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Reviewing Friedmann Equation and Inflation Theory by Sub Quantum Energy

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Abstract:

Our interpretation and understanding of the universe is dependent on the accepted theories. When a theory reaches unanswered questions, it will need to develop, like the Big Bang theory that developed by inflation.

In recent years, important aspects of inflationary cosmology have been borne out empirically. But the fields responsible for inflation cannot be Standard Model ones [1]. Also the big bang cannot be described using any known equations of physics until 10^{-6} seconds had elapsed. In this paper three things are done.

1- According to reconsidering relativistic Newton's second law, the Big Bang is explained.
2- Regarding the sub quantum energy, the Friedmann equation is reviewed.

3- Using the sub quantum energy form of Friedmann equation, the inflationary Big Bang theory is reviewed.

Keyword: sub quantum energy, graviton, photon, relativity, Friedmann equation, cosmology, Big Bang, inflation, Einstein equation, quantum mechanics, Singularity

1 Quantum Cosmology

Cosmology attempts to describe the behavior of the entire universe using these physical laws. In applying these laws to the universe one immediately encounters a problem. What is the initial state that the laws should be applied to? In practice, cosmologists tend to work backwards by using the observed properties of the universe now to understand what it was like at earlier times. This approach has proved very successful. However it has led cosmologists back to the question of the initial conditions.

Inflation theory is now accepted as the standard explanation of several cosmological problems. In order for inflation to have occurred, the universe must have been formed containing some matter in a highly excited state. Inflationary theory does not address the question of why this matter was in such an excited state.

Answering this demands a theory of the pre-inflationary initial conditions. There are two serious candidates for such a theory. The first, proposed by Andrei Linde of Stanford University, is called chaotic inflation. According to chaotic inflation, the universe starts off in a completely random state. In some regions matter will be more energetic than in others and inflation could ensue, producing the observable universe.

The second contender for a theory of initial conditions is quantum cosmology, the application of quantum theory to the entire universe. At first this sounds absurd because typically large systems (such as the universe) obey classical, not quantum, laws. Einstein's theory of general relativity is a classical theory that accurately describes the evolution of the universe from the first fraction of a second of its existence to now. However it is known that general relativity is inconsistent with the principles of quantum theory and is therefore not an appropriate description of physical processes that occur at very small length scales or over very short times. To describe such processes one requires a theory of quantum gravity.

Thus this paper, from a new approach, turns out to merge the fundamental principles of quantum physics, relativity and classical mechanics through a new definition of quiescent state of particles like photon, and attempts to present the reasons and the possibilities of the existence of the superluminal speeds. So according to this new view some complex concepts and unanswered questions of the timescale universe creation that we will explain in following sections.

2 Cosmological models of the universe

A static universe, is a cosmological model in which the universe is both spatially infinite and temporally infinite, and space is neither expanding nor contracting. Such a universe does not have spatial curvature; that is to say that it is 'flat'. A static infinite universe was first proposed by

Giordano Bruno [2]. In contrast to this model, Albert Einstein proposed a temporally infinite but spatially finite model as his preferred cosmology in 1917, in his paper Cosmological Considerations in the General Theory of Relativity. Einstein wrote in his 1931 paper [3];

"In my original investigation, I proceeded from the following assumptions:

1. All locations in the universe are equivalent; in particular the locally averaged density of stellar matter should therefore be the same everywhere.

2. Spatial structure and density should be constant over time.

At that time, I showed that both assumptions can be accounted for with a non-zero mean density ρ, if the so-called cosmological term is introduced into the field equations of the general theory of relativity such that these read:

$$\left(R_{ik} - \frac{1}{2} g_{ik} R\right) + \Lambda g_{ik} = -kT_{ik} \qquad (1)$$

These equations can be satisfied by a spatially spherical static world of radius $P = \sqrt{2/\kappa\rho}$ *where* ρ *is the (pressure-free) mean density of matter".*

He then points out that Hubble's observations may have rendered the assumption of a static universe invalid and asks whether relativity can account for the new findings: *"Now that it has become clear from Hubbel's* [sic] *results that the extra-galactic nebulae are uniformly distributed throughout space and are in dilatory motion (at least if their systematic redshifts are to be interpreted as Doppler effects), assumption (2) concerning the static nature of space has no longer any justification and the question arises as to whether the general theory of relativity can account for these findings."* [3].

The Einstein cosmological equation may be written in the form:

$$R_{\mu v} - \frac{1}{2} g_{\mu v} R + g_{\mu v} \Lambda = \frac{8\pi G}{c^4} T_{\mu v} \qquad (2)$$

Where $R_{\mu v}$ is the Ricci curvature tensor, R is the scalar curvature, $g_{\mu v}$ is the metric tensor, Λ is the cosmological constant, G is Newton's gravitational constant, c is the speed of light in vacuum, and $T_{\mu v}$ is the stress–energy tensor.

Einstein's static universe is closed and contains uniform dust and a positive cosmological constant with value precisely $\Lambda_E = 4\pi G\rho/c^2$, where ρ is the energy density of the matter in the universe and c is the speed of light. The radius of curvature of space of the Einstein universe is equal to:

$$R_E = \frac{c}{\sqrt{4\pi G\rho}} \qquad (3)$$

Now let's review the Friedmann equations which is in the heart of the standard model of cosmology. We will deal with the original equation;

$$\left(H^2 - \frac{8}{3}\pi G\rho\right) R^2 = -kc^2 \qquad (4)$$

$$\left[\left(\frac{1}{R}\frac{dR}{dt}\right)^2 - \frac{8}{3}\pi G\rho\right] R^2 = -kc^2 \qquad (5)$$

Where $H = (\frac{1}{R})\frac{dR}{dt}$ is Hubble "constant", G is the gravitational constant , ρ is the universe mass density , c the speed of light and the parameter k is 0 , +1 or -1 . One can write $\rho = \rho_0(R_0/R)^3$, where ρ_0 and R_0 are the present day values of the density and radius of the universe. We should keep in mind that there is a lot of uncertainty in both values. A critical mass density is obtained from writing k=0 in relation (4) and solving;

$$\rho_{critical} = 3\left(H_{present}\right)^2/(8\pi G) \qquad (6)$$

This separates the open k= -1 from the closed universe model with k= +1. The estimates of $\rho_{critical}$ which depends on the present value of H, give 10^{-30} *gram cm*$^{-3}$ or about one proton/m^3. The observed ρ is about 10% of the critical value.

The Einstein universe is one of Friedmann's solutions to Einstein's field equation for dust with density ρ, cosmological constant Λ_E, and radius of curvature R_E. It is the only non-trivial static solution to Friedmann's equations. The key idea is that the universe is expanding. Consequently, the universe was denser and hotter in the past. In particular, the Big Bang model suggests that at some moment all matter in the universe was contained in a single point, which is considered the beginning of the universe. The big bang theory does a remarkable job of describing the universe we see today. Despite its successes, the standard big bang theory was too simple to be complete. The Inflation Theory proposes a period of extremely rapid (exponential) expansion of the universe during its first few moments. It was developed around 1980 to explain several puzzles with the standard Big Bang theory, in which the universe expands relatively gradually throughout its history. Discovery of Gravity Waves from the Big Bang is the greatest evidence for the inflation theory. Discovery of Gravity Waves from the Big Bang is the greatest evidence for the inflation theory.

3 Reviewing Friedmann equation by Sub Quantum Energy (SQE)

There is a lot of ambiguity in the definition of the stress-energy tensor. The stress-energy tensor is a conserved current, and like all conserved currents it is only defined up to a total divergence. Also in special relativity the speed of light in a vacuum is the same for all observers, regardless of the motion of the light source. But in the presence of gravity the speed of light becomes relative. Contrary to special relativity, the measured speed of light in a gravitational field is not constant, but these variations depend upon the reference frame of the observer; what one observer sees as true another observer sees as false. However, the speed of light in general relativity is not constant [4, page 9]. In addition, in quantum field theory, the vacuum state is the quantum state with the lowest possible energy. The uncertainty principle requires every physical system to have a zero-point energy greater than the minimum of its classical potential well. Also under the terms of *SQE* (sub quantum energy), any space that has the gravitational effects can produce electromagnetic energy [4, page 28].

In the era of Einstein and Friedman, has not been a clear understanding of the subatomic particles and basically. Moreover, the approach of relativity toward the physical phenomena is hyper structural and explains the observations of the observer while there is little consideration to the intrinsic entity of the phenomena. The Einstein cosmological equation and Friedmann equations have used the speed of light c that have two problems:

1- The limit of speed is not c in the real space
2- The linear speed in the universe is v_{SQE} that is not constant, especially in the expanding time of big bang.

However, in last paper [4], through various arguments and investigation of some physical phenomena, it has been attempted to structure of photon and virtual photon, and relationship between photon and graviton. According the behavior of electromagnetic wave (or a single photon) in the gravitational field (blueshift) [4 page 7], gravitons convert to Sub Quantum Energy (*SQE*), *SQE*s produce negative and positive virtual, also negative and positive virtual photons combine and convert to real photon. [4, page 30]. In these processes, the gravitons or *SQE*s do not glue to each other.

In the inertial system we show v_{SQE} as the total transmission speeds rate and S_{SQE} the total non-transmission speeds rate of a *SQE*, so will always have;

$$\mathrm{v}_{SQE} + S_{SQE} = V_{SQE} \qquad (7)$$

Thus, according to the direction of external force which was affected on a particle/object, the total non-transmission speeds rate is converted to the transmission speeds or to the inverse [4 page 17].

In addition, graviton moves faster than *SQE*'s speed that is always as follows; [4 page 28]

$$|\mathrm{v}_G| > |V_{SQE}| > c \qquad (8)$$

There $|\mathrm{v}_G|$ is the total amount of graviton speed and c is the light speed.

Reviewing Friedmann Equation and Inflation Theory by Sub Quantum Energy

Now, according to the above concepts and definitions and the previous article [4], first the Friedmann equation and then the Big Bang will be reviewed.

According to the definition of the sub quantum divergence, the limit of linear speed in the universe [4 page 18] is:

$$\mathrm{v}_{SQE} = V_{SQE} \qquad (10)$$

According to the definition of an absolute black hole and singularity, the Friedmann equation (relation 5) can be written as follows [4 page 15 singularity]:

$$\left[\left(\frac{1}{R}\frac{dR}{dt}\right)^2 - \frac{8}{3}\pi G\rho\right] R^2 = -k\mathrm{v}_{SQE}^2 \qquad (11)$$

But there is $\mathrm{v}_{SQE} = 0$ and $S_{SQE} = V_{SQE}$ on the surface of absolute black hole at the moment of Big Bang [4 page 18]. So we have:

$$\left[\left(\frac{1}{R}\frac{dR}{dt}\right)^2 - \frac{8}{3}\pi G\rho\right] R^2 = 0 \qquad (12)$$

$$R^2 \neq 0 \;\Rightarrow \left(\frac{1}{R}\frac{dR}{dt}\right)^2 - \frac{8}{3}\pi G\rho = 0 \;\Rightarrow \left(\frac{1}{R}\frac{dR}{dt}\right)^2 = \frac{8}{3}\pi G\rho$$

So;

$$\frac{1}{R}\frac{dR}{dt} = \pm\sqrt{\frac{8}{3}\pi G\rho}$$

Let's ignore the minus part, so we can write:

$$\frac{dR}{R} = \sqrt{\frac{8}{3}\pi G\rho}\; dt$$

Then;

$$L_n R = \sqrt{\frac{8}{3}\pi G\rho}\; t + C\,, \qquad C \; is \; integer \; constant$$

$$R = e^{\sqrt{\frac{8}{3}\pi G\rho}\, t + C} = e^{C} e^{\sqrt{\frac{8}{3}\pi G\rho}\, t} \qquad (13)$$

For $t = 0$, it gives the initial universe radius R_0, so:

$$R_0 = e^{C}$$

So,

$$R = R_0 e^{\sqrt{\frac{8}{3}\pi G\rho}\, t} \qquad (14)$$

Equation 14 is an exponential function that shows the rapid expansion of the universe in the early moments of Big Bang. According to the Big Bang, because Newton's second law counteracts gravity, the physical laws malfunction for moments, and after passing some time the physical laws will return to their normal conditions so the gravitons combine with each other and produce *SQE*s. When the sub quantum energy appears, Friedmann equation will be valid as follows:

$$\left[\left(\frac{1}{R}\frac{dR}{dt}\right)^2 - \frac{8}{3}\pi G\rho\right] R^2 = -k\mathrm{v}_{SQE}^2 \qquad (15)$$

It is considerable that $|\mathrm{v}|$ depends to external forces that act on *SQE*s, so that $|\mathrm{v}|$ might be greater or smaller than light speed c. This view might also be a step closer to solving a major riddle in modern physics.

4 Conclusion:

Classical mechanics and relativity (special and general) describe the acceleration is an explanation of outward of phenomena regardless the properties of sub quantum scales. It should be noted that the interaction between large objects (e.g. collision of two bodies) under the action of the quantum layer (in fact sub quantum layer) done. In sub quantum level, the amount of speed is constant, in any condition and any space, and in any interaction linear momentum changes to nonlinear momentum and vice versa. According to *SQE*, we are able to show there is not a zero volume with infinite density in singularity also before the Big Bang.

So, regardless to reconsidering the relativistic Newton's second law, how can we resolve the dark energy problem?

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