh environmental conditions.

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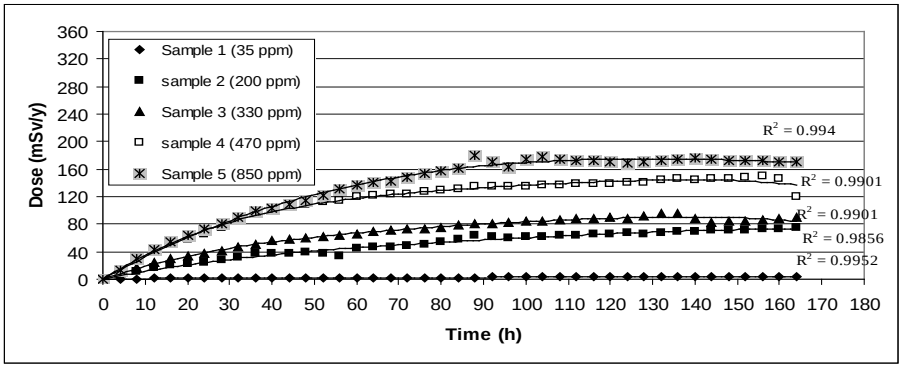

Figure 6 : Calculated annual dose (mSv/y) using the measurements of CRM device for all samples at high relative humidity and temperature versus time (h).

ii. *At Low Temperature and Humidity*

For the RGM 1/1, figure (7) shows experimental results of the calculated annual doses using equation (3) with the five samples. A gradually increase in the annual doses measured in (mSv/y) goes from low sample concentrations and minimum time period (4 – 20 h) to maximum sample concentrations maximum period (140 – 164 h)

At low samples concentrations, highly smoothed closed values are observed with minimum values.

A complete separation between the measured values for the annual dose of low and high samples concentrations and at low and high values for temperature and humidity, which indicate a high performance for this instrument at high and low samples concentrations and at normal environmental conditions that may gives it advantages for using in such cases.

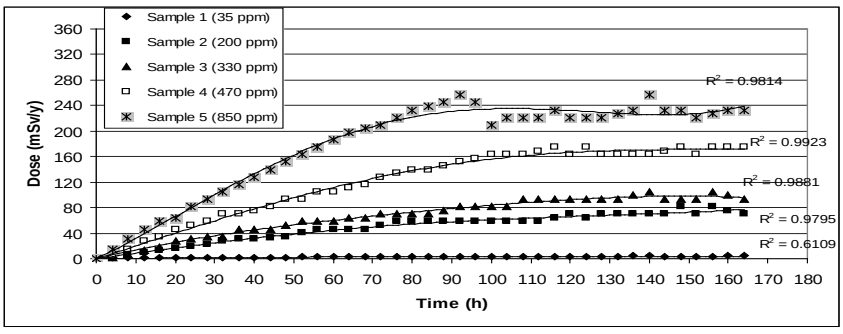

Figure 7 : Calculated annual dose (mSv/y) using the measurements of RGM device for all samples at low relative humidity and temperature versus time (h).

For the CRM- 1027, figure (8): At low and high samples concentrations, highly smoothed closed values with high resolution and discrimination at these concentrations values. This indicates high performance for this device at normal environmental conditions, giving it advantage for use in such cases. However at very high sample concentration it goes out of device range after 80 hours.

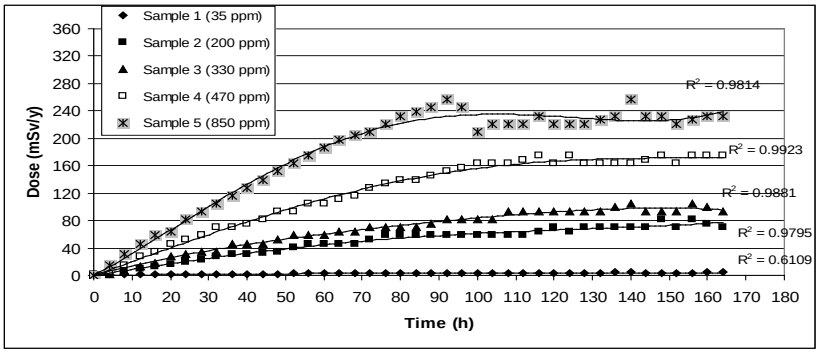

Figure 8 : Calculated annual dose (mSv/y) using the measurements of CRM device for all samples at low relative humidity and temperature versus time (h).

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V. Conclusions

The comparison of used devices showed a higher time is required to complete the surveillance process (from the beginning till the end of measurements) is 13 min. for both Tri-met and RDA 200 devices while it needs from 1 to 3 min. for RGM device, the CRM device takes about 1 to 2 sec. for the measurement but it needs to run at least 1 h for before each measurement. That is based on the principals of the measuring devices and the theory of operation of used instruments.

Higher cost estimation to complete the surveillance process (from the beginning till the end of measurements) is 4.75 L.E. for the use of RDA - 200 device for both the cost of filter paper and required batteries, 4 L.E. for the use of Tri-Met device for both the cost of filter paper and required batteries, 1 L.E. for the use of CRM device for the cost of the required batteries while no cost is required for the use of RGM device.

Lower stability of measurements with the change in environmental conditions showed a more stability for the RDA - 200 and Tri - met devices at high temperature and high humidity due to the limited effect of high temperature and relative humidity on the sampling and counting instruments. From the other hand a more stability for both RGM and CRM devices clearly appeared at low temperature and low humidity conditions this may be attributed to that they depend mainly on an electronic circuits which have a higher performance at these environmental conditions.

No human mistakes are found when using CRM device but a small human mistakes can be found when using RGM device in the misreading of its analogue scale, while there are many expected human mistakes when using RDA - 200 and Tri - met device due to the use of stop watch for sampling time, the handling of the filter paper when removing from the sampling pump and applying to the RDA - 200 or Tri - Met devices.

Small maintenance operations can be done easily and in short time for both RDA - 200 and Tri - Met devices while it is difficult to do maintenance for both RGM and CRM device which requires a specialist to do them.

Large number of steps needed for the use of RDA - 200 and Tri - Met devices which are 7 steps. While RGM device needs 3 steps and CRM device requires only 1 step to complete the whole process from the beginning till the end of measurements.

Higher weight of RGM device is the larger one of 14.5 Kg followed by the use of RDA 200 device and its accessories of 3 Kg. the weight of Tri - met device and its accessories is 2.5 Kg, while a weight of only 1 Kg is for CRM device.

Table (1) shows the comparison between different used devices according to the comparison matrix (time, cost, efficiency and ease of use).

Table 1 : the inter-comparison between the used instruments

		Grab Sampling Technique		Continuous monitoring	
		Tri-met	RDA 200	RGM	CRM
Time		Medium	Medium	Low	High
Cost		High	High*	Low	Medium
Efficiency		Medium*	Medium*	Medium	Medium
Ease of use	No. of steps	High	High	Medium	Low
	Weight	Medium	Medium*	High	Low
	Training ease	High	High	Medium	Low

**is noted for the slight increase.*

This study recommends the application of RDA 200 and Tri- Met devices at mines and mills according to their high performance and limited requirements to work at these places.

The application of CRM and RGM devices at laboratories according to their high performance and limited requirements to work at these places.

It is very important to construct a complete comparison when choosing the set of devices and techniques for the use during the surveillance process.

Good preparation for surveillance and monitoring radiation programs including the best use of techniques and devices will achieve the goal of radiation protection which will help in decreasing the life-shortening percentage from(10%-15%) to less than that.

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Rotating and Expanding Universe in the Light of Flyby Anomaly and Path Distribution

By Janez Špringer

The Flyby Anomaly- The flyby anomaly is an unexpected energy change during Earth flybys of spacecraft which causes a significant speed change of over 0,013 m/s [1].The difference of speed Δv is given by Anderson's empirical prediction formula [1]:

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Rotating and Expanding Universe in the Light of Flyby Anomaly and Path Distribution

Janez Špringer

In this paper one tries to explain the rotation and expansion of the Universe in the light of Anderson's flyby-anomaly prediction formula. The result of the effort is a prediction that the Universe rotates with the equatorial speed of half the speed of light and we land at the Pole of that Universe with the speed of expansion of the Universe which is apparently zero since in such circumstances the inbound speed equals the maximal decrement of speed. The maximal speed of expansion of the future Universe $100\frac{\mathrm{km}}{\mathrm{s}} < \mathrm{v}_{\mathrm{maximal}}^{\mathrm{future\ Universe}} < 123\frac{\mathrm{km}}{\mathrm{s}}$ is predicted on the basis of a comparison of the flyby and path distribution energy.

I. The Flyby Anomaly

The flyby anomaly is an unexpected energy change during Earth flybys of spacecraft which causes a significant speed change of over 0,013 m/s [1].The difference of speed Δv is given by Anderson's empirical prediction formula [1]:

$$\Delta \mathrm{v} = \frac{2v_{ekuatorial}}{c} v_{inbound}\ (\cos\delta_{inbound} - \cos\delta_{outbound}). \tag{1}$$

Here $v_{ekuatorial}$ is the equatorial speed of Earth, and $\delta_{inbound}$ and $\delta_{outbound}$ are the equatorial angles of the spacecraft. The maximal difference of speed Δv_{max} is given by the simplified Anderson's formula in the case where the inbound and outbound equatorial angles are 0 and $\frac{\pi}{2}$, respectively:

$$\Delta v_{max} = \frac{2v_{ekuatorial}}{c} v_{inbound}. \tag{2}$$

Since the maximal inbound speed is the escape speed the maximal difference of Earth-flyby speed yields:

$$\Delta W_{kinetic} = m\frac{(v_{inbound})^2}{2} - m\frac{(v_{inbound} - \Delta v_{max})^2}{2}. \tag{4}$$

Due to conservation law the negative kinetic energy increment of mass body should equal the same positive energy increment of that body, let us denote it E_{flyby} so that the whole energy of mass body remains unchanged:

$$-\Delta \mathrm{W}_{\mathrm{kinetic}} + \mathrm{E}_{\mathrm{flyby}} = 0. \tag{5}$$

Then taking into account the equations (2), and (5) we have:

$$\frac{E_{flyby}}{m} = v_{inbound}\,.\Delta v_{max} - \frac{\Delta v_{max}{}^2}{2} \tag{6a}$$

$$\frac{\mathrm{E}_{\mathrm{flyby}}}{\mathrm{mc}^2} = \frac{2\mathrm{v}_{\mathrm{inbound}}^2}{\mathrm{c}^2}\left(\frac{\mathrm{v}_{\mathrm{equatorial}}}{\mathrm{c}} - \frac{\mathrm{v}_{\mathrm{equatorial}}^2}{\mathrm{c}^2}\right). \tag{6b}$$

The expression on the $\frac{E_{flyby}}{mc^2}$ is the flyby energy share resulting from the negative kinetic energy increment after the perpendicular change of the direction of motion of the mass body m in the gravity field at the $\frac{\pi}{2}$– latitude of the rotating massive body. It can be written in the more transparent form using the ratio of speeds $\mathrm{a} = \mathrm{v}/\mathrm{c}$

$$\frac{\mathrm{E}_{\mathrm{flyby}}}{\mathrm{mc}^2} = 2\mathrm{a}_{\mathrm{inbound}}^2\left(\mathrm{a}_{\mathrm{equatorial}} - \mathrm{a}_{\mathrm{equatorial}}^2\right). \tag{6c}$$

It is evident from the equations (6*b*), and (6*c*) that the flyby energy share is zero at the zero equatorial speed as well as that one of the speed of light. Both of them are the equatorial speeds enabling the minimal flyby energy share where no flyby anomaly is expected. On the other hand the optimal equatorial speed and flyby anomaly exists at the given inbound speed where the energy share of the flyby energy occupies the maximal value. The latter is found with the help of the derivation of the function (6*c*):

$$\left(\frac{\mathrm{E}_{\mathrm{flyby}}}{\mathrm{mc}^2}\right)' = 2\mathrm{a}_{\mathrm{inbound}}^2\left(1 - 2\mathrm{a}_{\mathrm{equatorial}}\right).$$

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$$2a_{\text{inbound}}^{2}\left(1-2a_{\text{equatorial}}^{\text{optimal}}\right)=0$$
$$a_{\text{equatorial}}^{\text{optimal}}=\frac{1}{2}\quad\text{or}\quad v_{\text{equatorial}}^{\text{optimal}}=\frac{1}{2}c. \tag{7}$$

The optimal equatorial speed for all inbound speeds equals half of the speed of light. The maximal flyby energy share belonging to this speed is given by the equation (6c):

$$\left(\frac{E_{\text{flyby}}}{mc^2}\right)_{\text{maximal}}=\frac{1}{2}a_{\text{inbound}}^{2}\,. \tag{8}$$

The maximal flyby energy share is only of the inbound speed dependent and equals half of the square of the inbound speed expressed in the units of the speed of light. Possessing the maximal flyby energy share the mass body apparently stops moving according to the equations (2) and (7) since the maximal difference of flyby speed Δv_{max} equals the inbound speed $v_{inbound}$:

$$\Delta v_{max}=\frac{2v_{ekuatorial}}{c}v_{inbound}=\frac{2}{c}\frac{c}{2}v_{inbound}=v_{inbound}\,. \tag{9}$$

The mass body slows down the speed so much that it stays at apparent zero speed.

$$v_{apparent}=-\Delta v_{max}+v_{inbound}=0. \tag{10}$$

At maximal flyby energy share of the mass body where the massive body rotates with the equatorial speed $\frac{c}{2}$ the whole kinetic energy is transformed into the flyby energy. Its value is given using the equation (6*b*):

$$E_{\text{flyby}}^{\max}=E_{\text{flyby}}\left(v_{\text{equatorial}}=\frac{c}{2}\right)=\frac{m.v_{\text{inbound}}^{2}}{2}. \tag{11}$$

At the first sub-maximal flyby energy share of the mass body where the massive body rotates with the equatorial speed lower than $\frac{c}{2}$ only a part of kinetic energy is transformed into the flyby energy:

$$E_{\text{flyby}}\left(v_{\text{equatorial}}<\frac{c}{2}\right)<\frac{m.v_{\text{inbound}}^{2}}{2}. \tag{12}$$

The mass body slows down the speed but keeps the same apparent direction as the inbound speed:

$$v_{apparent}=-\Delta v_{max}+v_{inbound}>0. \tag{13}$$

At the second sub-maximal flyby energy share the mass body where the massive body rotates with the the equatorial speed higher than $\frac{c}{2}$ again only a part of the kinetic energy is transformed into the flyby energy:

$$E_{\text{flyby}}\left(v_{\text{equatorial}}>\frac{c}{2}\right)<\frac{m.v_{\text{inbound}}^{2}}{2}. \tag{14}$$

The mass body slows down the speed so much that it takes the opposite apparent direction than the inbound speed:

$$v_{apparent}=-\Delta v_{max}+v_{inbound}<0. \tag{15}$$

At the equatorial speed of light the apparent speed has also the opposite value than the inbound speed:

$$v_{apparent}=-2v_{inbound}+v_{inbound}=-v_{inbound}\,. \tag{16}$$

II. The Rotating and Expanding Universe

The Universe expands with the apparent zero speed:

$$v_{\text{apparent}}=-v_{\text{expansion}}+v_{\text{expansion}}=0. \tag{17}$$

The equation (17) resembles to the equation (10), so we can propose that the maximal flyby decrement of speed $-\Delta v_{max}$ and the inbound speed $+v_{inbound}$ equal the speed of the expansion of Universe in the negative direction $-v_{\text{expansion}}$ and positive direction $+v_{\text{expansion}}$, respectively. If the flyby concept holds true for the whole Universe, one can consider we are making right now the pure flyby at apparent zero speed in the circumstances of our maximal flyby energy share. In such case we are landing at the Pole of the Universe which rotates with the equatorial speed of half of the speed of light $\frac{1}{2}c$. The inbound and outbound equatorial angles are 0 and $\frac{\pi}{2}$, respectively, and the inbound speed is the speed of the expansion of Universe [2]:

$$v_{\text{inbound}}^{\text{Universe}}=v_{\text{expansion}}^{\text{Universe}}\approx 70\,\frac{\text{km}}{\text{s}}. \tag{18}$$

With the help of the equation (8) the maximal present Universe-flyby energy share is given:

$$\left(\frac{E_{\text{flyby}}}{mc^2}\right)_{\text{maximal}}^{\text{present Universe}}\approx 3\text{ x }10^{-8}. \tag{19}$$

It increases with time since the expansion of Universe is speeding up. [3],[4] The maximal possible future Universe-flyby energy share could be limited with the path distribution energy share of the electron in the ground state of Hydrogen atom [5][6] ,of course, if the latter appears as a true physical phenomenon since with the greater energy share no path distribution would be possible:

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$$\left(\frac{E_{flyby}}{mc^2}\right)_{maximal}^{future\ Universe} < \frac{E_{distribution}^{2-sided}}{mc^2} \approx 5.6\ x\ 10^{-8} \leq \frac{E_{distribution}^{\infty-sided}}{mc^2} \approx 8.4\ x\ 10^{-8}. \quad (20)$$

Then with the help of the equation (8) and regarding the sidedness of the path distribution of the electron in the ground state of Hydrogen atom the maximal speed of the expansion of the future Universe is predicted:

$$100\frac{\mathrm{km}}{\mathrm{s}} < v_{\mathrm{maximal}}^{\mathrm{future\ Universe}} < 123\frac{\mathrm{km}}{\mathrm{s}}. \quad (21)$$

III. Conclusions

We analyzed Anderson's flyby-anomaly prediction formula in the case where the inbound and outbound equatorial angles are 0 and $\frac{\pi}{2}$, respectively. Extending the validity of the discussed concept to the flybys in the gravity field of a rotating massive body in general, including that one of the whole Universe, the flyby inbound speed and the speed of expansion of the Universe were related in the circumstances of the maximal flyby-energy share increment and the latter compared with the path distribution energy share of the electron in the ground state of Hydrogen atom.

The next the critical reader needs to consider:"The speculation of the maximal speed of the future Universe-expansion $100\frac{\mathrm{km}}{\mathrm{s}} < v_{\mathrm{maximal}}^{\mathrm{future\ Universe}} < 123\frac{\mathrm{km}}{\mathrm{s}}$ was made on the proposal of the general validity of Anderson's flyby prediction formula which has been otherwise verified only at the relatively low equatorial speed of the Earth as well as on the basis of a comparison of the Universe-flyby energy share with the path distribution energy share of the electron which is not a proven physical phenomenon."

The physical reality is the twin sister of good imagination. (Author)

IV. Acknowleddgment

Thanking Dr.R.K.Dixit for the polite invitation to submit the article in GJSFR.

Dedication

This fragment is dedicated to my birthplace Maribor and place of childhood Selnica ob Dravi.

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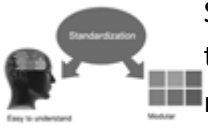

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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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