Exploration

On the Cosmic Variation of the Fine Structure Constant

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Abstract

In this article, we explore in a simple way the variation of *Fine Structure Constant* (FSC) as a purely classical phenomenon. The need to explain the variation of the FSC has been triggered by observations of Quasar absorption lines from various ions of iron and magnesium by John Webb and his collaborators who have interpreted their measurements as strongly pointing to a possible time and spacial variation of the FSC. Our interpretation may be helpful in *rethinking* the standard cosmological model which assumes that all matter, energy and physical existence were created in an instant. If the herein proposed mechanism behind the variation of the FSC is correct, we argue that it should be possible to resolve the issue related to the distances of Quasars.

Keywords: structure constant, fundamental constants, variation.

1 Introduction

Constants are a frequent occurrence in the equations of physics *e.g.* the normalised Planck constant $\hbar$ in Max Planck $(1858-1947)$'s revolutionary energy formula $E=\hbar\omega$ for the quanta where E is the energy of a quanta whose angular frequency is ω; the Newtonian gravitational constant $G = 6.667\times 10^{-11}\,\mathrm{m^3s^{-2}kg^{-1}}$ which occurs in Sir Isaac Newton $(1642-1727)$'s ground breaking formula for gravitation $\boldsymbol{F}=-G\mathcal{M}\mathrm{m}\hat{\boldsymbol{r}}/r^2$; the speed of light in vacuum $c=2.99792458\times 10^8\,\mathrm{ms^{-1}}$ which occurs *e.g.* in Albert Einstein $(1879-1955)$'s insightful famous formula $E=\mathrm{m}c^2$, *etc.* These constants are commonly referred to as *Fundamental Natural Constants* (FNCs), suggesting amongst others that they are sacred and sacrosanct, they are unchanging, they are eternal and fixed by some divine powers beyond the reach of the realm of the seemingly finite human-mind. How true is this assumption? Only measurements can decisively and conclusively answer this deep and very interesting question about physical and natural reality.

The path to the road of enquiry into the variation of the FNCs began sometime in 1935 and 1937 with the great British theoretical physicists - Edward Milne $(1896-1950)$ and Paul Dirac $(1902-1984)$. Milne (1935, 1937) and Dirac (1937) where perhaps the first (in the recorded literature) to question this *status quo* by suggesting that this long held assumption that Newton's constant of gravitation, G, was a sacrosanct and sacred constant of *Nature* that has remained constant since the Universe come into being. If current observations indicating the cosmological variation of the *Fine Structure Constant* (FSC) stand up to the most ruthless scientific scrutiny, Dirac and Milne may have been right after all – *albeit*, not on the variation of Newton's constant G, but the FSC. For example, on a level accuracy of one part per ten billion, very recent measurements Mould & Uddin (2014) suggest that G has not varied over the course of the Universe's history.

As is now common knowledge – just before the dawn of the 21^{th} century, that is in 1999, supposedly controversial high-redshift cosmological and astronomical observations (Webb et al. 1999) were brought forth by John Webb, of the University *of* New South Wales (in Australia) and his collaborators. These interesting observations seem to strongly suggest that one of the supposed sacrosanct and finest constants

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of physics – the dimensionless and seemingly arcane FSC α_0; may not be a constant as we have long believed as these observations indicate that this constant may very well have been significantly larger and smaller in the past than it is today in different parts of the Universe: *i.e.* $(-10^{-5} \lesssim \Delta\alpha_0/\alpha_0 \lesssim +10^{-5})$. These observations have further been supported by subsequent observations *e.g.* Webb *et al.* Webb et al. (2001, 2011), Muphy *et al.* Murphy et al. (2001,3, 2009), and King *et al.* King et al. (2012). If conclusively this is proven to be true (as we strongly believe), then, this has far reaching implications on the nature of the *Fundamental Laws of Nature*.

The dimensionless fine structure constant governs the strength of the long range electromagnetic interaction and is given by:

$$\alpha_0 = \frac{e^2}{4\pi\varepsilon_0\hbar c} = \frac{1}{137.035999074(44)}, \tag{1.1}$$

where $e = 1.602176565(35)\times 10^{-19}$ C is the magnitude of the elementary electronic charge of the Electron and proton and $\hbar = 1.054571726(47)\times 10^{-34}$ Js is Planck's normalised constant. For our purposes – which will become clear latter; we shall denote the FSC with the symbol α_0 and not the traditional symbol α. As will be seen, we will define two more FSCs, α_1 and α_2.

If α_0 is to vary over cosmic epochs, then, all or some of the four constants $(e, \hbar, c, \varepsilon_0)$ making-up this dimensionless constant must also vary with time over cosmic epochs because:

$$\frac{\Delta\alpha_0}{\alpha_0} = 2\left(\frac{\Delta e}{e}\right) - \frac{\Delta\varepsilon_0}{\varepsilon_0} - \frac{\Delta\hbar}{\hbar} - \frac{\Delta c}{c}. \tag{1.2}$$

We will maintain that e and c are universal constants, holding the same values everywhere at all times in all of the Universe [*i.e.* $(\Delta e/e \equiv 0)$, $(\Delta c/c \equiv 0)$]. At least for c, we can justify from the theory that we will set-forth of the variation of the FSC that c must truly be a fundamental constant of *Nature*. We however can not justify from this theory why $\hbar$ and e must not vary. Our holding them as true fundamental constants of *Nature* is more out of intuition than anything else. From all this, it follows that for the variation of the FSC, we are holding ε_0 as the culprit, *i.e.*:

$$\frac{\Delta\alpha_0}{\alpha_0} = -\frac{\Delta\varepsilon_0}{\varepsilon_0}. \tag{1.3}$$

At present there exists no properly constituted theory that explains why any of the supposed fundamental constants must vary. Most theories that do make the endeavour to explain the possibility of the variation of the FSC are speculative theories based on exotic and exogenous ideas (cf., Silva et al. 2014, Bamba et al. 2012, Barrow & Lip 2012, Olive et al. 2012, Calabrese et al. 2011) and some of these theories are yet to make contact with experience such as string and string-related theories. Here, our theory is surprisingly simple as it is not built on any exotic nor exogenous ideas, but on the well accepted and verified classical Maxwellian Electrodynamic theory. The interpretation of the resulting variation of the FSC from our theory is pretty much straight forward, however, the resulting picture of the Universe that emerges from this interpretation may seriously require us to fundamentally *rethink* if not *reconsider anew* the central and most basic tenets of present cosmology.

To keep matters as simple as one can, we assume that the mass and electronic charge of the Electron and Proton are fixed for all times – from antiquity to eternity; this assumption of a constant mass for the Electron and Proton resonates with the latest findings from quasar and other astronomical observations (see *e.g.*, Malec et al. 2009, van Weerdenburg et al. 2011, Bagdonaite et al. 2012, 2013, 2015). Actually, we consider these two particles (Electron and Proton) to be *Eternal Particles*. Present day particle physics defines an *Elementary Particle* or *Fundamental Particle*, as a particle not made up of smaller particles, and because of this, such a particle can not be broken down into smaller constituents. Because a Proton is comprised of quarks, it follows that it can not be a fundamental particle. We envisage an eternal particle as a particle that may or may not comprised of smaller constitutes such as quarks – this particle as whole (*i.e.*, as a composite particle with or without its smaller constitutes such as quarks); it can not be broken down into any another particle *via* decay, not even into the smaller constituents that make it; this particle is eternally stable, once created, it can not be destroyed and its electrical charge and mass are fixed for all times. This is the picture we have of the Electron and the Proton − ultimately, this picture may be wrong, but one thing that is true is that current wisdom seems to suggest this, that the Electron and Proton can not be broken down into smaller particles, even into the quarks that make up the Proton.

The remainder or the present reading is structured as follows. Hereafter, we give an exposition of classical Maxwellian electrodynamics, in which process we extract the equation that we need for our purposes. Thereafter, we go onto set into motion the sought for theory of a time varying FSC. In the subsequent section thereafter, we use the proposed theory of the time varying FSC to decipher the meaning of the observational findings of John Webb *et al.* Webb et al. (1999, 2001, 2011), Murphy et al. (2001,3), King et al. (2012). Lastly, we give a general discussion, the conclusions drawn thereof and as-well the recommendations.

2 Classical Maxwellian Electrodynamics

As is well known, Maxwell's celebrated and embellished classical theory of electrodynamics can be summed up in two simple looking tensor equations, namely:

$$\partial^{\mu} F_{\mu\nu} = \mu_0 J_{\nu}, \tag{2.1}$$

which is the source-coupled set of field equations, and:

$$F_{\mu\nu,\lambda} + F_{\lambda\mu,\nu} + F_{\nu\lambda,\mu} = 0, \tag{2.2}$$

which is the source free set of field equations, where μ_0 is the permeability of free space and, $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$, is the electromagnetic field tensor, $J_\mu = \varrho_{\rm e} v_\mu$, is the four current and the Greek indices (μ, ν, λ) are such that $[(\mu, \nu, \lambda) = 0, 1, 2, 3]$. In the four current, $J_\mu = \varrho_{\rm e} v_\mu$, $\varrho_{\rm e}$ is the electronic charge density and $v_\mu = (c, \boldsymbol{v})$ is the four velocity and in the electromagnetic field tensor, $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$, the object $A_\mu = (\Phi_{\rm e}, \boldsymbol{A})$, is the electromagnetic four vector potential with $\Phi_{\rm e}$ being the electric potential and $\boldsymbol{A}$ the magnetic vector potential. The electromagnetic four vector potential A_μ satisfies the Lorentz gauge, namely $\partial^\mu A_\mu = 0$.

In proving or demonstrating that Maxwell's theory does have contained in it the variation of the fundamental constants μ_0 and the permeability of free space ε_0 (hence α), we will not need equation (2.2). With the Lorentz gauge taken into account, (2.1) yields the well known four Poisson-Laplace equation for electrodynamics, namely:

$$\Box A_\nu = \mu_0 J_\nu, \tag{2.3}$$

where $\Box$ is the four Laplacian or the D'Alembert operator defined as $\Box = \boldsymbol{\nabla}^2 - \partial^2/c^2\partial t^2$. We are going to take the component $(\nu = 0)$ and from there demonstrate that the fundamental constants μ_0 and ε_0 must vary with time.

3 Theory of a Time Varying FSC

All we need from (3.1) is the component for which $(\nu = 0)$, and this equation is:

$$\boldsymbol{\nabla}^2 \Phi_{\rm e} - \frac{1}{c^2}\frac{\partial^2 \Phi_{\rm e}}{\partial t^2} = \varrho_e/\varepsilon_0. \tag{3.1}$$

We will consider the natural time-dependent radial solutions of (3.1) for a point charge. By natural solutions we mean those solutions which are separable when expressed in spherical coordinates *i.e.*

$\Phi_{\rm e}(r,\theta,\varphi,t) = \Phi_{\rm e}(r)\Phi_{\rm e}(\theta)\Phi_{\rm e}(\varphi)\phi_{\rm e}(t)$. Since we are considering only the time-dependent radial solutions, this means we are considering the solutions $\Phi_{\rm e}(r,t) = \Phi_{\rm e}(r)\phi_{\rm e}(t)$. For simplicity, we will consider the vacuum solutions of (3.1). For the time-dependent component, the solutions that we obtain for the vacuum solutions are the same as those for the non-vacuum solutions; so there really is no need to find the complicated solution for the general case of the non-vacuum.

Thus setting $\varrho_{\rm e} = 0$ and $\Phi_{\rm e}(r,t) = \Phi_{\rm e}(r)\phi_{\rm e}(t)$ in (3.1), we will obtain:

$$\frac{\boldsymbol{\nabla}^2\Phi_{\rm e}(r)}{\Phi_{\rm e}(r)} = \frac{1}{\phi_{\rm e}(t)}\frac{1}{c^2}\frac{\partial^2\phi_{\rm e}(t)}{\partial t^2} = \mu^2, \tag{3.2}$$

where μ^2 is pure constant with no temporal nor spatial variation. There are three cases to be considered here and these are ($\mu^2 = 0$), ($\mu^2 > 0$) and ($\mu^2 < 0$). This implies that there will be three solutions for $\Phi_{\rm e}(r,t)$ and these will correspond to three solutions for $\Phi_{\rm e}(r)$ and $\phi_{\rm e}(t)$. Let us write these three solutions with a superscript label as $\Phi_{\rm e}^{(a)}(r,t) = \Phi_{\rm e}^{(a)}(r)\phi_{\rm e}^{(a)}(t)$ where a takes three values *i.e.*, ($a = 0$) corresponding to ($\mu^2 = 0$); ($a = 1$) corresponding to ($\mu^2 > 0$); and ($a = 2$) corresponding to ($\mu^2 < 0$).

In the next three subsections, we will present the solutions to the three scenarios ($\mu^2 = 0$), ($\mu^2 > 0$) and ($\mu^2 < 0$). Our solutions are those for which the strength of the electromagnetic force decreases with the passage of time and we shall set $\phi_{\rm e}^{(a)}(0) = 1$.

3.1 Case ($\mu^2 = 0$)

In the case, ($\mu^2 = 0$), we will have, $\Phi_{\rm e}^{(0)}(r) = q/4\pi\varepsilon_0 r$, for the space component and, $\phi_{\rm e}^{(0)}(t) = (1 - t/t_0)$, where t_0 is a fundamental natural constant. From this, it follows that the electrical potential must be given by:

$$\Phi_{\rm e}^{(0)}(r,t) = \frac{\phi_{\rm e}^{(0)}(t)}{4\pi\varepsilon_0}\frac{q}{r}. \tag{3.3}$$

Einstein once said that if one is constructing a theory, it is important for them at somepoint to imagine they are the creator of the Universe and having done this, they must ask themselves how would they have created the Universe if it where them that created it. Assuming we are in-charge of creating the Universe, if we choose to maintain ε_0 as a fundamental natural constant, then, the time variation can be associated with the electric charge *i.e.* $q \longmapsto q(t) = q(0)\phi_{\rm e}^{(0)}(t)$ where $q(0)$ is the electronic change at the time of creation; in this way the quantity ε_0 is a fundamental physical constant that does not vary with time; so that:

$$\Phi_{\rm e}^{(0)}(r,t) = \frac{1}{4\pi\varepsilon_0}\frac{q(t)}{r}. \tag{3.4}$$

On the other hand, if we choose to maintain the electric charge q as a fundamental natural constant, then, the time variation can be associated with the permittivity of free space ε_0, *i.e.* $\varepsilon_0 \longmapsto \varepsilon_0(t) = \varepsilon(0)/\phi_{\rm e}^{(0)}(t)$ where $\varepsilon(0)$ is the permittivity of free space at the time of creation and this quantity is a fundamental physical constant does not vary with time; so that:

$$\Phi_{\rm e}^{(0)}(r,t) = \frac{1}{4\pi\varepsilon_0(t)}\frac{q}{r}. \tag{3.5}$$

We are of the strong feeling that the electronic charge is a fundamental constant of *Nature*. Therefore, we are of the view that (3.4) and not (3.5) is what is obtaining in *Nature*, hence we shall – for now – take the position that $\varepsilon_0(t) = \varepsilon(0)/\phi_{\rm e}^{(0)}(t)$.

Now, if $\Phi_{\rm e}^{(a)}(r,t)$ is separable, the components of the vector $\boldsymbol{A}(r,t)$ *i.e.* $A_j^{(a)}(r,t)$, will be separable too *i.e.* $A_j^{(a)}(r,t) = A_j^{(a)}(r)\xi_j^{(a)}(t)$. We will assume that the time dependent component of

$A_j^{(a)}(r,t)$ is the identical to that in the electric potential $\Phi_{\rm e}^{(a)}(r,t)$ *i.e.* $\phi_{\rm e}^{(a)}(t) \equiv \xi_j^{(a)}(t)$, therefore $A_\mu^{(a)}(r,t) = \phi_{\rm e}^{(a)}(t)A_\mu^{(a)}(r)$. What this all means for $\mu_0(t)$ is that must have:

$$\mu_0(t) = \mu_0(0)\phi_{\rm e}^{(0)}(t). \tag{3.6}$$

where $\mu_0(0)$ is the permeability of free space at the time of creation – $\mu(0)$ is a fundamental physical constant. If as we have assumed that, $\phi_{\rm e}^{(a)}(t) \equiv \xi_j^{(a)}(t)$, the speed of light, c, will remains a constant for all times, *i.e.*:

$$c = \frac{1}{\sqrt{\mu_0(t)\varepsilon_0(t)}} = \frac{1}{\sqrt{\mu_0\varepsilon_0}}. \tag{3.7}$$

So, even if ε_0 and μ_0 where time variables, the speed of light c, is exempted from being a possible cause in the variation of α.

Now, on the time variation of ε_0; based on some of our on-going work, work which is at present not published, we are strongly for a scenario where both the electronic charge and the permittivity of free space are true fundamental constants, the meaning of which is that we are of the position that $(t_0 = \infty)$. Therefore, as our working hypothesis, we shall take e and ε_0 to to a fundamental constant.

3.2 Case $(\mu^2 > 0)$

In the second case *i.e.*, the case $(\mu^2 > 0)$, we will have $\Phi_{\rm e}^{(1)}(r) = qe^{-\mu_1 r}/4\pi\varepsilon_1 r$ for the space component and $\phi_{\rm e}^{(0)}(t) = e^{-\mu_1 ct}$ for the time component; μ_1 and ε_1 are fundamental natural constants where ε_1 plays the same role as the permeability of free space ε_0. Perhaps we must call this constant ε_1 the permittivity of free space within the range $l_1 = 1/\mu_1$ of the Electron. From the foregoing, it follows that:

$$\Phi_{\rm e}^{(1)}(r,t) = \frac{\phi_{\rm e}^{(1)}(t)}{4\pi\varepsilon_1}\frac{qe^{-\mu_1 r}}{r}. \tag{3.8}$$

As before, we choose the time variation to be in ε_1 *i.e.* $\varepsilon_1(t) = \varepsilon_1(0)/\phi_{\rm e}^{(1)}(t)$ where $\varepsilon_1(0)$ is the permittivity of free space within the range $l_1 = 1/\mu_1$ of the Electron at the time of creation and this quantity is a fundamental physical constant that does not vary with the passage of cosmic time. It follows that:

$$\Phi_{\rm e}^{(1)}(r,t) = \frac{1}{4\pi\varepsilon_1(t)}\frac{qe^{\mu_1 r}}{r}. \tag{3.9}$$

As in the previous case, we will have for $\mu_1(t)$, that $\mu_1(t) = \mu_1(0)\phi_{\rm e}^{(1)}(t)$ where $\mu_1(0)$ is the permeability of free space within the range $l_1 = 1/\mu_1$ of the Electron at the time of creation and this quantity is a fundamental physical constant does not vary with time. The two constants $\mu_1(t)$ and $\varepsilon_1(t)$ are related to the speed of light in the same manner that $\mu_0(t)$ and $\varepsilon_0(t)$ are related to the speed of light c, *i.e.*, $c = 1/\sqrt{\mu_1(t)\varepsilon_1(t)} = 1/\sqrt{\mu_1\varepsilon_1}$.

Notice that if the sign of ε_1, is positive, like charges will repel and unlike charges will attract on a length-scale $l_1 = 1/\mu_1$. If on the other hand, the sign of ε_1, is negative, like charges will attract and unlike charges will repel on length-scale $l_1 = 1/\mu_1$. Given that Protons lump-up to form the nucleus of atoms, it is reasonable to assume that the sign of ε_1, is negative so as to account for this occurrence. Further, because ε_1 falls of exponential with time, if the potential $\Phi_{\rm e}^{(1)}(r,t)$, truly is responsible for the binding of Protons into forming a nucleus, it follows that the binding energy of the nucleus is getting smaller and smaller with the passage of cosmic time, at some point, this binding force surely will be so weak, Protons and Neutrons may dissipate in which process the atom will disintegrate. Surely, this is quite interesting, however, we must limit ourself to the scope of the present reading, thus we shall go no further in the exploration of this rather interesting discovery.

3.3 Case ($\mu^2 < 0$)

In the third and last case *i.e.*, the case ($\mu^2 < 0$), we will have $\Phi_e^{(2)}(r) = q\cos(\mu_2 r+\theta)/4\pi\varepsilon_1 r$ for the space component and $\phi_e^{(2)}(t) = \cos(\mu_2 ct+\theta)$ where μ_2 is fundamental natural constants, ε_2 is another physical constant plays the same role as the permeability of free space ε_0 and θ is an arbitrary constant peculiar to the Electron and proton in question. Like ε_1, the constant ε_2 is the permeability of free associated with the potential $\Phi_e^{(2)}(r,t)$ with the range $1/\mu_2$ of the Electron. From the above, it follows that:

$$\Phi_e^{(2)}(r,t) = \frac{\phi_e^{(2)}(t)}{4\pi\varepsilon_0}\frac{q\cos(\mu_2 r+\theta)}{r}. \tag{3.10}$$

As before, we choose the time variation to be in ε_2 *i.e.* $\varepsilon_2(t) = \varepsilon_2(0)/\phi_e^{(2)}(t)$ where $\varepsilon_2(0)$ is the value of $\varepsilon_2(t)$ at the time of creation and this quantity is a fundamental physical constant that does not vary with the passage of cosmic time. From the foregoing, it follows that:

$$\Phi_e^{(2)}(r,t) = \frac{1}{4\pi\varepsilon_2(t)}\frac{q\cos(\mu_2 r+\theta)}{r}. \tag{3.11}$$

As in the previous case, we will have for $\varepsilon_2(t)$, that $\mu_2(t) = \mu_2(0)\phi_e^{(2)}(t)$ and these two constants are related to the speed of light c just as $[\mu_0(t), \varepsilon_0(t)]$ and $[\mu_1(t), \varepsilon_1(t)]$ are related to the speed of light *i.e.* $c = 1/\sqrt{\mu_2(t)\varepsilon_2(t)} = 1/\sqrt{\mu_2(0)\varepsilon_2(0)}$.

Whatever the sign of $\varepsilon_2(0)$, the sign of $\varepsilon_2(t)$ will change from being positive to negative of a time-scale $t_2 = 2\pi/\mu_2 c$. If t_2 is very small, small enough to be of the order of the time-scale of atomic fluctuations, then, the potential $\Phi_e^{(2)}(r,t)$ generate both attractive and repulsive forces. Further, because of the term $\cos(\mu_2 r+\theta)$, the space dependent term will have crests and troops of alternate repulsive and attractive forces. This is quite interesting, however, we must limit ourself to the scope of the present reading, thus we shall go no further in the exploration of this rather interesting discovery.

3.4 Constancy of the Speed of Light

In all the three cases presented above, despite the fact that one can have ε_j and μ_j as time variables, the net effect of this time variability is that the speed of light is not a time variable, therefore the speed of light is in our theory exempted from being a culprit in the observed variation of the FSC.

3.5 Preliminary Summary

First and foremost, what we have uncovered here is that Maxwell's classical theory allows for the existence of at least three electrical potentials. Amongst these three potentials is the Yukawa potential Yukawa (1935) discovered in 1935 by the Japanese – Hideki Yukawa (1907 – 1981), that is, the electrical potential $\Phi_e^{(2)}(r,t) = qe^{-\mu_1 r}/4\pi\varepsilon_1 r$. Yukawa derived this potential from the static solution of the Klein-Gordon equation $\Box\Psi = (m_0 c/\hbar)^2\Psi$. Our understanding of the Yukawa potential since its discovery has been that this potential has its origins as described by Yukawa in 1935. From what we have presented here, this potential is very much a part and parcel of the electrical phenomenon.

Of the three potentials $\Phi_e^{(a)}(r,t) : (a = 0, 1, 2)$; one may ask "Which one does or has *Nature* chosen to vehicle the electrical phenomenon of the Universe?" This valid question is asked on the basis that if there are three solutions, *Nature* must employ only one of them and not all three. When one thinks of this deeper and further than just grazing the surface, they will come to the conclusion that there is nothing wrong with *Nature* employing all three solution simultaneously. We take this approach, that all three potential are active simultaneously in all electrically laden *Fundamental Particles* such as the Electron, Proton *etc*. Therefore, the total electrical potential $\Phi_e(r,t)$ will be such that:

$$\Phi_{\mathrm{e}}^{(a)}(r,t)=\sum_{a=0}^{2}\Phi_{\mathrm{e}}^{(a)}(r,t). \tag{3.12}$$

The third component $\Phi_{\mathrm{e}}^{(2)}(r,t)$ has a sinusoidal time variation such that if $t_1 = 2\pi/\mu_1 c$ is small, say of the order the randomness on the quantum scale say $t_1 \sim 10^{-20}$ s, one can use this component to explain the randomness that is seen on the quantum scale. This randomness will come not only as the result of the sinusoidal time variation, but on the fact the θ is different for different particles. This uniqueness of θ will certainly give raise to randomness on a time-scale t_*. We do not want to delve deeper in this matter, but merely point out that this component may be used to decipher the origins of quantum randomness.

3.6 Yukawa Potential and the Variation of the FSC

The solutions to the time-independent Schrödinger equation *i.e.*:

$$-\frac{\hbar^2}{2\mathrm{m}}\boldsymbol{\nabla}^2\Psi+V\Psi=E_n\Psi, \tag{3.13}$$

are well known. In most cases considered, the Schrödinger equation only takes into account just one potential, which is the Coulomb potential $V = Qq/4\pi\varepsilon_0 r$. We have advanced the idea to the effect that the Electron and or the Proton – or any electrically charged particle for that matter; carries at least three electrical potentials. If this is the case, it means that these other two potential need to be taken into account in-order to better understand atomic transitions. We want to explore the effects of these potentials on the Electron around the Proton (or atomic nucleus). For simplicity, we shall assume that the third potential $\Phi_{\mathrm{e}}^{(2)}$ is negligible, the meaning of which is that apart from the Coulomb potential, we shall assume that the Electron is acted upon by the dynamic Yukawa potential: $\Phi_{\mathrm{e}}^{(1)}(r,t) = qe^{-\mu_1 r}/4\pi\varepsilon_1(t)$.

In the simple case of an Electron around the Proton, it follows that the total electrical potential V' is such that:

$$V'=-\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}-\frac{1}{4\pi\varepsilon_1(t)}\frac{e^2}{r}\mathrm{e}^{-\mu_1 r}. \tag{3.14}$$

The Yukawa potential has a turning point at $r = 1/\mu_1 = r_1$. Considering the Electron to be orbiting at distances much smaller that r_1, *i.e.* at $(r \ggg r_1)$, we will have $(\mathrm{e}^{-\mu_1 r} \sim 1 - \mu_1 r)$. This means the potential energy of the Electron can be estimated as:

$$V'=-\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}-\frac{1}{4\pi\varepsilon_1(t)}\frac{e^2}{r}+\frac{\mu_1 e^2}{4\pi\varepsilon_1(t)}, \tag{3.15}$$

which we can write as $V' = V + V_0$, *i.e.*:

$$V'=-\frac{1}{4\pi\epsilon_0(t)}\frac{e^2}{r}+V_0, \tag{3.16}$$

where $V_0 = \mu_1 e^2/4\pi\varepsilon_1(t)$ and:

$$\epsilon_0(t)=\left(\frac{1}{\varepsilon_0}+\frac{1}{\varepsilon_1(t)}\right)^{-1}=\frac{\varepsilon_0\varepsilon_1(t)}{\varepsilon_0+\varepsilon_1(t)}. \tag{3.17}$$

The resulting Schrödinger equation from all this is:

$$-\frac{\hbar^2}{2\mathrm{m}}\boldsymbol{\nabla}^2\Psi-\left(\frac{1}{4\pi\epsilon_0(t)}\frac{e^2}{r}\right)\Psi=(E_n-V_1^*)\Psi, \tag{3.18}$$

where E_n is the usual energy levels of the Hydrogen atom. What (3.16) is telling us is that the dynamic Yukawa potential contributes a Coulomb-type potential to the Coulomb electrical potential energy of the Electron around the Proton. It is difficult to separate the real Coulomb potential from the Yukawa potential. The effect thereof or the end-result emerging from the Yukawa potential is to alter the value of the Coulomb- permittivity of free space ε_0. The actual value that we will measure and associated with the Coulomb- permittivity of free space $\epsilon_0(t)$ and not ε_0. This means that in our equations, wherever we have ε_0, we must replace this with $\epsilon_0(t)$. In the case of the FSC, we will have:

$$\alpha_0(t) = \frac{e^2}{4\pi\epsilon(t)\hbar c}, \tag{3.19}$$

and the FSC now has some time variation and this is not coming from ε_0 but from $\varepsilon_1(t)$. We want to compute $\dot{\alpha}_0(t)/\alpha_0(t)$ and for this we need to compute $\dot{\epsilon}_0(t)/\epsilon_0(t)$. We know from (3.17), that:

$$\frac{\dot{\epsilon}_0(t)}{\epsilon_0(t)} = 2\left(\frac{\varepsilon_0}{\varepsilon_0 + \varepsilon_1(t)}\right)\frac{\dot{\varepsilon}_1(t)}{\varepsilon_1(t)} = -2\left(\frac{\varepsilon_0}{\varepsilon_0 + \varepsilon_1(t)}\right)\mu_1 c. \tag{3.20}$$

If $[\varepsilon_1(t) \ggg \varepsilon_0]$ that is to say, if the dynamic Yukawa potential is much weaker in strength than the Coulomb potential, then $[\epsilon(t) \sim \varepsilon_0]$ – the meaning of which is that on a practical level, this dynamic Yukawa potential is much too small to be significant on short cosmic time scales; it follows from this that (3.20) will reduce to:

$$\frac{\dot{\epsilon}_0(t)}{\epsilon_0(t)} = -2\left(\frac{\varepsilon_0}{\varepsilon_1(t)}\right)\mu_1 c, \tag{3.21}$$

hence from (3.19), we obtain:

$$\frac{\dot{\alpha}_0(t)}{\alpha_0(t)} = 2\left(\frac{\varepsilon_0}{\varepsilon_1(t)}\right)\mu_1 c, \tag{3.22}$$

it follows that:

$$\frac{\Delta\alpha_0(t)}{\alpha_0(t)} = 2\mu_1 c\left(\frac{\varepsilon_0}{\varepsilon_1(0)}\right)\Delta t = 2\mu_1 c\zeta(t)\Delta t. \tag{3.23}$$

where $\zeta(t) = \varepsilon_0/\varepsilon_1(t)$. At any given cosmic epoch, the value of $\zeta(t)$ is the same for any galaxy (or quasar) that we decide to observe.

Now, onto the main vein of the what the present reading truly seeks. What we should realise about the time Δt in the above expression is that it is the cosmic time difference since creation of the two galaxies under probe *i.e.*, it is the time difference since creation between the Electron (or Proton) under probe compared to the Earth Electron since it came into being. Therefore, the difference in the FSC $\Delta\alpha_0(t)$, is by its own-self a direct measure of the time difference in the creation times of the Electrons (or Protons) in question. Simple as the this idea may appear at face value, it has tantalizing implications insofar as the BBC-model is concerned. This is what we will look at in the next section.

4 Deepest and Most Profound Implications

The time different Δt in (3.23) is the time difference between the creation of two different pieces of matter residing in two different galaxies – our galaxy and the galaxy under the telescope *i.e.* $\Delta t = t_{gal} - t_{Gal}$ where t_{Gal} is the cosmic age of our own Milkyway Galaxy and t_{gal} is the age is the galaxy under our telescope. Assuming that all matter found in a particular galaxy was created at the same instance, then, Δt is the time difference between the creation of the two galaxies in question in which this matter resides.

If as assumed above that material comprising any galaxy must all have been created at the same time, it follows that comparison of $\Delta\alpha_0(t)/\alpha_0(t)$ for material residing in the same galaxy, we must have $\Delta\alpha_0(t)/\alpha_0(t) \sim 0$, just as is the case with the measurements of Rosenband et al. (2008) whose Earth based experiments using the frequency ratio of Al^+ and Hg^+ in single-ion optical atomic clocks yielded $\dot{\alpha}_0(t)/\alpha_0(t) = -(1.60 \pm 2.30) \times 10^{-17}\,\text{yr}^{-1}$; this result is compatible with zero. Other laboratory measurements (see *e.g.*, Leefer et al. 2013, Peik et al. 2004, Sisterna & Vucetich 1990) have consistently yielded a null result. In the framework of the present ideas, this makes perfect sense as this means that material of our local neighbourhood was created at the same time - as one would naturally expect.

Now – on a much more interesting and surprising note; if for $\Delta\alpha_0(t)/\alpha_0(t)$, we have $[\Delta\alpha_0(t)/\alpha_0(t) < 0]$, this implies that $[t_{Gal} > t_{gal}]$; the meaning of which is that the galaxy in question is younger than our own galaxy – our galaxy was created first before this galaxy was created; and on the same footing, if $[\Delta\alpha_0(t)/\alpha_0(t) > 0] \Longrightarrow [t_{Gal} < t_{gal}]$; and this means that the galaxy in question is much older than our own galaxy, it was created first and ours latter.

Interestingly and perhaps surprisingly, as shown in Figure 1, Webb et al. (2011) have discovered not just a variation of the FSC, but a spatial variation of the FSC. In their first measurements made in the South pole Webb et al. (1999) using the Keck telescope in Mauna Kea – Hawaii; they found out that $[\Delta\alpha_0(t)/\alpha_0(t) > 0]$. When they moved to the Northern skies using the Very Large Telescope (VLT) in Paranal – Chile; they found the opposite result $[\Delta\alpha_0(t)/\alpha_0(t) < 0]$ (Webb et al. 2011). A revival group (Chand et al. 2004, Srianand et al. 2004) found no variation in the FSC. Even in the latest measurement, no variations are still being found *e.g.* by O'Bryan et al. (2015). However, a much more careful analysis of the same sample of Chand et al. (2004) and Srianand et al. (2004) suggested that the errors should be enlarged by a factor of six, and that a much larger, dedicated VLT survey be performed by Murphy et al. (2007, 2008).

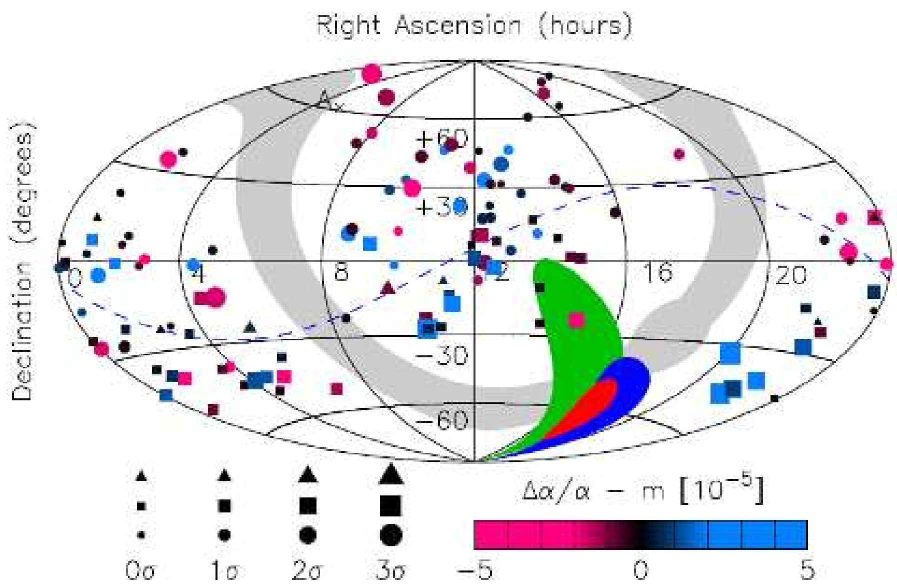

Figure 1: An all-sky plot in equatorial coordinates showing the independent Keck telescope (green, leftmost) and VLT (blue, rightmost) best-t dipoles, and the combined sample (red, center). Adapted from the reading Webb et al. (2011).

Obviously, this scenario where at one time one finds $[\Delta\alpha_0(t)/\alpha_0(t) \sim 0]$, at another $[\Delta\alpha_0(t)/\alpha_0(t) > 0]$ and then $[\Delta\alpha_0(t)/\alpha_0(t) < 0]$ brings about some confusion – especially on the yardstick derived from the wisdom of the seemingly sacrosanct and all-powerful *Cosmological Principle* which posits that the distribution of matter in the Universe is homogeneous and isotropic when viewed on a large enough scale. Guided by the *Cosmological Principle*, naturally, physicists expect that if truly the FSC is a variable, we must measure the same value for $\Delta\alpha_0(t)/\alpha_0(t)$, for any pair of galaxies at any given cosmic epoch. As explained earlier, this is expected only for a Universe in which all of the material in it was created at the same time *i.e.* at an instant whose cosmic time we can set to $(t \equiv 0)$.

If $\zeta(t)$ is extremely large in magnitude, then, Δt will be extremely small because $|\Delta\alpha_0(t)/\alpha_0(t)| \lll 1$, the meaning of which is that the material of the present Universe was created almost at an instant. If however, $\zeta(t)$ is small, then, all the material of the present Universe can not have been created in a single event because Δt will be very large. In this event, the Universe can not have been created an instant – as the BBC-model pre-supposes, but in a continuous process rather than a moment.

What the above means is that this free parameter $\zeta(t)$ is important insofar as whether or not the BBC-model is correct in its proclamation of an instant of creation. This free parameter $\zeta(t)$ can take any value, but whatever that value may be for as long as it is not zero, matter can not have been created at an instant. Actually, according to the present theory, if matter was created at an instant, we must have $\alpha_0(t) = \infty$. The very fact that the FSC has a finite value directly points to the fact that the BBC-model can not be correct in its proclamation of an instant of creation.

In the event that $\zeta(t) \lll 1)$, in which case material was create not at an instant, one will be forgiven for asking "Did this creation stop? If so, what stopped it? Upon a deeper reflection, one may wonder if it not natural that, the creation of matter is a continuous process? If it happened at some instant, it can happen in the next, and the next *etc.* These are the questions and thoughts that begin to flood the mind. There really is nothing to cause us to think that if the material of the Universe was created tens to hundreds of thousand of years apart, this creation must at some-point come to a halt. The creation of matter may very well be an on-going continuous process.

4.1 Eternal Continuous Creation Cosmology

The picture of the Universe that instantly and immediately comes and collapses to our curious and searching mind is one of an *Eternal Continuous Creation Universe* as the one shown in Figure 2. We envisage here an infinite continuous matter creating Universe, one extending from $(R = 0)$ to $(R = \infty)$. This Universe has at its center a *cosmic egg*, or *cosmic white-hole* out of which matter pours out whereforth it undergoes a Hubble flow as it traverses outward to the infinite expanse of the Universe. For any galaxy, an observer will measure that in their inner Universe [as shown in Figure 2], that $[\alpha_0(t) < 0]$ and in their outer Universe $[\alpha_0(t) > 0]$. For those galaxies that are at the same radial distance from the center of the Universe as their own galaxy, they will measure $[\alpha_0(t) = 0]$. This picture – wrong it may or might be; it does somehow explain the reason why the measured value of $\Delta\alpha_0(t)/\alpha_0(t)$ is not uniform and why there appears to be a spatial variation of this physical quantity.

A similar model has been proposed by Chen & Chen (2016). Chen & Chen (2016) propose a new, Shell Model of the Universe, which contends that the universe is created from multiple, concentric big bangs as is the case in the present proposed model. According to their model as in the present case, the center of the Chen-Chen Shell Model presents itself as a unique, preferential reference frame, which furnishes the simplest description of the motions of galaxies in the cosmos. The appeal of the Chen-Chen Shell Model of the Universe lies in its simplistic ability to resolve the paradox of quasars, explain the variability in Hubble's Constant, and solve the problematic accelerated expansion of the universe.

4.2 Major and Immediate Criticism

One major and immediate criticism that may heavily be levelled against the envisaged Eternal Universe is the issue of conservation of mass-energy. *Prima facie* – since in this Eternal Universe there is matter being created on a continuous basis, the Law *of* Conservation of mass and energy is not upheld. But, if one considers that negative energy and mass particles are not at all ruled out by the Laws *of* Nature insofar as we currently understand them, one can invoke the idea that for every positive mass-energy created, there is created with it, an equal negative mass-energy particle. Let us call this negative mass-energy – *negative-mass-energy*, or for short *negmatter-energy*. These negative and positive masses and energies may not nullify when they come into contact as happens when matter and antimatter come into contact. This negative mass and energy is not to be envisage as antimatter mass, but as negative mass and energy. In this picture, antimatter is mere matter with the same sign in its mass and energy – *albeit* – with opposite electrical properties.

Eternal Continuous Creation Universe

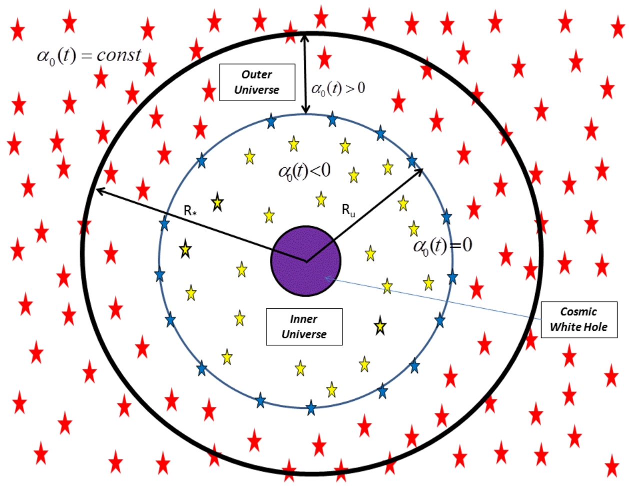

Figure 2: We envisage here an infinite Universe, with it at its center a tiny *cosmic egg*, or *cosmic white-hole* out of which all matter hence-forth pours out after which it undergoes a Hubble flow as it traverses outward to the infinite expanse of the Universe. For any galaxy, an observer will measure that in their inner Universe as shown on the diagram, that $[\alpha_0(t) > 0]$ and that in their outer Universe $[\alpha_0(t) < 0]$. For those galaxies that are at the same radial distance from the center of the Universe as that of the observer, they will measure $[\alpha_0(t) = 0]$ for such as galaxy.

Matter-energy and neg-matter-energy could be made to not interact with each and as-well, neg-matter-energy may be made to be invisible in much the same sense as the *Invisible Dirac Sea*. This would be made to contribute to the negative pressure that is typically assumed to be responsible for the expansion of the Universe. For fear of digression, we have no intention here of working out the full details of this kind of a cosmology as we are fully aware that this is a task best left for a full separate reading. All we want here is to put across the deepest and most profound implications of the simple derivation we have made here that Maxwellian Electrodynamics does allow for a time varying FSC.

4.3 Hubble Parameter

If the cosmological model that we envisage in Figure 2 has any correspondence with physical and natural reality, then, the issue of where or not the Hubble parameter H_0 is a fundamental natural constant of variably can be answered conclusively. The distance, $D_{ij}(t)$, between any two galaxies i and j which are angular distance θ apart is given by the cosine formula, $D^2_{ij}(t) = R^2_i(t) + R^2_j(t) - 2R_i(t)R_j(t)\cos\theta$, and if the Hubble Law is to be obeyed by any two galaxies, then, we must have $\dot{R}_i/R_i = \dot{R}_j/R_j = H_0$ where H_0 is a fundamental natural constant that does not vary with time; in which case we will have:

$$\dot{D}_{ij}(t) = H_0 D_{ij}(t), \tag{4.1}$$

where H_0 has to be be a fundamental natural constant. This fact leads us to:

$$R(t) = \ell_p e^{H_0 t}, \tag{4.2}$$

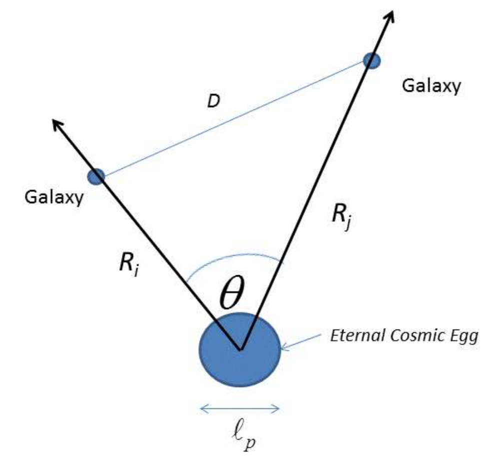

Figure 3: In the diagram are two galaxies a distance D_{ij} apart and each a distance R_i and R_j from the center of the Universe. The galaxies move radially outward from the center. For the Hubble Law to hold for such a setting $\dot{R}_i/R_i = \dot{R}_j/R_j = H_0$ where H_0 is a fundamental natural constant that does not vary with time.

where ℓ_p is fundamental natural constant with the dimension of length. What this means is that the Universe undergoes an exponential expansion from an initial dense state. We expect that eventually, when a fully-fledged model of the proposed cosmology is finally written down, ℓ_p will be identified with the Planck length.

An important outcome from the proposed cosmology model is that $1/H_0$ is no longer a measure of the age of the Universe. Actually, different parts of the Universe have different ages depending on their distance from the center. All galaxies at the same radial distance are of the same age. This Universe extends to infinity. One intriguing aspect of such a Universe is that if it extends to infinity it must be timeless. It has no unique moment of creation, but exists from antiquity to eternity.

4.4 Cosmic Acceleration

The dominant and prevalent wisdom in current cosmology holds that the Universe is undergoing an accelerated expansion. That is to say, the Universe is expanding at an ever increasing rate. This conclusion has been drawn from the 1998−9 observations made by Riess et al. (1998) and Perlmutter et al. (1999) of distant supernovae which when placed on the Hubble diagram *i.e.* a diagram of their recessional velocity against their distance from our own galaxy, their position lies off the main Hubble slope. From Einstein's General Theory *of* Relativity (GTR), the only way to explain such as occurrence is if the Universe is undergoing an accelerated expansion.

From the equation, one can show that if the Universe rotates *i.e.* ($\omega_\theta = \dot{\theta} \neq 0$), then, clearly, from cosine formula, $D_{ij}^2(t) = R_i^2(t) + R_j^2(t) - 2R_i(t)R_j(t)\cos\theta$, one can show that the emergent Hubble equation is $\dot{D}_{ij}(t) = H_{ij}^* D_{ij}(t)$, where:

$$H_{ij}^{*} = H_0 + \overbrace{2\left(\frac{R_i(t)}{D_{ij}(t)}\right)\omega_\theta|\sin\theta|}^{\textbf{Scatter Term}}. \tag{4.3}$$

The extra-term in (4.3) will certainly lead to a scatter *i.e.*, to a scenario where points on the Hubble diagram depart from the Hubble slope for those galaxies that are further away *i.e.* $R_i(t)/D_i(t) \ggg 1$. It is clear from this that one can explain this occurrence of the scatter at larger distance on the Hubble diagram not as a result of the Universe undergoing an accelerated expansion but simple a Universe that is undergoing some homologous differential rotation. From the logic of the present ideas, if $R_i(t)/D_i(t) \ggg 1$, then, we must have for such galaxies that $[\Delta\alpha_0(t) < 0]$ because these galaxies exist in out outer Universe. This certainly is an important prediction that puts the presented theory on the falsification platform. We are of the view that the above presented set of ideas is a viable alternative view and must be explored further than has been conducted here.

5 New Extra Electrodynamic Equations

Our current understanding of Electrodynamics is that this phenomenon (Electrodynamics) is a long range phenomenon and is exactly described by Maxwell's equations. A closer look at the ideas generated here reveals that it may very well be possible that at smaller scales, Maxwell's equation may take a different form. Just as we have shown that there may exists three electrical potentials, there exists corresponding three magnetic vector potentials associated with these electrical potentials. To see this, we have to inspect the space components (2.3).

$$\Box A_k = \mu_0 J_k, \quad (k = 1, 2, 3). \tag{5.1}$$

Under the same philosophy as that used in the theory leading a time varying FSC, we consider the empty space solution of (5.1). We assume separability in $A_k(r,t)$ *i.e.* $A_k(r,t) = A_k(r)\chi_k(t)$, where as in (3.2) we obtain:

$$\frac{\nabla^2 A_k(r)}{A_k(r)} = \frac{1}{\chi_k(t)}\frac{1}{c^2}\frac{\partial^2\chi_k(t)}{\partial t^2} = \mu^2. \tag{5.2}$$

Clearly, from this, it is easy to see that for every component of $\Phi_{\mathrm{e}}^{(a)}(r,t)$, there will exist a corresponding magnetic vector component $\boldsymbol{A}^{(a)} = (A_k^{(a)} : a = 0, 1, 2)$ each corresponding to the scenarios $(\mu^2 = 0)$, $(\mu^2 > 0)$ and $(\mu^2 < 0)$, respectively. What this means is that we will have three magnetic vector potentials, $A_\mu^{(a)}$. Consequently, there will be three versions of Maxwell's equations, *i.e.*:

$$\partial^\mu F_{\mu\nu}^{(a)} = \mu_0 J_\nu^{(a)}, \tag{5.3}$$

$$F_{\mu\nu,\lambda}^{(a)} + F_{\lambda\mu,\nu}^{(a)} + F_{\nu\lambda,\mu}^{(a)} = 0, \tag{5.4}$$

where $F_{\mu\nu}^{(a)} = \partial_\mu A_\nu^{(a)} - \partial_\nu A_\mu^{(a)}$.

As demonstrated in the reading Nyambuya (2012), one can show that in addition to the three electrical potentials, the exists two more natural solutions to the equations (3.2) and (5.2), the meaning of which is that the index-a would have to run from 0 to 4. We have avoided presenting these extra two solutions because we do not want to digress but to stick to the main thrust of the present reading – which is the time variation of the FSC. In the said reading Nyambuya (2012), we used a similar equation to justify why the Newtonian gravitational constant G must vary with time and that there must exist four more components to the gravitational potential. When applied to the gravitational phenomenon, one of the two extra solutions can explain the logarithmic placement of planets and the other can qualitatively explain in-conjunction with the Yukawa term, the Pioneer Anomaly. We believe these equations need to be explored must deeper than has been conducted.

6 General Discussion

If one accepts the simple thesis presented herein of how classical Maxwellian Electrodynamics surprisingly accounts for the variation of the FSC, then, they will agree that there is nothing controversial about John Webb *et al.* Webb et al. (1999, 2001, 2011), Murphy *et al.*; Murphy et al. (2001,3, 2009) and King *et al.* King et al. (2012)'s observations but that there is everything interesting about these observational findings. Amongst others, these important observational findings present us with the most revealing evidence yet that the *Cosmological Principle* may not hold on larger scales but only on smaller scales and as-well, they present us with the most convincing piece of evidence yet, that the supposed creation of matter at instant as purported by the widely accepted BBC-model may not be the case.

6.1 BBC and the Creation of Matter

The creation of matter may very well be a continuous and on-going process, especially if t_0 is to be found to be large, say as large as the inverse of the Hubble parameter. Actually, for as long as $(t_0 > 0)$ (as is the case), then, the creation of matter at an instant does and can not hold. It is from this fact that a $(t_0 > 0)$ leads to matter not being created at an instant that one asks themselves the perdurable question:

If matter is created not at an instant,
what would cause a stoppage in its continuous creation?

In reality, there really appears to be nothing to cause a stoppage, thus leading to the interesting idea of a continuous eternal processes of creation of matter where the Law *of* Conservation of mass and energy is expected to be upheld. The creation of matter at an instant may allow us (physicists) to solve the problems currently faced by the BBC-model in its bare form *i.e.*, problems that have required the inflationary cosmology model to resolve – in which process the BBC-model emerges as an acceptable model.

6.2 Cosmological Principle

What we found out is that encoded in $\alpha_0(t)$ may very well be information of the age of that particular Proton and or Electron and this information allows us to measure the difference in the age for any two pieces of Electrons (or Protons). The non-uniformity of $\Delta\alpha_0(t)/\alpha_0(t)$ implies the physics taking place in different parts of the Universe is different and the FSC significantly governs most of the physics chemical and nuclear reactions. In this way, the seemingly sacrosanct Cosmological Principle which holds the Universe to be homogeneous and isotropic may not hold.

Yes, the Universe may be homogeneous but not isotropic because different places will have different physics in operation. While the Laws *of* Physics *i.e.*, the equations governing the behaviour of matter, energy, space and time all have the same form, the constants in these equations will be different, leading to different physics altogether. For example, the transition lines of the hydrogen atom in a region with a different value for the FSC will not be the same. This brings to mind the issue of the $2.73\,^{\circ}$K background radiation. Since the FSC is different at different portions of the Universe, will everyone everywhere in the Universe measure this radiation to have the same temperature $2.73\,^{\circ}$K? We ask.

6.3 Quasar Redshift Controversy

A potential use of the ideas presented herein would be in the resolution of the so-called Quasar Redshift Controversy, that is on the issue of whether or not the redshift of Quasars is of a cosmological nature (cf., Tang & Zhang 2005, Bell & McDiarmid 2006, Bell 2007, Ratcliffe 2010, López-Corredoira 2011). In the May 1967 issue of the Astrophysical Journal, Prof. Halton Christian Arp (1927 – 2013) identified a number of instances in which the data available from observations indicated, in his opinion, that pairs of objects-radio galaxies or quasars had been ejected in opposite directions as a result of explosive events taking place in large central galaxies Arp (1967*b*). Prof. Arp went on the identify a number of Quasar-Galaxies association Arp (1967*a*, 1981). If Prof. Arp's hypothesis is correct, it would mean that quasars are not at the cosmological distances *i.e.*, at distance that correspond to their full redshifts, but are at ordinary galactic distances. Prof. Arp's hypothesis has received support from a significant number of astrophysicists (see *e.g.*, Bell & McDiarmid 2006, Karlsson 1977), but the majority of his colleagues in the astronomical profession have preferred that Quasars are at their cosmological distance Tang & Zhang (2005) and this is so largely because any departure from the standard redshift distance relation raises a very awkward question as to the nature and origin of the excess redshift and possible a need to rethink the BBC-model.

If Prof. Arp is right on his hypothesis of Quasar-Galaxy associations, then, these Quasars must be of the same cosmic age as the associated galaxies since their material originates from the same galaxy. According to (3.23), it follows that the values of the variation of the FSC for the Quasar $[\Delta\alpha_0(t)/\alpha_0(t)]_{\rm QSO}$ and that of the associated galaxy $[\Delta\alpha_0(t)/\alpha_0(t)]_{\rm Gal}$ must be comparable (they must exhibit a strong correlation somehow) and at best, these values ($[\Delta\alpha_0(t)/\alpha_0(t)]_{\rm QSO}$ and $[\Delta\alpha_0(t)/\alpha_0(t)]_{\rm Gal}$) must be such that:

$$\frac{[\Delta\alpha_0(t)/\alpha_0(t)]_{\rm QSO}}{[\Delta\alpha_0(t)/\alpha_0(t)]_{\rm Gal}} = 1. \tag{6.1}$$

Therefore – if the present ideas of the variation of the FSC prove fruitful, then, we here have a decisive method to potentially resolve the Quasar-Galaxy association hypothesis of Prof. Arp. If correct, this method will certainly resolve the controversial issue of the distances Quasars – are they or are they not at their cosmological distance?

6.4 Steady State Cosmology

The ECC-model here proposed has similar features to the *now-thought-to-be* obsolete Steady-State Cosmology (SSC) which was first put forward by Sir James Jeans (1877 – 1946), in the 1920's and revised in 1948 by Hermann Bondi (1919 – 2005), Thomas Gold (1920 – 2004) and Fred Hoyle (1915 – 2001). Sir Fred Hoyle is best remembered for being the last and foremost advocate of the SSC-model. In later year, Sir Fred Holye *et al.* revised the SSC into a new cosmology model known as the Quasi-SSC (QSSC) (Hoyle et al. 1993, 1994, 1995). In the QSSC-model the Universe is always expanding but maintaining a constant average density of matter and in this Universe, matter is being continuously created throughout the Universe to form new stars and galaxies at the same rate that old ones become unobservable as a consequence of their increasing distance and velocity of recession. A QSSC-model, like the ECC-model has no beginning or end in time; and from any point within the SSC-model.

Unlike in the QSSC-model, in the ECC-model, matter is continuously created only at the center where all the forces of *Nature* start off with their greatest strength, thus, this region is expected to be hot as is supposed by the BBC-model. As the matter zooms out, the strength of the forces of *Nature* decreases, in which process this matter is expected to cool in the process. This once again brings to mind the issue of the $2.73\,^{\circ}$K background radiation. Yes, this radiation strongly appears to be coming equally from all directions and exhibits a blackbody spectrum. Since the FSC is different at different portions of the Universe, is this radiation measured to have the same temperature at different locations of the Universe? Is this $2.73\,^{\circ}$K background radiation not local in nature and not global as currently assumed? The answer to his question becomes more urgent if one take into account the spatial variation of the FSC which tells us that physics will be different for different regions of space. We make no attempts to answer these question but mere bring them up to demonstrate the urgency of the matters at hand.

6.5 Anthropic Principle

On the issue of the *Anthropic Principle*, we have two versions, the *Weak Anthropic Principle* (WAP) which holds that the Laws *of* Nature must be fine tuned so that the Universe as a whole is compatible with conscious life such as human-beings; and we have the *Strong Anthropic Principle* (SAP) which holds that the Universe is compelled, in some sense, for conscious life to eventually emerge, the meaning of which is that the fundamental physical constants, such the FSC, are so fine tuned to achieve this end.

The case of the SAP, if intelligent life can only evolve *if and only if* $1/\alpha_0(t) \sim 137$, then, as the WAP holds, we exist in that privileged region of the Universe where intelligent can only evolve. The SAP will have to be modified because not only is the Universe such that it must have those properties which allow life to develop within it at some stage in its history, but it has this property forever, however, only a certain section of the Universe allows for this. As our galaxy slides out of this region, life in our galaxy will come to a halt, but behind us, we shall live galaxies where life is possible.

6.6 Further Remarks

The reader must surely forgive us for presenting the ECC-model in its premature form. We are working on this model and we realise that it would take sometime before it is ready as a fully-fledged self-consistent cosmological model which is expected to be published as a monograph. What we merely present in the present reading is this issue of the variation of the FSC. We feel one can not wait until the ECC-model is complete while an historic and important debate on what is causing the FSC to vary, is on-going. In the meantime, researchers need to solve this issue how the FSC can vary and it is this that we have presented as our present contribution to this on-going debate. We believe the theory of the variation of FSC here presented is credible and acceptable. What may be queried is the resulting interpretation of the emergent cosmological model.

Finally and in-closing, kindly allow us to say that, we are very much aware of the fact that the ideas presented in the present reading may prove to be controversial, that they may forthwith be rejected at face value and this is so, especially, given the occurrence that these ideas seem to rail against a central tenet of a dominate and widely accepted cosmological model – *i.e.*, the BBC-model. It is, and, never is it our intention, to bring about controversies, but merely to present scientific findings as they are revealed unto us. In the present case, we have not brought in any exotic nor new ideas out of the provinces of accepted physics but merely used the power of logic within framework of what is already universally accepted, in-which process we un-earthed surprising – *if not shocking* – facts. Because of this, what we hope this reading will simply be understood as having tried to achieve an acceptable theory of the variation of the fundamental physical constants, which in the present case is the FSC. The cosmology that we have suggested is something that flows from the logic thereof. This, the reader may dispute and may be at variance with us – *but* – not the fact the classical Maxwellian Electrodynamics implies a time varying FSC.

7 Conclusion

Assuming the acceptability of the thesis presented herein, we hereby make the following conclusion:

1. Maxwellian electrodynamics allows for the existence of a time variable FSC. In addition to the well known Coulomb potential, there exists at least two electrical potential that are expected to act a must shorter distances and these potential have their FSCs *i.e.* $\alpha_1(t\,) = e^2/4\pi\varepsilon_1(t)$ and $\alpha_2(t) = e^2/4\pi\varepsilon_2(t)$ respectively.

2. All the laboratory measurements which have consistently yielded a null result are well explained in the present theory as one would expect that the material making up a galaxy would at least be created almost instantly. For all matter created at an instant we would expect – from the present theory of a time varying FSC; a null result in $\Delta\alpha_0(t)/\alpha_0(t)$, this explains why laboratory measurements have consistently yielded a null result for $\Delta\alpha_0(t)/\alpha_0(t)$.

3. Quasar light coming from galaxies for which $[\Delta\alpha_0(t)/\alpha_0(t) > 0]$, is light coming galaxies that where created after our own galaxy was created and these galaxies reside in the inner Universe and on the same footing, Quasar light coming from galaxies for which $[\Delta\alpha_0(t)/\alpha_0(t) < 0]$, is light coming galaxies that where created before our own galaxy was created and this galaxies reside in the outer Universe.

4. The interpretation given here of a variable FSC when combined with the spatial variation of the FSC as observed by John Webb et al. (1999, 2001, 2011), Murphy et al. (2001,3), King et al. (2012), all but point to the conclusion that seemingly sacrosanct *Cosmological Principle* may not hold on global scales but maybe only locally in the immediate neighbourhood.

5. The *Anthropic Principle* may find impetus in that the the region of space that we exist in the Universe may very well be the only region that would allow for the existence of intelligent life if and only if intelligent life requires that $1/\alpha_0(t) \sim 137.035999074$.

8 Additional Thoughts

Assuming the acceptability of the thesis presented herein, we hereby make the following recommendations:

1. There is need to fully explore an eternal cosmology model as one suggested herein. For example we have shown that this model can explain the spatial variation of the FSC and that evidence of the accelerated expansion of the Universe may actually be evidence for its rotation. More importantly, we have found that matter may not have been created at an instant. Where does this leave the leading cosmological model – the BBC? How can this Eternal Creation Cosmology be made to be consistent with all cosmological observations made to date.

2. There is need to fully explore the Maxwellian electrodynamic equations emerging from the extra-components that we have generated herein. We are certain that these new potentials hold some surprises that may explain some current mysteries and anomalies. While we can not give details here, we would like to explore the Yukawa electrical potential for a possible source of energy that may power stars *via* neutron emission.

3. There is need for much more refined observations to settle the issue of whether or not the FSC is variable as present observations seem to indicate. From a theoretical standpoint, we have here shown that there is no problem with a time varying FSC as this is well with the domains of classical Maxwellian Electrodynamics.

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