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On the Salient Features of the Vethathirian Cosmology

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Abstract: In recent papers (Alagar Ramanujam et. al. 2016, 2019) a set of axioms for Space was proposed and using them, a cosmological model called the Vethathirian cosmological model was developed. This model differs significantly from both the Big Bang model and the Steady State model. In this paper, we review the Vethathirian model and derive further results. It is predicted here that the acceleration of the expansion of the universe will cease to exist after about 15.9 billion years from now and at that time the radius of the universe will be 113.5 billion light years. These numerical values are calculated here by assuming the following from the current literature (Auguste Meessen, 2017). 1) Of the total density of the universe $1/4^{th}$ is taken as matter density (ρ_m) of the universe and $3/4^{th}$ of the total density is Dark Energy density (ρ_E) and 2) The current experimental value for the Hubble constant H is taken as 24.6 x 10^{-19} per second.

Keywords: *Dark Energy, Space, Extended Hubble's Law, Expanding Universe.*

I. INTRODUCTION

It has been shown in our earlier paper (Alagar Ramanujam et. al. 2017) that our axioms proposed for Space, required a modification of the Hubble law (v = $\dot{r}$= H r where H is a constant). If r is the radius of the universe at a time t, the expression for r is (Alagar Ramanujam et. al. 2017)

$$r = r_e - (r_e - R_0) \cos (\alpha t) \quad \textbf{(1)}$$

where $\alpha^2 = 4/3 \pi G \rho_m$

r_e is the radius of the universe when the acceleration of its expansion becomes zero and R_0 is the radius of the earliest universe at t = 0 when the universe started expanding. For a detailed nature of the earliest universe refer to (Alagar Ramanujam et. al.2019).

Differentiating r with respect to t, we have,

$$\dot{r} = r_e (\alpha \sin \alpha t) \quad \textbf{(2)}$$

$$\dot{r}/ r = H = [\alpha \sin (\alpha t)] / [1-\cos (\alpha t)] \quad \textbf{(3)}$$

Eqn. (3) shows that H is a function of time and not a constant as assumed by Hubble.

Here, since R_0 is infinitely small when compared to r_e, it is neglected.

Eqn. (3) is the modified Hubble's law. In the following few paragraphs we state the additional features of the Vethathirian model.

In the Vethathirian cosmological model, mass of a particle is defined in terms of its causative factors. While Higgs considered the mass of a particle as arising due to its interaction with a field which he introduced and called Higgs field, the mass of a particle in Vethathirian model, arises out of the action of Space on the particle. Hence for the particles to acquire mass, there is no need to introduce any field in an ad-hoc way. If m is the mass of a body (Alagar Ramanujam et. al. 2016, 2019)

$$m = \beta A (C – R) \quad \textbf{(4)}$$

Here β is a constant, A is the surface area of the body, C is the compressive pressure on the body due to Space and R is the Outward radiation pressure from the surface of the body. A (C – R) represents the net grip on the body given by the Space. This grip offers a resistance to a force applied on the body to move it and this resistance is interpreted as inertia or mass of the body. Since Space is everywhere, the body has massiveness wherever it is placed. While Newton said what mass does and Einstein brought out the mass – energy equivalence, Vethathirian cosmology declares **what mass is**.

Given two objects in Space, the Space surrounding the objects compresses them to move towards each other. So in Vethathirian cosmology gravity is considered as a property of Space and not a property of matter. By using this concept of gravity, the formula F = G Mm / r^2 was derived (Alagar Ramanujam et. al. 2009, 2016, 2019). This derivation is the first of its kind where the formula F = G Mm / r^2 is derived from basic axioms without a prior knowledge of Kepler's Laws of Planetary motion.(Alagar Ramanujam et.al. 2009) It may be pointed out here that Newton did not derive his gravity formula from basic axioms but only deduced them from Kepler's laws.

In Vethathirian cosmology, the density of the universe (both matter density and dark energy density put together) is not a function of time but a constant in time. In our view, the constancy of the density of the universe is maintained by a continuous net production of matter from Space. The term "net production" means the difference between the production of matter from Space and the dissolution of matter back to Space. In Vethathirian cosmology, as reflected in the axioms, Space is considered as the source of both matter and energy. As the model claims, there was no Bang but a sprouting of particles from Space. An infinitesimal portion of Space with a spin motion becomes a dust. Such dust are compressed by the Space to form a group structure which becomes a fundamental particle. The fundamental particles thus formed are compressed and combined further by Space to form various systems in the universe. As the universe continuously gets matter from Space, its volume increases so that volume and matter are in dynamic equilibrium keeping the density constant.

Space is considered here as the primordial state from where matter is produced continuously. Decades ago, Hoyle and Narlikar (Narlikar, 2002) proposed a theory called the Steady State theory and there also they considered the density of the universe to be constantly. To maintain the constancy of the density, they assumed a field called 'C-Field' from where particles are being formed. But what is significant in Vethathirian cosmology is that Space itself is considered as the source from where particles are produced.

Space becoming material particles has been discussed by various authors in the current literature, naming the process by different words such as Space-Time disintegration (Pranav Sharma, 2015), Space-Time Quantisation (Auguste Meessen, 2017) and Quantum Fluctuations (John Wheeler, 1987). To quote Pranav Sharma "We understand space-time as a physical entity, considered as the playground of all physical phenomenon. When talking about disintegration of space-time we assume it to follow laws of quantum mechanics and a quantized entity having a lowest possible value, should exist in whose integral multiples, should multiply forming different dimensional structures" (Pranav Sharma, 2015).

II. ACCELERATEDEXPANSIONOFTHEUNIVERSE

The accelerated expansion of the boundary of the universe was discovered in 1998, when two independent projects, the Supernova Cosmology Project and the High-Z Supernova Search Team simultaneously obtained results suggesting an acceleration in the expansion of the universe by using distant type Ia Supernovae as standard candles. The discovery was unexpected for the cosmologists who were expecting a deceleration in the expansion of the universe because of the Newtonian attraction between any two components of the universe. Three members of these two groups (Saul Perlmutter, Brian P. Schmidt and Adam G. Riess) have subsequently been awarded Nobel Prize for their discovery. The source of the force that drives the boundary of the universe away with an acceleration has not received enough attention both in the Big Bang and in the Steady State models.

In the absence of a plausible explanation, the force driving the boundary of the universe away is now being called Dark Force (or Dark Energy) (Turner, 1999; Yadav, 2016; Sha et. al. 2017; Riess et. al. 1998; Shibli, 2007). The cosmologist Michael Turner coined the term "Dark Energy" in 1998, and stated in 2002 that it is "the causative agent of the current epoch of accelerating expansion". The big challenge for the cosmologists today is making sense of the term Dark Energy. An astrophysicist Jamie Farnes of Oxford University remarks that "We are at a point where our best theories seem to be breaking. We clearly need a breakthrough idea. There is something key we are missing about how the universe is working".

Determining the nature and properties of dark energy poses a great challenge to present day cosmologists. In Vethathirian cosmology (Alagar Ramanujam et. al. 2019), the source of the Dark Energy has been extensively dealt with.

III. CERTAIN PARAMETERS OF THE UNIVERSE

The kinematics of the universe is governed by the cosmological equation (Alagar Ramanujam et. al. 2019)

$$\ddot{r} = -4/3\,\pi\,G\,\rho_m\,r + 1/3\,\rho_m\,c^2 + \rho_E\,c^2 \quad \text{..........................}\textbf{(5)}$$

This equation shows that the acceleration goes on decreasing and will become zero for a particular value of r.

The acceleration will become zero when $4/3\,\pi\,G\,\rho_m\,r = 1/3\rho_m c^2 + \rho_E c^2$

If r_e is the radius of the universe when the acceleration is zero then

$$r_e = (1/3\,\rho_m\,c^2 + \rho_E\,c^2)/\,4/3\,\pi\,G$$

If $\rho(\rho_m+\rho_E)$ is the density of the universe, following the current opinion among the cosmologists, ρ_m is taken as $\rho/4$ and ρ_E is taken as $3\rho/4$. From these relations r_e is calculated as

$$r_e = 113.5 \text{ billion light years}$$

From eqn. (3) we have

$$\dot{r}/r = H = (\alpha \sin(\alpha t))/(1 - \cos(\alpha t))$$

Taking from the available literature the current radius of the universe as 46.5 billion light years and the current value of H as 24.6×10^{-19}, the value of α can be calculated from the above formula. The value of $\alpha = 12.55 \times 10^{-19}$.

From the value of α, ρ is calculated as 2.2546×10^{-26} kg/m^3. The age of the universe when the acceleration becomes zero can be calculated from the eqn. (1),

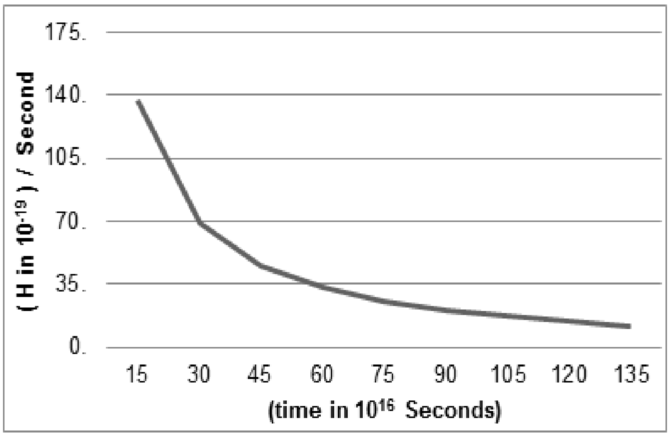
$$r = r_e - (r_e - R_0)\cos(\alpha t)$$

As the radius R_0 of the earliest universe is so small when compared to r_e, we neglect R_0 in our calculation. Replacing r in the above equation by the value of r_e (113.5billion light years), the corresponding t is calculated as 39.7 billion years. Thus, the accelerating phase of the universe will continue till the age of the universe becomes 39.7 billion years. Thereafter the universe will continue to expand with a velocity attained at that time. However, that expansion will be opposed by the compressive pressure represented by the negative term in the R.H.S. of eqn. (1) which now dominates the outward pressure.

We have from eqn. (3),

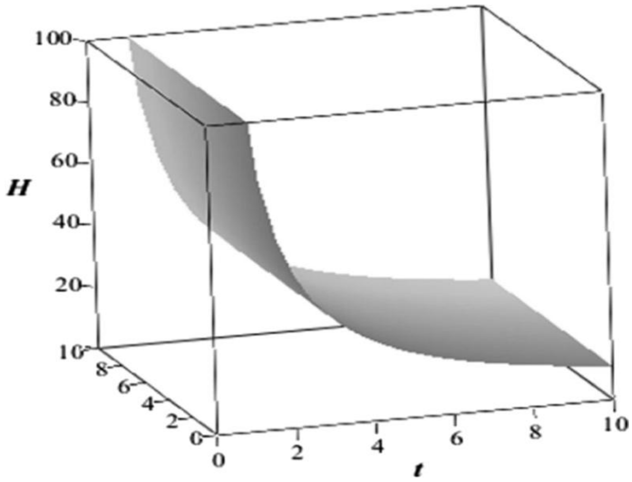
$$H = \dot{r}/r = (\alpha \sin(\alpha t))/(1 - \cos(\alpha t))$$

A graph between H and t as given below shows that the value of H steadily decreases with time t.



(Fig-1)

According to our expression for the Hubble factor H given in eqn.(3), H goes on decreasing with time . Our graph agrees fairly well with a similar graph (Fig-2) obtained by Mishra and Vadrevu (Mishra et. al. 2017).



(Fig-2)

The Hubble factor H goes on decreasing with time. The current value of the Hubble factor is about 24.6 x 10^{-19}. Using this value in eqn. (3) and the α value as 12.55 x 10^{-19}, the current age of the universe is calculated as 23.8 billion years. According to the Big Bang model the age of the universe is 13.77 billion years.

IV. MICROWAVE BACKGROUND

We discuss in this section a significant prediction of the Vethathirian cosmology in connection with the microwave background.

The discovery of the microwave background in 1965 by Penzias and Wilson was a milestone in the study of cosmology. It was considered as a great support to the Big Bang theory. We show in this section that it is not necessary to take the discovery of microwave background as a support to Big Bang theory.

Around 1948, it was generally thought that the temperature at the time of the Big Bang was extremely high and in the course of time as the universe expanded the temperature should have gone on decreasing to a very low value at present. To quote Narlikar : "….in the standard 'relic' interpretation of this background, its present-day temperature cannot be estimated at all. Although Alpher and Hermann (1948) had a good guess at it by proposing 5 K, in their 1948 paper, Gamow himself gave various estimates (all guesses) ranging from 7K to 50 K".

As stated above, Gamow (1948) predicted the present-day background temperature of the universe as 50 K. However, his students Alpher and Hermann (1948) predicted a value of 5K as the base temperature of the universe.

We show here that the base temperature of the universe need not be a remnant of the initial high temperature. We use Stefan-Boltzmann law which connects the density of the body and its temperature. Since the value of the density of the universe is available, we can calculate the base temperature of the universe. We have Stefan-Boltzmann law for a black body,

$$E = \sigma T^4 \quad \text{.................}\mathbf{(6)}$$

where E is the energy in Joule radiated from per unit area of the body per unit time and σ is the Stefan-Boltzmann constant. Since

$$\rho = (\rho_m + \rho_E) = 2.2544 \times 10^{-26} \text{ kg/m}^3$$

$$\text{and } \sigma = 5.6703 \times 10^{-8} \text{ W}\cdot\text{m}^{-2}\cdot\text{K}^{-4}$$

$$E = \rho c^2 = \sigma T^4$$

$$T^4 = (2.2544 \times 10^{-26} \text{x } 9 \text{ x } 10^{16}) / (5.6703 \text{ x } 10^{-8})$$

$$T = 0.4349 \text{ K}$$

Thus Vethathirian cosmology predicts a background temperature of about 0.4349 K.

It is surprising and gratifying to note that the actual experimental value of the base temperature (the Microwave background) of the universe 2.78K is closer to our prediction than to the values predicted by Gamow and other authors.

V. VETHATHIRIAN COSMOLOGY IN CURVED SPACE

Let us remind that the Vethathirian cosmology is characterised by the following aspects,

1. It is a fact before us that the universe contains matter and radiation. This fact should motivate us to ask the question : Where it all come from?The aim of our work is to find a logical answer for this question. As a first step towards answering the above question, we framed the axioms for Space.

2. Following the 'Perfect Cosmological Principle' (PCP) advanced by Bondi and Gold (Herman Bondi et. al. 1948) the density of the universe is considered constant in time.

3. Space is considered as a source of energy from which the universe evolves. Whatever energy is lost by Space is gained by the universe. Thus the conservation of energy is maintained.

Our discussion so far concerning the various dynamical aspects of the universe was mainly Newtonian. In this section we consider Vethathirian cosmology in curved Space. For this purpose we make use of Einstein tensor and Robertson-Walker metric. Using them we write

$$[\, R_{\mu\nu} - (1/2)\, R g_{\mu\nu} \,] = A_{\mu\nu} = (K/M)\, U_\mu U_\nu \quad \text{........................}\mathbf{(7)}$$

$R_{\mu\nu}$ is the Ricci tensor, R is scalar curvature and $g_{\mu\nu}$ is the Robertson-Walker Metric tensor. On the R.H.S., K is a constant, M is the Mass of the Universe and U_μ is the four velocity of a galaxy. $A_{\mu\nu}$ is our new energy-momentum tensor. $u^\mu = (1,0,0,0)$. The values for $g_{\mu\nu}$ are given by the metric,

$$dS^2 = c^2\, dt^2 - S^2(t)\, [dr^2 / (1-kr^2) + r^2 (d\theta^2 + \sin^2\theta\, d\Phi^2)]$$

In the eqn.(7) , the zero- divergence of the left hand side is a well established fact. The zero- divergence of $A_{\mu\nu}$ follows from the relation $u^\mu = (1,0,0,0)$ and $M = 4/3\pi S^3\rho$. The various cosmological models that the eqn.(7) leads to remains to be investigated and the results will be published elsewhere.

DISCUSSION

When Einstein talked of the curvature of Space about hundred years ago, he became the first to give a dynamical role for Space. "Matter acts on Space and curves it", he declared. Apart from the property of being curved by the presence of matter, Einstein did not attribute any other dynamical properties to Space. In sharp contrast to this, the first axiom in Vethathirian cosmology gives an enormous role for Space and talks of the potential energy inherent in Space and its properties.

Our explanation for the Dark Energy is the following. As discussed in our reference (Alagar Ramanujam et. al. 2019), infinitely small localized rotations occur all over Space. These localized rotations in Space with the spin motion are considered as dust. Due to the surrounding compression, these dust are forced into discrete groups known as "Fundamental particles". Here the remark of Gregory Ryskin (Gregory, 2015) is very meaningful. According to him; "On the Cosmological level, Space-Time and matter are not separable, but form a single entity". Since every dust is spinning, fundamental particles also have spin (Alagar Ramanujam et. al. 2016, 2019). Due to the continuous compressive force and the spin of the particle, dust are being gradually squeezed out of the particle. These thrown out dust produce ripples in Space which finally go to push the boundary of the universe away. These ripples in Space-time emanating from every fundamental particle constitute what we call Dark Force or Dark Energy. In this connection, we agree with the observations of Murad Shibli: "The Dark Energy is a property of the Space-Time itself".

It is gratifying that while the axioms of Newton deal with matter and the axioms of Einstein deal with light, the axioms of Vethathirian cosmology deal with the all-pervading Space which is the base for the whole universe. The origin and the functional aspect of Dark Energy driving the expansion of the universe have received a reasonable theoretical basis in Vethathirian Cosmology.

Coming to the microwave background, the Vethathirian cosmology predicts a value for the temperature of the cosmic background which is very close to the actual measured value. Numerical values have been obtained here for various dynamical parameters of the universe. When we take relativistic effects into account, the values given here for the various parameters may get a fine tuning.

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