On the Possibility of Replacing the Time in Cosmology by the Average Density of Matter

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Abstract. According to the Planck Mission, the observed universe consists of 26.8% of dark matter, 68.3% of dark energy and 4.9% of ordinary matter. We reached almost 100% of the agreement with the statement of the Planck mission by calibrating or fine-tuning a speculative equilibrium equation performed in this work. Based on our theoretical insights that were used in the construction of the average scale of matter density, the equation was solved for roots corresponding to 4.915% of the ordinary substance, 26.785% of dark matter and 68.300% of dark energy. We also developed the scale further that additionally uses the invariant properties of the roots of the equation with a sample of independent distances from the red shift of the extragalactic NASA / IPAC database (NED), which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

Keywords: *Universe Composition, Dark Matter, Red Shift, Visible Matter, Dark Energy*

1. Introduction

Contemporary cosmology is experiencing a considerable shift, as many renowned scientists are involved in revising the general relativity model of space and time [1,2]. The departure from the model accepted view of the origin of Universe is driven by the realization that the theoretical predictions based on universal gravitation laws do not correspond to observations at large scale, *i.e.*, at cosmological distances and locations. Distant parts of the universe that we can observe are on average surprisingly homogeneous and isotropic in structure, as the parameters such as density, brightness, *etc.*, are the same at all points and in all directions. According to Saul Perlmutter, Brian Schmidt and Adam Riess, cosmological observations confirm the cosmic *expansion* with acceleration[i] [3,4]. Provided the Cosmological Principle is indeed the reality, the gravitational laws, on the contrary, fail to manifest itself in the form of a shrinking universe. It should be mentioned that some researchers claimed that the observations do not seem to confirm the dynamic expansion of the universe [5, 6]. While our aim is not to challenge this view, in this work, we consider the cosmic expansion of the Universe. In fact, our initiative reveals that the expansion is manifested through the dark and observable matter undergoing a phase transition from an unknown "thermal or dark energy field" in the form of some "three-dimensional spheres/manifolds."

Hence, we hypothesize that a new matter must emerge as soon as the matter stable state has been established, since the old matter composition violates equilibrium equation or stable state criterion. Based on this premise, the previous stable state violates itself, resulting in the creation of new matter. This newly created matter—the manifold in space—on average as a whole, achieves a lower *relativistic density* μ compared to that of the previous state. This violation arises due to gravitational potential energy, or any other energy form such as latent thermal energy, induced into the manifold, providing a theoretical foundation for a stable states evolution as a dynamics of some speculative equation roots. Hence, according to this postulate, the declining density μ not only serves as an indicator of matter creation but also allows the time component of the space-time metric tensor—typically established by the t parameter—to be replaced by μ. While this is a far-reaching and highly unconventional assumption, it promotes a more diverse perspective on understanding of the dynamics of the matter and energy evolution in the Universe. In view of the aforementioned assumption, the time variable in the tensor will be omitted from all further considerations.

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By calibrating equilibrium equation, it was possible to achieve a nearly 100% agreement between the obtained percentages of the visible and dark matter[1] in their proportions to dark energy and the latest Planck Mission data [7-9]. Second, the model supported the Big Bang inflation stage. Using our theoretical foundations, we have shown that three-dimensional manifold S^3 embedded in the globe $\Re^4$ were first inflated solely by the dark matter. Third, we predicted that, after the inflation stage, as the manifold S^3 expanded, its density μ decreased, while volume-velocity accelerated. This prediction was supported by the equation, the roots of which confirm that the manifold initially expanded more slowly when the density was high. Drawing upon the previously presented thesis pertaining to the parameter μ of the matter average density, it was possible to subject NED-D distances to linear transformation into a certain interval of densities. This interval confirmed with very high degree of reliability that it is feasible to replace the time with density by establishing a match to 81 categories of distances to extragalactic objects introduced in the article published by Steer et al. [10]. We further posited a critical value of the density at which the thermal/dark energy will be exhausted. We denote this event as the origin of the density scale, i.e., the *"moment"* when the globe $\Re^4$ would allegedly collapse into "standstill" composition with critical density state. The standard cosmological □-CDM model [11], which depends on 24 parameters whose values have to be calibrated exogenously to fit the observations, supports a very high likelihood of such an event. We also confirmed some of NASA statements regarding the past evolution of the Universe.

In critical density state, the dark matter is postulated to contract, whereas visible matter will continue to expand. Superposition of dark and visible matter was previously postulated, albeit separated by cosmological distances. This stance provided theoretical basis for the two forms of matter phase transition to be taking place on opposite poles of the globe $\Re^4$.

Before we proceed with our analysis, we wish to outline the structure of this paper, which is presented in seven sections, including introduction. In Section II, we present the foundation of our geometric model, supplementing it with plausible/pedagogical exercises by describing hypothetical dark energy undergoing a phase transition into matter. In Section III, we describe a phase transition equilibrium related to the unconventional parameters Λ, λ and μ in the form of an equation. Section IV is dedicated to the matter density scale construction, which is achieved by fine-tuning or calibrating the parameters with regard to the current mass-energy composition of the Universe. In the calibration, we consolidate the roots of our equilibrium equation with the latest data pertaining to cosmological observations. It should be noted that our model confirms rather than disproves the NASA statements of Universe dynamics, which are based on the past and current observations. After providing some concluding remarks in Section VI, in Section VII, we present mathematical derivation of three-dimensional manifold S^3 that, in accordance with our initial hypothesis, are filled with matter. Finally, in the appendix, we illustrate phase transition of dark energy by presenting our stereographical projection of S^3 manifold into Euclidian space E^3.

1 The dark matter effects were first postulated via latent gravitational forces, Jan Henrik Oort, **1932**, [12]; Fritz Zwicky, **1933**, [13]; and Vera Rubin, **1970**, [14].

2. PEDAGOGICAL FOUNDATIONS

Our knowledge of the Universe is limited by the horizon of observations. This horizon is determined by the speed of light, whereby we can only observe those areas of the Universe from which the light has already reached us. Hence, we do not see the objects in their present state, but rather in the one in which they were at the time of the emission of light that has reached us at the moment of observation.

Suppose we pointed our telescope toward some portion of three-dimensional sky on which we superimposed a grid cell. By analyzing the characteristics of the light beam reaching us, we would allegedly be able to estimate the *number* of photons, electrons, and all atoms of various types of matter, including galaxies, in those particular moments when the beam was emitted. Once the process is complete, we can focus the same telescope on some other part of the sky. Assuming that the Cosmological Principle [15] is true, we can expect to obtain similar results when observing parts of the Universe at the same distance from our observation point in any direction. Such *measurements* will be particularly useful when the observations made are incompatible with Newton's dynamics—*i.e.*, the measurements made at cosmological distances. In this scenario, the key challenge is to compare the relativistic energy densities measured at nearby and faraway distances as indicators of the age dynamics of the Universe.

Such measurements may also allow events to be described in relation to others in terms of their timing. Indeed, nuclear physicists can determine the age of a material by noting the average number of atoms that have undergone radioactive decay. Using this approach, geologists can establish the age of a rock by observing unstable atoms undergoing a decay, recording the half of the atoms still present in the rock and comparing samples that have undergone the decay—referred to as radioactive half-life. Let us assume that we are able to count not only the average number of atoms undergoing the decay, but establish an exact number of atoms belonging, for example, to an Sn isotope in a rock. Let us further assume that we can do so with a high accuracy by taking into account every single atom remaining after the decay. Clearly, we cannot perform such an experiment. However, we can establish the *quasi-number* of atoms remaining after the decay as some *quasi-time* equivalent to the age of the rock under observation. By examining different parameters characterizing the rock, such as size, temperature, *etc*., we can establish the *quasi-velocity* of these parameters by noting the number of atoms that have not yet undergone decay. In the same vein by the matter density, we can establish the *quasi-age* of the Universe without recourse to the clock.

Returning to the earlier discussion on the observation of different parts of the Universe, we can also assume that the density of various particles (photons, electrons, neutrinos, galaxies, *etc*.) established through the observation of a nearby portion differs from that taken at faraway distances. We can now assert that, at nearby distances, the density in the grid cell is lower than that in the same cell when superimposed on parts of the universe at faraway distances, representing their state at some point in the past. This assumption is in line with the Hubble's law [ii] rather than it contradicts the law. Thus, we can discover the age dynamics of the Universe using *energy-densities* at these two locations, as the areas of lower density (at nearby distances) have emerged later than similar areas characterized by a greater density (at far away distances). Consequently, our aim is to emphasize that the density of matter can be chosen as an indicator of time. Such an approach permits establishing the origin of time, whereby the time point $t = 0$ is denoted by the density of matter $\mu >> 0$. Similarly, it will be possible to establish the future and the past on this scale, thus investigating the evolution of the Universe in terms of relativistic *density* instead of a time parameter.

Matter exists in four fundamental states—solid, liquid, gas and plasma—and can undergo a phase transition from one state to another. At normal atmospheric pressure, water is in solid state (ice) at temperatures below $0^{\circ}C$, whereby the liquid state symmetry transforms into crystal symmetry. In this context, it is noteworthy that a liquid can be cooled below its freezing point (known as super-cooling) without it becoming solid. Thus, when undergoing a phase transition to ice, water cooled below $0^{\circ}C$ can release latent heat [16]. The same concept can be applied to thermal energy, or whatever it is, as something super-cooled under absolute zero ($0^{\circ}K$). This line of reasoning might prompt the conclusion that, in the Universe, a phase transition of super-cooled energy field into matter occurred, releasing an extensive amount of latent heat. The matter released by transition expands; however, elsewhere at the globe surface, a latent *thermal/dark energy phase transition* might take place simultaneously.

Three-dimensional coordinates can be used to measure the ice floe linearly. Yet, the volume of water is usually expressed in liters, rather than in cubic meters, *etc*. Pedagogically speaking, for *Creatures* in the form of ice crystals, the water undergoing a phase transition is supposedly invisible, as they can neither observe nor measure phenomena pertaining to liquid matter. They can, however, feel the latent heat or matter creation effects. From the mathematical perspective, the dark, the thermal, or whatever energy form we choose to consider, can undergo a phase transition from zero to a positive measure state. Measure is a means of assigning a numerical value to every space volume that allows examining the union of volumes as a sum of their individual measures. The mass of matter is an example of such a measure.

In contemporary cosmology, as previously noted, the Universe corresponds to Cosmological Principle of a homogenous and isotropic space characterized by uniform distribution of galaxies at each point and in all directions, *etc*. The Principle acknowledges the universality of laws of physics. These laws are applicable in the Universe with the same precision because there is no point of reference (although any point within the Universe could be used for this purpose). It is pedagogically correct to recall a two-dimensional surface for flat *Creatures*, like that chosen by Einstein [17], implying that flat *Creatures* cannot imagine a three-dimensional world by walking on the flat surface of a manifold. This analogy seemingly suggests that we as three-dimensional *Creatures* "inhabit" a three-dimensional space. In this space, we are still observing a three-dimensional unbounded Euclidian space E^3, being inside of a bounded manifold $S^3(r)$ of radius r, $0 \le r \le 1$, embedded into four-dimensional closed hyper-globe $\Re^4$ of radius 1. All manifold points, according to the Cosmological Principle, are equal in all directions, without a center or a terminal point. However, our view also accounts for departures (as shown in [18]) from the Cosmological Principle, which as an absolute can never be realized in nature. Indeed, it is well known that primary anomalies in material undergoing phase transition might result in secondary anomalies following the transition phase.

In the theory of choice, topology and some branches of social science, the emphasis is on the so-called Closer Operator [19]. In this work, the operator is introduced by constant Λ in equilibrium equation to ensure matter creation dynamic. The constant Λ indicates the similar idempotent stability of expanding manifolds S^3, representing potential level Λ of the expected phase transition of the manifestation of dark energy.

To be more specific, our three-dimensional manifold of radius $r = 1$—we prefer to denote it as a closed topology, *i.e.,* a manifold S^3—comprises of a kind of dark energy that is not accessible to existing measuring instruments (akin to the *crystal creatures* not being able to use liquid measuring system in their solid world). As a result of some accident, at a given point within S^3, dark energy phase transition into a seed lump of solid matter occurs, which represents a transition of a 0-measure to a positive one. We emphasize that the lump of matter formed from potential energy field embedding the lump must preserve the stable or idempotent dynamic while undergoing rapid inflation from zero and progressing further, *like a hole expansion* within dark energy similar to the discussions presented by Linde [20a, 20b]. In short, the lump of matter has to be in a dynamic equilibrium with dark energy. The equilibrium view on matter dynamics is an alternative to □-CDM, where the manifold radius $R >> 0$ is time-dependent. In contrast, the radius $R = 1$ considered here is fixed. In making this assumption, we are not violating any mathematical foundations or attempting to challenge the postulates of rational science.

The matter creation singularity problem—the initial inflation phase [21] of the Big Bang—has, however, not yet been addressed. We argue that the singularity does not exist because our equation permits a zero solution. We thus postulate that, starting from a state described by the zero solution, the matter suddenly inflates the hole or manifold in phase transition of space from the aforementioned dark energy. According to this view, when a *"lump of matter"* emerges, it will impose an additional pressure on the previously allegedly *super cooled energy*, thereby causing an additional *inflating effect*. We further assume that this would give rise to additional matter creation, akin to an "avalanche" rolling down the hill and gaining mass (and thus weight) due to *"potential energy of super-cooled energy field."* According to our equation, the avalanche of the matter creation has to remain in a dynamically stable condition. This assumption confirms that the phase transition of dark energy into matter starts suddenly and will continue to progress if the *super-cooled energy* is of incredibly high density. In other words, once the avalanche has occurred, it will govern the matter creation inside the manifold. However, a *friable ball* cannot roll down a slope forever, as it would eventually crumble into pieces. While the snowball dynamic is just a pedagogical illustration of the matter evolution, it is useful for depicting its initial and terminal state.

A Tale of Matter Creation

Conceive a globe; say 1 m in radius and some black paint. Suppose that the black paint is a matter under creation undergoing a phase transition from some latent dark energy. Choose any point at the globe surface and draw a circle of radius r around the point, *e.g.*, encircle the point as the North Pole N. Then paint the circle inside this perimeter with black paint. Increase the radius r and draw a larger circle around the N point and once again cover the newly created area with black paint. Repeat this process until you reach the opposite side—the south S pole of the globe. The entire globe is now black.

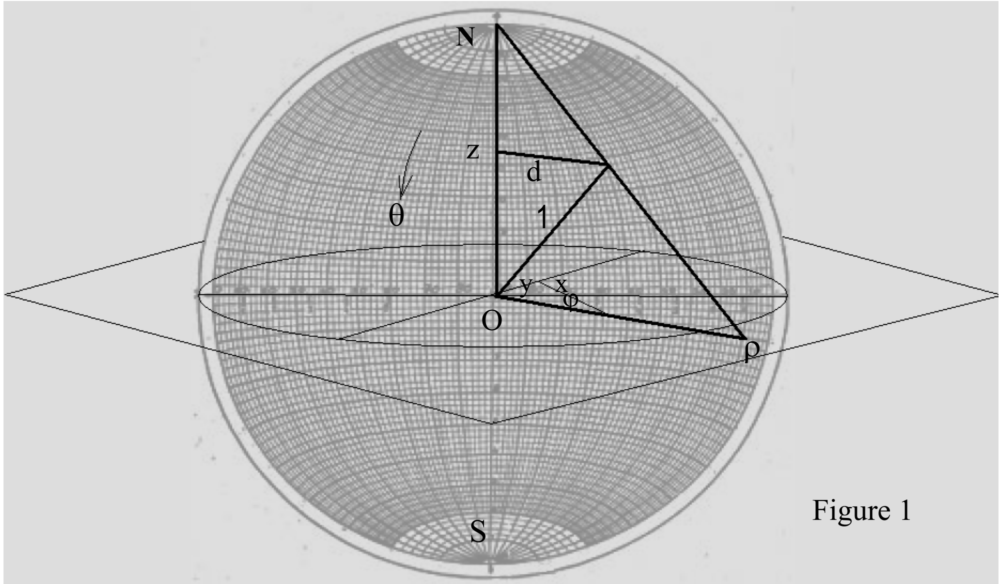


Figure 1

Unfortunately, only a few people can conceive a four-dimensional hyper-manifold. However, the aforementioned process can be applied to an S^3-dimensional manifold of the $\Re^4$ dimensional globe. Around the North Pole as a reference system center, try to envision drawing an imaginary $S^3(r)$ manifold given by polar coordinates of radius r, $0 \le r \le 1$. Our $S^3(r)$ manifold is of a fixed curvature of radius 1. Fill $S^3(r)$ with black paint—it will certainly take much more effort to fill this manifold. Proceed in similar way already described for an ordinary globe $\Re^3$ encircling point N until the whole S^3 surface of the $\Re^4$ globe is filled with black paint. Suppose that the black paint has density and that the painting process with very small radius r was triggered at the North Pole by some phenomena related to the dark energy phase transition. Assume further that the density of painting is linearly decreasing with the radius r. Moreover, suppose that outside the $S^3(r)$ manifold, the painting process on its boundary is governed by potential energy threshold level Λ like a phase transition of thermal/dark energy at freezing level $-\Lambda^{\circ}K$ [2] depending on of the whole $S^3(r)$ manifold. We posit that the potential energy of the black paint at the boundary of $S^3(r)$ manifold is proportional to the total mass M of the $S^3(r)$ but is an inverse function of the radius r. Thus, the total mass M within our $S^3(r)$ manifold will be growing on average, *i.e.,* following our supposition of painting creation at the freezing point $-\Lambda^{\circ}K$, in proportion of order higher than the radius r of encircled area. Herby, in accord with the earlier assumption that the density will linearly decrease with r, the painting process, just as matter, cannot be terminated or arrested. In other words, a hole expansion will manifest as a series of $S^3(r)$ manifolds.

[2] The author of these lines only recently discovered the article titled "On the possible nature of dark matter and dark energy" written by Rogalin V.E., which completely confirms the comprehension about the parameter Λ of the dark energy phase transition according to Equation (2); http://research-journal.org/wp-content/uploads/2015/07/6-2-37.pdf#page=14, last visited 18.07.2017.

The expansion of the hole in the form of growing $S^3(r)$ manifold is governed by the density parameter μ. We assert, nonetheless, that the matter creation will nevertheless stop at some critical density κ when the dark energy outside the $S^3(r)$ manifold is be exhausted, and the manifold S^3 filled with matter will completely enclose the globe $\Re^4$. While the aim of this exercise was to emphasize the importance of the density of the matter in the Universe, it is advisable to examine more technical details next.

We will proceed first with a very short illustration of what is well known as stereographical projection. Let the S^2 manifold geometry correspond to $x^2+y^2+z^2=1$ of radius 1. The North Pole corresponds to the point $N=(0,0,1)$, and the South Pole is denoted by $S=(0,0,-1)$. Conceive an intersection plain E^2 at the origin O perpendicular to the z-axis. We can project a line from N through $(x,y,z)\in S^2$, which will intersect the plain at a distance ρ from the origin O. Using S^2 geometry it can be verified that $d^2+z^2=1$ what yields $d^2=(1-z)(1+z)$. Now convert $\frac{d}{\rho}=\frac{1-z}{1}$ into $d^2=\rho^2(1-z)^2$. For d^2 this yields $z=\frac{-1+\rho^2}{1+\rho^2}$, $d=\frac{2\cdot\rho}{1+\rho^2}$. These latter equations correspond to a smooth mapping of S^2 triples $\left(\frac{2\cdot\rho}{1+\rho^2}\times\cos(\varphi);\frac{2\cdot\rho}{1+\rho^2}\times\sin(\varphi);\frac{-1+\rho^2}{1+\rho^2}\right)$ — a diffeomorphism/projection into E^2 coordinates $(x,y)=(\rho\sin(\varphi),\rho\cos(\varphi))$, $0\le\varphi\le 2\cdot\pi$, $0\le\rho<\infty$.

Let us finally find the metric of our stereographical projection drawn by Figure 1. The partial derivatives of the projection/diffeomorphism represent three functions of two variables. The transpose of the Jacobin matrix J is given by

$$J^T=\begin{pmatrix} 2\cdot\frac{1-\rho^2}{(1+\rho^2)^2}\times\cos(\varphi); & 2\cdot\frac{1-\rho^2}{(1+\rho^2)^2}\times\sin(\varphi); & \frac{4\cdot\rho}{(1+\rho^2)^2} \\ -\frac{2\cdot\rho}{1+\rho^2}\times\sin(\varphi); & \frac{2\cdot\rho}{1+\rho^2}\times\cos(\varphi); & 0 \end{pmatrix}.$$

Consequently, Gram Matrix as the space metric tensor $G=J^T\times J$ yields $G=\frac{4}{(1+\rho^2)^2}\begin{pmatrix}1 & 0\\ 0 & \rho^2\end{pmatrix}$ provided by Скляренко Е. Г. [22]. Herby, our S^2 stereographical projection on Figure 1 is represented by $dl^2=\frac{4}{(1+\rho^2)^2}\left(d\rho^2+\rho^2 d\varphi^2\right)$. We will refer later to distance $d=\frac{2\cdot\rho}{1+\rho^2}$ representing the inverse part of the diffeomorphism of S^2 or S^3 stereographic projections, where $d\rho^2+\rho^2 d\varphi^2$ denotes the metric in the Euclidian plain E^2.

3. Equilibrium Equation

In formulating speculations using our equilibrium equation describing the current mass-energy composition in space, our aim is to identify some stable states embedded into the four-dimensional hyper-globe $\Re^4$ of a radius 1 given by

$$x^2+y^2+z^2+r^2=1 \qquad (1)$$

as topologies among three-dimensional manifolds $S^3(r)$ of radius r, $0\le r\le 1$, $x^2+y^2+z^2\le r$.

Cosmological Speculation

Cosmological Principle is an attribute of two-dimensional surface S^2 of a three-dimensional globe $\Re^3$. In extending the Principle to the manifold S^3 enclosing a hyper-globe $\Re^4$, we preserve the same properties. Therefore, any S^3 embedded into hyper-globe $\Re^4$ corresponds to manifold, which is in accordance with the Cosmological Principle stipulating homogeneity and isotropy of the Universe. Before proceeding further with the analysis, we will present a hypothetical situation based on the assumption that the Cosmological Principle is an absolute, and thus preserves homogeneity and isotropy.

We assume that closed three-dimensional $S^3(r)$ manifold of radius r, $0 \le r \le 1$, are surrounded by dark energy within the globe $\Re^4$ of radius 1. It should be reiterated that the observer does not necessarily have to be placed at the North Pole of $\Re^4$. However, we shall adopt $(0,0,0)$ in $S^3(r)$ as the reference system origin O, while allowing the observer to be positioned at any point within the manifold $S^3(r)$. Such representation facilitates explanations of some known observational anomalies, such as supervoid areas of space, local zones with higher and lower density of matter, *etc.*, as anomalies in phase transitions of dark energy into matter.

According to Newton's laws, if a mass M of radius r hypothetically converges into a zero point O, the potential energy of a gravitational field at a distance r from O equals $-G\frac{M}{r}$, where $G = 6.67384^{-11}$ $m^3kg^{-1}s^{-2}$ is the gravitational constant. We can further hypothesize the process of phase transition, which occurs within the manifold $S^3(r)$—that is, at a distance r from some origin O. It is plausible to speculate that, at a distance r from the origin O, the dark energy phase transition takes place if the potential gravitational field intensity is strong enough—e.g., below the value of an universal constant Λ, *i.e.*, at $-G\frac{M}{r} \le -\Lambda$. The matter creation, according to our speculative thesis, is thus determined by an equilibrium equation $-G \cdot M + \Lambda \cdot r = 0$. As previously noted, once the process of matter creation begins, it cannot cease or be arrested because an increase in the mass M used in solving the equation must be of a higher order than the increase in radius r needed for the mass M to be in equilibrium stipulated by the equation solution.

In the context of relativistic potential energy, the gravitational constant G and the speed of light constant c may be omitted. Indeed, these parameters can be instead incorporated into the mass density μ, referring henceforth to mass M as mass M_{rel}. Here, with respect to the manifold, the numerical values of mass M_{rel} are of key importance. Whether we refer to it as a relativistic mass or by any other nomenclature is irrelevant for our theoretical purposes, as the gravitational constant G and speed of light c can be the built-in measuring units of the density parameter μ.

Let us now turn our attention to the relativistic potential energy level on the manifold that forms the three-dimensional vectors (x,y,z) denoting manifold S^3. In fact, these vectors represent the level of potential energy at the distance r from the centum of the manifold $S^3(r)$ of radius r. As already postulated by our speculative thesis, the matter-energy composition undergoes phase transition, which allegedly occurs on the three-dimensional manifold embedded into the four-dimensional hyper-globe denoted by $\Re^4$. Moreover, we introduce a parameter λ, allegedly representing a fine-tuning or calibrating parameter of the dark energy defined by Newton's formula. It features in the "relativistic potential energy" $-\frac{G \cdot M}{c^2 \cdot r^\lambda}$ or $-\frac{M_{rel}}{r^\lambda}$ modified, as said, as in MOND model [23]. In accordance with the Speculation on the matter-energy, transition occurs at the relativistic energy level equal to $-\Lambda$ representing some universal constant, as discussed above. Thus, the transition occurs by violating the equation $-\frac{M_{rel}(r)}{r^\lambda} + \Lambda = 0$, where $M_{rel}(r)$ corresponds to the mass M_{rel} of the manifold $S^3(r)$. This equation describes the stable set equilibrium applied to the matter-energy composition. In the subsequent analyses, we will replace M_{rel} by its mass $M_{rel} = V.S^3(r) \cdot \mu$ of a manifold $S^3(r)$ or total mass of a hole within an allegedly expanding/inflating energy field, where $V.S^3(r)$ signifies the total volume of $S^3(r)$. Note that we previously referred to the parameter μ as an average density. Hence, the product of μ and volume corresponds to M_{rel}—mass of the manifold $S^3(r)$ under inflation. The parameter μ is of purely theoretical relevance, as it can neither be observed nor measured. Consequently, the equilibrium equation might be rewritten in the form $-V.S^3(r) \cdot \mu + \Lambda \cdot r^\lambda = 0$. In Section 7, we provide mathematical derivation of the latter equation upon our hyper-spherical manifold.

In accordance with Equation (1) the surface rod dl^2 of three-dimensional manifold $S^3(r)$, $0 \le r < 1$, $0 \le \varphi \le 2\pi$, $0 \le \theta \le \pi$ yields a stereographical projection of $S^3(\rho)$ given by

$$dl^2 = \frac{4}{(1+\rho^2)^2}\left[d\rho^2 + \rho^2\left(\sin^2\theta \cdot d\varphi^2 + d\theta^2\right)\right],$$

which guarantees that the manifold is mapped into a flat E^3 topology at nearby distances like a stereographical projection of S^3 from North Pole into Euclidian space E^3. Hereby, the rod of the stereographical volume is defined by $dl^3 = \frac{8 \cdot \rho^2}{(1+\rho^2)^3} d\rho \cdot \sin(\theta) d\theta \cdot d\varphi$, $0 \le \rho < \infty$, $0 \le \varphi \le 2\pi$ and $0 \le \theta \le \pi$. Thus, $8\int_0^{2\pi}\int_0^{\pi}\int_0^{\rho} \frac{\xi^2 d\xi \cdot \sin(\theta) d\theta \cdot d\varphi}{(1+\xi^2)^3}$ represents the volume of hyper-manifold $V.S^3(\rho)$ of ρ-"radius", whereas $V.S^3(\infty) = 2\pi^2$ represents the entire hyper-manifold volume. Taking the integral into account, we obtain:

$$V.S^3(\rho) = 4\pi\left[\tan^{-1}(\rho) + \rho \cdot \frac{-1+\rho^2}{(1+\rho^2)^2}\right];$$

The volume of radius ρ of hyper-manifold $S^3(\rho)$.

Hence, with regard to the equilibrium, the equation can now be rewritten as:

$$-4\pi \cdot \left[\tan^{-1}(\rho) + \rho \cdot \frac{-1+\rho^2}{(1+\rho^2)^2}\right] \cdot \mu + \Lambda \cdot \rho^\lambda = 0 \qquad (2)$$

4. THE DENSITY SCALE CONSTRUCTION

Parameters Λ, λ and μ represent a triplet in Equation (2), where $-\Lambda$ is a mass-energy emerging energy-level that speculatively characterizes the super-cooled thermal/dark energy. Similarly, λ is a tuning or calibrating parameter for the postulated potential energy of the field itself, and μ denotes our speculative density of the manifold. By introducing the curvature of the manifold S^3 equal to 1, we have succeeded in calibrating the roots of the equation, which results in the following values for the aforementioned triplet: $\Lambda = 0.91499$, $\lambda = 0.83751$ and $\mu = 0.12457$. This parameter value set provides the best fit to the Planck Mission Statement. As previously noted, the modified potential energy $-\frac{M_{rel}}{\rho^{\lambda}}$ for $\lambda < 1$ declines more rapidly at nearby distances (*i.e.*, when $0 < \rho \le 1$) than for faraway distances (when $1 < \rho < \infty$).

In order to calibrate Equation (2), which must be taken as speculative, the roots must be accurately aligned with the latest Plank Mission data of the mass-energy composition in the Universe. In fact, Equation (2) can almost always be solved for two roots, where $\rho_0 < \rho_1$. The case with one root $\rho_0 = \rho_1$, as well as that described by $\rho_S = 0$, exists as well, as do those including no roots at all.

Before we proceed further, it is necessary to establish the share of the volume $V.S^3(\rho)$ with respect to the entire volume $V.S^3(\infty) = 2\pi^2$ in order to conform to the matter composition put forth by the Planck Mission. Indeed, the share equals:

$$sh(\rho) = \frac{2}{\pi}\left[\tan^{-1}(\rho) + \rho\frac{-1+\rho^2}{\left(1+\rho^2\right)^2}\right].$$

For the triplet given above, the roots $\rho_0 = 0.67535$ and $\rho_1 = 3.06548$ solve Equation (2). It can thus be verified that:

Dark matter:	$Dm\% \,\big|\, sh(\rho_0) \approx 26.785\%$,
Dark energy:	$De\% \,\big|\, sh(\rho_1) - sh(\rho_0) \approx 68.300\%$,
Visible matter:	$Vm\% \,\big|\, sh(\infty) - sh(\rho_1) \approx 4.915\%$.

These percentages, with regard to the Plank Mission Statement, allow us to refer to ∞ as the visible matter creation/starting point, which terminates at ρ_1. We can also refer to ρ_0 as the dark energy starting point, whereby the dark energy terminates when it reaches ρ_1, while the dark matter commences at 0 and ends at ρ_0. The inverse stereographical distance $r_0 - r_1$ in r-reference system $r = \frac{2\rho}{(1+\rho^2)}$ denotes the dark energy width. From the above, it can be inferred that, while the percentages align with the Planck Mission Statement nearly perfectly, the roots ρ_0 and ρ_1 produce a good fit only when $\mu = 0.12457$. Whatever the value $\mu = 0.12457$ of the density parameter represents or is interpreted to imply, this Speculation points at $\mu = 0.12457$ as an alleged current density state of the Universe.

4.1. The density scale origin

The conclusion made here is based on the premise that, in line with our Speculation, the manifold composition must stop changing when the density declines below the threshold $\mu < 0.08727$. In this case, the dark matter will *collapse into or be in contact* with the visible manifold when $\mu \approx 0.08727$ because $\rho_0 \approx \rho_1$. By implementing a ratio scale of density on the x-axis as a ratio of density μ to somewhat critical density κ, *i.e.*, $\frac{\mu}{\kappa}$, while moving from higher to lower density values, the roots should confirm, or at least not contradict, the currently accepted statements about the Universe dynamics.

Let us now introduce a scale that commences at the point corresponding to the critical density ratio $\frac{\mu}{\kappa} \approx 1$, $\kappa \approx 0.08727$. The manifold points on this scale at the ratio $\frac{\mu}{\kappa} \approx 1.42751$ as the current composition. In contrast, when $\frac{\mu}{\kappa}$ exceeds very high values on the density scale, a negligible or infinitesimally small lump of dark matter can suddenly emerge from the zero solution $\rho_S = 0$ of our speculative equation, Equation (2), yielding $Dm\% \approx 3{,}30283 \cdot 10^{-15}\%$ and $Vm\% \approx 0.00 \cdot 10^{-15}\%$ for the visible matter. This fits well with the current postulates on the beginning of *dark ages of the universe* [24], indicating that dark energy $De\% \approx 100\%$ constitutes almost the entire manifold, as illustrated by Figure 5 in the appendix. At the other end of the scale, when density decreases, and thus starts approaching the critical level $\kappa \approx 0.08727$, the roots of the equation cease to exist, while the alleged composition suggests $Vm\% \approx 32.67\%$ and $Dm\% \approx 67.33\%$. This last opportunity $\rho_0 \approx \rho_1$ for finding the equation roots is reached when $\frac{\mu}{\kappa} \to 1$, where the dark energy width approaches zero $(\rho_1 - \rho_0 \to 0)$. Thus, the roots of our speculative equilibrium equation, Equation (2), do not contradict, but rather confirm, the NASA statement that the current density of the Universe Ω_0 on a scale $\Omega \to 1$ is ca. $\Omega_0 \approx 1.0002 \pm 0.0026$ apart from the conventional critical density $\Omega = 1$ required for it to expand forever, as hypothesized by the standard Λ-CDM model [12].

5. DENSITY SCALE CONFORMATION USING NED-D DISTANCES

Our contemporary knowledge of the structure of the Universe extends to galaxies and quasars, which form groups and clusters of various categories of extragalactic objects. The entire space is permeated with radiation comprising of the infrared, visible, ultraviolet and X-ray radiation emitted by extragalactic objects, as well as neutrino fluxes. It also includes relict microwave and neutrino radiation, the occurrence of which is purported to be associated with the Big Bang explosion that initiated the emergence of the Universe.

The complexity of the Universe, which we are trying to understand, and whose visual elements we strive to control, inevitably results in difficulties in attempting to represent observations in the field of astronomy in a form that is understandable to a mathematician. We hope that our mathematical modeling succeeded in overcoming such challenges, as it permits similar language to be adopted by both the observer and the theoretical physicist. In creating this connection, we relied on the density μ parameter, developed in the previous section, which replaces the time by density dynamics of the Universe. It nonetheless explicates the distribution of matter in the Universe that is acceptable to both mathematicians and physicists.

In spite of confirmation of the density scale obtained by solving Equation (2), for which we utilized the data sourced from **NED-D** given in Table 3, Astronomical Journal, 153:37 (20 pp), the density scale μ remains merely of theoretical value. On the other hand, the density scale explaining the dynamics of the Universe in alternative terms related to extragalactic objects can be interpreted as evidence supporting the reliability of our mathematical model, rather than pointing to its inconsistency.

NED-D Table 3, Astronomical Journal, 153:37

		Estimates	Galaxies	Refcodes	Authors	Citations	Min(Mpc)	Mean(Mpc)	Max(Mpc)	Err(mag)	Est.with Err
1	AGB	3	2	3	5	91	0,535	7,27	14,9	0,19	67
2	AGN_time_lag	18	18	2	9	13	14,5	76,1	146	0,16	100
3	B_Stars	2	1	2	3	38	0,046	0,0518	0,0575	0,25	100
4	BL_Lac_Luminosity	115	99	16	652	320	120	1050	3600	0,31	10
5	Blue_Supergiant	2	2	1	1	5	0,0501	0,0566	0,063	0,50	100
6	Brightest_Stars	361	171	102	328	3312	0,0435	5,08	25,1	0,42	35
7	Carbon_Stars	20	15	17	66	575	0,031	0,837	4,11	0,23	60
8	Cepheids	1987	100	347	1980	22527	0,0355	6,73	55	0,10	91
9	CMD	671	136	187	1112	11097	0,006	1,28	86,7	0,12	65
10	Delta_Scuti	13	4	3	5	71	0,0492	0,07	0,153	0,10	92
11	FGLR	11	9	6	39	204	0,0501	1,99	6,55	0,09	55
12	GRB	665	218	23	142	915	151	4730	40700	0,77	81
13	GCLF	788	206	93	369	4463	0,64	20	111	0,24	98
14	GC_SBF	2	1	1	8	59	0,817	0,825	0,832	0,12	100
15	H_II_LF	16	16	2	8	104	15,1	7770	21400	1,24	100
16	Horizontal_Branch	109	49	62	395	6668	0,0185	0,312	0,94	0,13	74
17	M_Stars	11	7	6	36	301	0,0372	0,585	5,25	0,09	45
18	Miras	46	14	30	100	1399	0,0439	0,744	4,49	0,18	72
19	Novae	18	7	15	49	933	0,0479	10,6	20,6	0,36	78
20	OB_Stars	5	2	5	10	376	0,0457	0,0566	0,0661	0,28	80
21	PNLF	273	77	64	301	3397	0,0181	7,73	97,7	0,18	71
22	PAGB_Stars	2	2	1	2	1	0,692	0,753	0,813	0,00	0
23	Quasar_spectrum	11	11	1	9	13	3520	3775	3970	0,00	0
24	Red_Clump	214	27	69	317	4323	0,013	0,269	2,11	0,08	75
25	RSV_Stars	9	6	6	13	74	0,0453	4,32	7,59	0,19	100
26	RV_Stars	5	1	1	2	38	0,0605	0,0613	0,0619	0,05	100
27	RR_Lyrae	474	50	202	1101	8703	0,006	0,248	1,91	0,12	71
28	S_Doradus_Stars	5	5	1	1	58	0,759	2,93	5,25	0,00	0
29	SGRB	39	35	4	70	118	8	1900	4030	0,94	21
30	Subdwarf_fitting	1	1	1	4	298	0,0535	0,0535	0,0535	0,12	100
31	SZ_effect	312	49	23	154	1658	96	1198	5070	0,55	43
32	SNIa	13700	3130	130	1908	30282	2,73	1190	23900	0,21	97
33	SNIa_SDSS	3027	1772	1	49	23	77,6	1740	94300	0,30	100
34	SNII_radio	13	13	2	8	86	0,071	18,2	70,7	0,36	92
35	SBF	1534	545	68	298	4948	0,637	22,1	110	0,20	99
36	SX_Phe_Stars	2	2	2	2	57	0,0279	0,064	0,1	0,05	50
37	TRGB	1374	352	335	1845	15730	0,0071	3,34	20	0,12	82
38	Type_II_Cepheids	33	15	20	83	610	0,0472	1,69	31	0,14	85
39	White_Dwarfs	1	1	1	4	298	0,0479	0,0479	0,0479	0,15	100
40	Wolf-Rayet	3	1	3	7	128	0,87	1,11	1,5	0,34	33
41	Statistical	27	13	18	52	1478	0,0481	1,35	18	0,09	96
42	Standard_Rulers	12	12	1	1	11	0,9	7,22	17	0,00	0
43	Eclipsing_Binary	175	5	38	249	2014	0,0209	0,0968	0,964	0,08	70
44	GC_radius	108	107	11	77	605	0,0501	15,7	24,9	0,17	94
45	G_Lens	110	49	15	82	570	730	3310	15300	0,58	72

5.1. NED-D Mean (Mpc) utilization in the density scale

In the authors' words, the data highlights *"Estimates of galaxy distances based on indicators that are independent of cosmological redshift are fundamental to astrophysics. Researchers use them to establish the extragalactic distance scale, to underpin estimates of the Hubble constant, and to study peculiar velocities induced by gravitational attractions that perturb the motions of galaxies with respect to the 'Hubble flow' of universal expansion,"* Steer et al. [10].

Let us now return to the question of the average density of matter in the Universe. As already noted, when estimating the average density, it was relatively easy to take into account the "observed distances" given in the *Mean (Mpc)* column of Table 3 above. It was also comparatively straightforward to transform the distances into the light years time scale indicating the propagation of light through space until light from extragalactic objects reaches the telescope of the observer. In making this connection, it was also plausible to accept that light from extragalactic objects, indicated by column *Mean (Mpc*), was emitted at some point in the past, with such various moments of origin denoted as $[\tau_0,...,\tau_n]$ representing some interval determined by the closest and the farthest object in the column *Mean (Mpc)*. On the other hand, we have repeatedly pointed out the theoretical possibility of replacing the time parameter by the average density μ dynamics of matter distribution in the Universe. Thus, at this juncture, it should be clear that our reasoning leads to the emergence of a certain interval $[\mu_0,...\mu_n]$ of average densities μ. Indeed, such an interval can be constructed, thus supporting our claim that average density can be used in place of the time, given that $\Lambda = 0.91499$ and $\lambda = 0.83751$. These conditions result in obtaining solutions of Equation (2) that are highly correlated with the values presented in the *Mean (Mpc)* column of Table 3. We will confirm and illustrate our claim graphically.

Distances linear transformation

Invariance is one of the fundamental properties of the density scale (as well as any other scale), since it allows linear transformations to be implemented, supporting the theoretical construction irrespective of the chosen scale interval. Here, we will illustrate the invariance by a linear transformation of the *Mean (Mpc)* column into the scale of average matter densities substituting the resulting densities μ in the equation

$$\Gamma(\mu,\rho) = -4\pi \cdot \left[\tan^{-1}(\rho) + \rho \cdot \frac{-1+\rho^2}{(1+\rho^2)^2} \right] \cdot \mu + \Lambda \cdot \rho^\lambda = 0,$$

where $\Lambda = 0.91499$ and $\lambda = 0.83751$. In solving this equation with respect to distances ρ, we obtain a theoretical distribution of distances, which will be appropriately compared with the distances in the original *Mean (Mpc)* column. After making some amendments to Table 3 using redshift independent distances from https://ned.ipac.caltech.edu, last visited 18.07.2017, we have extended the column *Mean (Mpc)* with the following extragalactic objects: GRB 060206, GRB 060614, XRF 020903, GRB 9911208, UGC 00014, and UGC 12555. This expansion results in having 81 objects at our disposal. We have sorted these objects in ascending order, which we denoted in the form of a sequence of Mpc distances $\langle a \rangle = \langle a_0, a_1, ..., a_{80} \rangle$ arranged in internal $[a_0 = 0.0479, ..., a_{80} = 7770]$.

In the equation given above, we propose using a linear transformation $\Omega(a_i) = 0.00029 \cdot a_i +$ $+ 0.47763$ of distances $\langle a \rangle$ into sequence of densities $\langle \Omega_0 = 0.48, ..., \Omega_{80} = 2.79 \rangle$. These densities allow a sequence of equations $\Gamma(\Omega(a_i),\rho) = 0$, $i = \overline{0,80}$ for ρ_i to be solved, resulting in a sequence of distances presented in an interval $[\rho_0 = 13.12, \rho_{80} = 130.03]$. We claim that the latter sequence $u(\rho) = \langle \rho_0, \rho_1, \ldots, \rho_{80} \rangle$—being the equation solutions for ρ_i—has a very high correlation (0.998531) with the original sequence $\langle a \rangle$ taken from the column *Mean (Mpc)*, as illustrated in Figures 2 and 3 below.

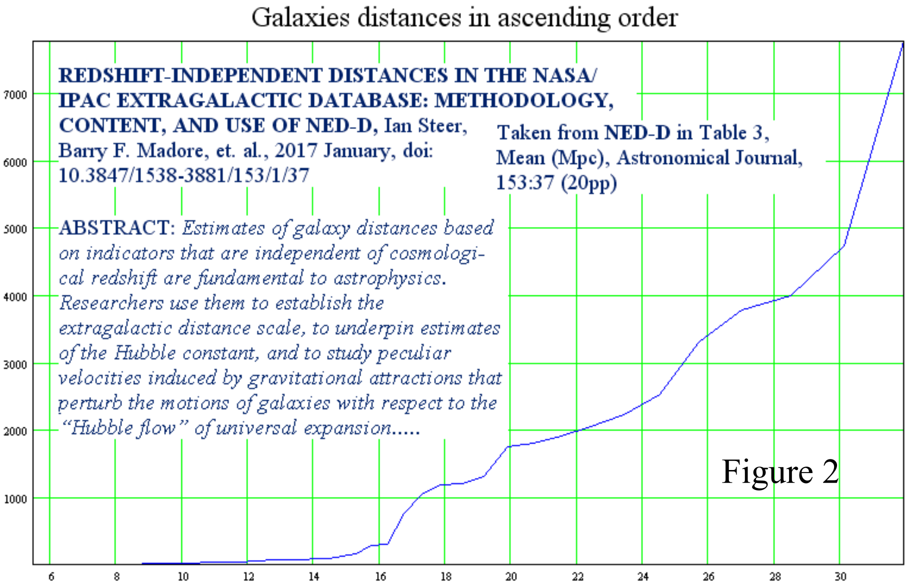


Figure 2

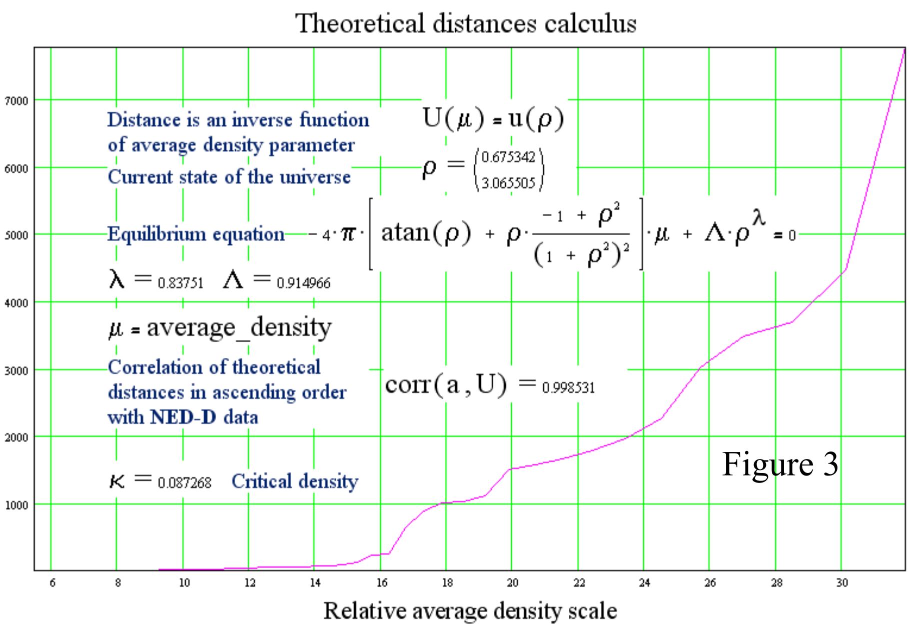


Figure 3

5.2. Discussion

As previously stated, in our discussions, we started with the assumption that homogeneity and isotropy of the space, the so-called Cosmological Principle, is valid. Isotropy implies absence of allocated directions (top, bottom and others), *i.e.,* independence of the properties of bodies moving by inertia from the direction of their motion. Complete isotropy is inherent only in vacuum, as anisotropy in the distribution of the binding forces characterizes the structure of real bodies. They split in some directions better than in others. In the same way, complete homogeneity, characteristic only of an abstract Euclidean space, is an idealization. The real space of material systems is inhomogeneous, as it differs in the metric and in the values of curvature, depending on the distribution of gravitating masses.

It is thus evident that the introduction of the density scale in the context of Universe dynamics may be viewed as a rejection of the hypothesis of homogeneity of the space, while retaining the isotropy assumption. However, the heterogeneity of space is manifested in the form of homogeneity of the visible hemisphere. Nonetheless, the density of matter may well have a certain character of a decrease violating homogeneity if we consider the dynamics in depth of the space by estimating the distance to the observed extragalactic objects by relying on the light emitted at some point in the past. If we also include the principle of a phase transition of dark energy into visible matter, we believe that we can arrive at a coherent picture of the Universe.

To test this assertion objectively, we must use valid data. Still, it is debatable whether available data is an objective basis for verifying the time replacement with the density parameter. When testing a particular theory, the researcher constructs a hypothesis based on the verifiable facts or previously established theories and examines the obtained data in relation to this knowledge base. Referring to the doctrine of Mach's economy of thoughts the kind of math we use is not important, but how the math predicts the reality does. Accepting this view, we confirmed the validity of the replacement of the time by the parameter of average density of matter.

When, in the context described above, a researcher is attempting to verify the correctness of a newly developed theory, he/she should also take into account the reliability of the data used. In some cases, the theory can be verified by examining it through its own prism, which is also employed when observing the reality. This is not the case here because the reliability of the data in Table 3 is not in doubt. On the other hand, if it would not be possible to achieve a high correlation between the data presented in Table 3 and the solutions of Equation (2), the confirmation should end where it started. Therefore, the only objection that really matters is that we interpreted the data on the basis of Equation (2) using the hypothesis of phase transition of the dark energy into matter while the average density decreases with the evolution of the Universe. Clearly, the transition hypothesis cannot be adequately confirmed without the assertion of the validity of the phase transition of dark energy into matter on the basis observations. It is also clear that we are not in the position to provide such evidence.

6. Concluding Remarks

In this work, we presented a speculative equilibrium equation describing the matter composition at the point of emergence from dark energy and as it continues to emerge. Calibrating the equation in accordance with the current mass-energy composition of the Universe allowed us to reach some speculative conclusions with regard to the dark matter dynamics. We suggested looking at Big Bang as an occurrence of a suddenly freezing thermal energy field below $0^{\circ}\mathrm{K}$ releasing a latent heat. While this was a plausible line of reasoning, the math that can describe this process allowed us to explain the current composition of the Universe.

Finding the equation roots might have some predictive power, since they are nearly 100% compatible with the Planck Mission Statement. None of our Speculations presented here fundamentally contradicts the latest views on the data composition in terms of the percentages of visible and dark matter in proportion to the dark energy. Specifically, contradictions are avoided due to the calibration and by imposing the curvature relationship $R = 1$. Obviously, we eliminated the mathematical impossibility of Big-Bang singularity problem of *expansion* of the geometry from an alleged singularity $r \approx 0$. Instead, we focused on a series of holes/bobbles, represented as hyper-manifolds S^3 of radius $0 \le r \le 1$ enclosing the $\Re^4$ hyper-globe by adopting unity radius of curvature of the space. The latter eliminated any ambiguity in the outcomes pertaining to the visible and dark matter fractions in proportion to the dark energy in case that the grid incorporated gravitational constant G and speed of light c into potential energy measurements, *i.e.*, the case when the grid guarantees the correct output irrespective of G and c. We were interested in the composition of dark matter, visible matter and dark energy wherever these three components might be in reality. Subsuming the constant G and speed of light c under the density parameter μ also resulted in our calculus becoming transparent to the curvature of the space. That was the motivation behind the choice of curvature $\text{const} = 1$. Our speculative equation required fine-tuning or calibration of the so-called Λ-parameter of speculative mass-energy phase transition level, as well as the λ-parameter characterizing a modified potential energy field. This allowed the optimal values to be determined, with respect to achieving the best tuning effect posited by the Planck Mission.

The next important assumption pertained to the density parameter μ of the emerging matter, to which we referred as a relativistic density. While acknowledging that the explanation requires more convincing arguments of equivalence of energy and mass, we proceeded with our analyses by assuming that the density was aligned with the "normal density" of matter. The concept of density allowed us to interpret, as well as predict, the dynamics and "quasi-velocity" of the formation of a hole or a globe within space. It was also possible to make assertions that essentially coincide with the NASA statement that, in the past, the manifold expanded more slowly than it does presently. As our manifold implies, only a tiny globe of dark matter solves the equation in high/right region of the density scale. At the high/right extreme of the density scale, the manifold comprised solely of dark energy, *i.e.,* when the time $t \le 0$ since the visible matter radius suggested almost a zero solution. At the low/left extreme of the scale, approaching the critical value, in contrast to the visible matter, the dark matter will allegedly start to diminish.

7. Mathematical Derivation

At cosmological distances, the space is purported to be homogeneously filled with matter and is completely isotropic. The generic metric that meets these conditions is given by S^3 manifold of four-dimensional globe $\Re^4$. In the derivation below, we will consider only the case of closed model with positive curvature.

$$\begin{aligned} x^2 + y^2 + z^2 + r^2 &= 1 \\ x^2 + y^2 + z^2 &\le r \le 1 \end{aligned}$$

These equations represents so-called closed space manifold S^3 of curvature 1 as a surface enclosing four-dimensional hyper-globe $\Re^4$.

The spherical coordinates x, y, z are related to the E^3 coordinates by $\varphi = \tan^{-1}\left(\frac{y}{x}\right)$, $\theta = \cos^{-1}\left(\frac{z}{r}\right)$, where $r = \sqrt{x^2 + y^2 + z^2}$.

$x = r \cdot \cos(\varphi) \cdot \sin(\theta)$,
$y = r \cdot \sin(\varphi) \cdot \sin(\theta)$,
$z = r \cdot \cos(\theta)$, where $0 \le r < 1$, $0 \le \varphi \le 2 \cdot \pi$, and $0 \le \theta \le \pi$,

The stereographical projection from North Pole $(0,0,0,1)$ intersecting E^3 at the origin $O = (0,0,0)$ perpendicular to r-axis is given by four functions of three variables: $0 \le \rho < \infty$, $0 \le \varphi \le 2 \cdot \pi$, and $0 \le \theta \le \pi$:

$$\left(\frac{2 \cdot \rho}{1+\rho^2} \times \cos(\varphi) \cdot \sin(\theta); \frac{2 \cdot \rho}{1+\rho^2} \times \sin(\varphi) \cdot \sin(\theta); \frac{2 \cdot \rho}{1+\rho^2} \times \cos(\theta); \frac{\rho^2 - 1}{\rho^2 + 1}\right).$$

The partial derivatives of the projection/diffeomorphism represent the Jacobin matrix J, whereby its transpose J^T is given as follows:

$$J^T = \begin{pmatrix} 2\frac{1-\rho^2}{\left(1+\rho^2\right)^2} \times \cos(\varphi)\sin(\theta) & 2\frac{1-\rho^2}{\left(1+\rho^2\right)^2} \times \sin(\varphi)\sin(\theta & 2\frac{1-\rho^2}{\left(1+\rho^2\right)^2} \times \cos(\theta & \frac{4 \cdot \rho}{\left(1+\rho^2\right)^2} \\ -\frac{2 \cdot \rho}{1+\rho^2} \times \sin(\varphi)\sin(\theta) & \frac{2 \cdot \rho}{1+\rho^2} \times \cos(\varphi)\sin(\theta) & 0 & 0 \\ \frac{2 \cdot \rho}{1+\rho^2} \times \cos(\varphi)\cos(\theta) & \frac{2 \cdot \rho}{1+\rho^2} \times \sin(\varphi)\cos(\theta) & -\frac{2 \cdot \rho}{1+\rho^2} \cdot \times \sin(\theta) & 0 \end{pmatrix}$$

Consequently, Gram Matrix as the space metric tensor $G = J^T \times J$ yields

$$G = \begin{pmatrix} \frac{4}{\left(1+\rho^2\right)^2} & 0 & 0 \\ 0 & \frac{4 \cdot \rho^2}{\left(1+\rho^2\right)^2}\left(1 - \cos^2(\theta)\right) & 0 \\ 0 & 0 & \frac{4 \cdot \rho^2}{\left(1+\rho^2\right)^2} \end{pmatrix},$$

which leads to the metric rod $dl^2 = \frac{4}{\left(1+\rho^2\right)^2}\left[d\rho^2 + \rho^2\left(\sin^2(\theta)d\varphi^2 + d\theta^2\right)\right]$.

From flat E^3 topology, the rod volume dl^3 is equal to $dx \cdot dy \cdot dz$, whereas the rod length is given by $dl^2 = dx^2 + dy^2 + dz^2$. Applying the same rule to the previous flat expression for dl^2, we obtain

$$dl^3 = 8 \cdot \frac{\rho^2 d\rho \cdot \sin(\theta) d\theta \cdot d\varphi}{(1+\rho^2)^3},$$

within a coordinate triple: $0 \le \rho < \infty$, $0 \le \theta \le \pi$ and $0 \le \varphi \le 2\pi$:

$$8 \int_0^{2\pi} \int_0^{\pi} \int_0^{\rho} \frac{\xi^2 d\xi \cdot \sin(\theta) d\theta \cdot d\varphi}{(1+\xi^2)^3}$$

the latter represents the space volume $V.S^3(\rho)$ of a hyper-manifold $S^3(\rho)$ with a "radius" ρ.

N.B. The *radius* ρ can be interpreted as a new dimension, implying that the space volume is proportional to Euclidian space E^3 at nearby distances. Taking the integral into account, we can derive the expression for a volume:

$$V.S^3(\rho) = 4\pi \cdot \frac{-\rho + \tan^{-1}(\rho) + \tan^{-1}(\rho) \cdot \rho^4 + \rho^3 + 2 \cdot \tan^{-1}(\rho) \cdot \rho^2}{(1+\rho^2)^2}.$$

After accounting for the sub-expression $\tan^{-1}(\rho)$, we obtain

$$V.S^3(\rho) = 4\pi \cdot \frac{(1+\rho^4 + 2 \cdot \rho^2)}{(1+\rho^2)^2} \cdot \tan^{-1}(\rho) + 4\pi \cdot \frac{-\rho + \rho^3}{(1+\rho^2)^2}.$$

Finally, we arrive at

$$V.S^3(\rho) = 4\pi \left[\tan^{-1}(\rho) + \rho \cdot \frac{-1+\rho^2}{(1+\rho^2)^2} \right]$$

APPENDIX. ***The density scale effects***

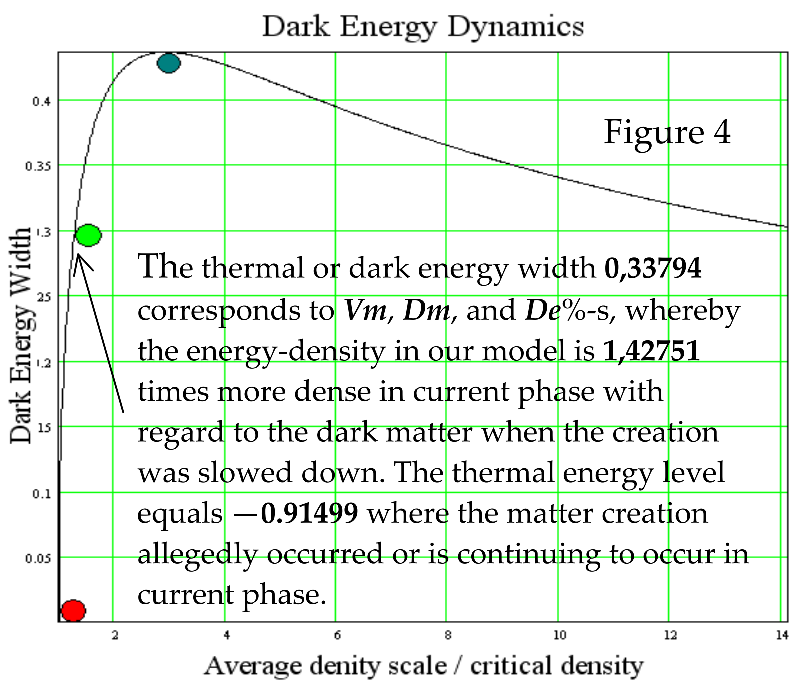
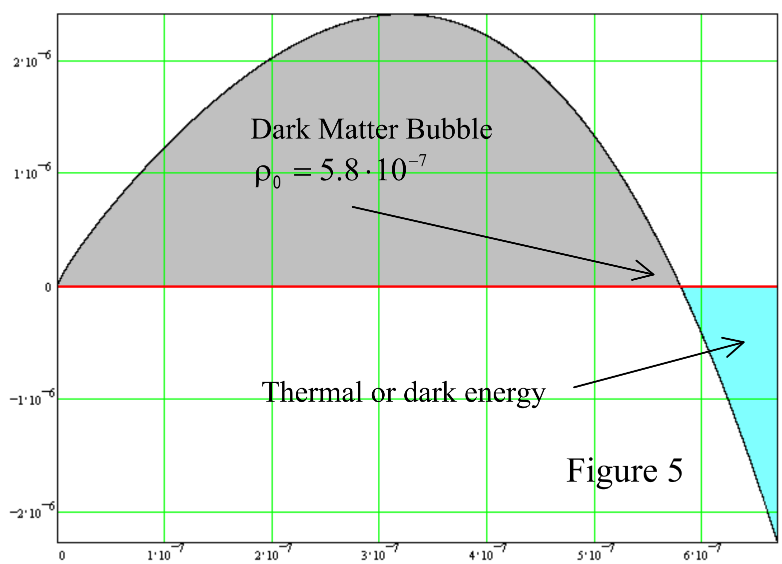


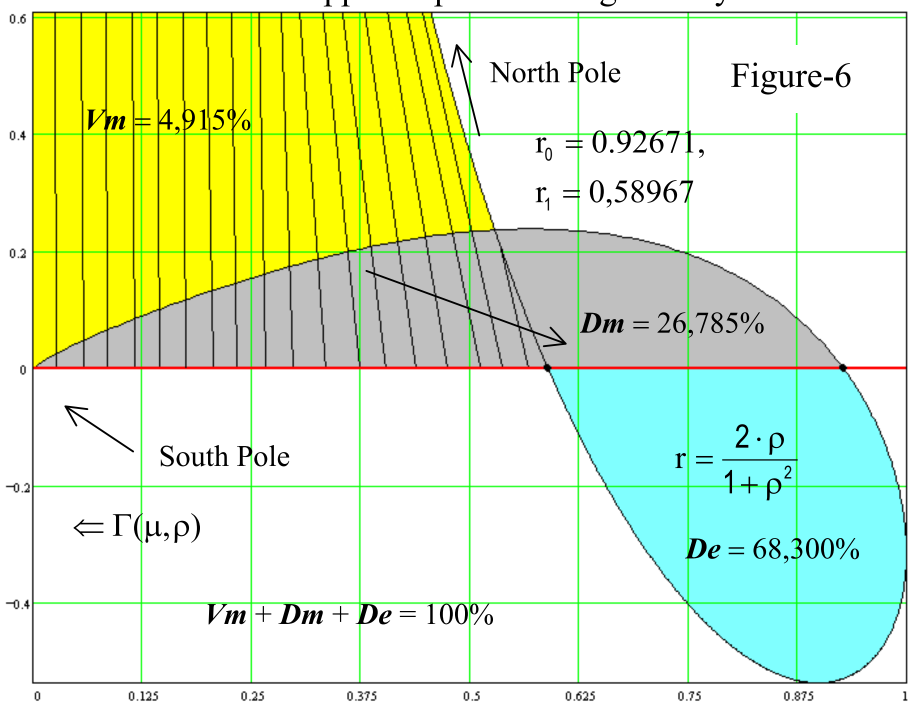
Figure 4 above shows the dynamics of dark energy as a function of density. The scale of the density on the x-axis extends from its critical ratio 1 and will continue to reflect the dark energy width as it shifts to the right. If one moves in the opposite direction (to the left), using the analogy implied by the proposed scale, the figure shows that the formation of dark matter [25] precedes that of the visible matter because the gap between the two forms increases. On the y-axis, when the inverse stereographical distance $r_1 - r_0 = 2 \cdot \left[\frac{\rho_1}{1+\rho_1^2} - \frac{\rho_0}{1+\rho_0^2} \right]$ reaches some point, it will stop increasing, thus closing the aforementioned gap. The reduction, as indicated in Figure 4, will be most pronounced in the vicinity of 1, where the red circle indicates the end of the evolution of the manifold—the moment of reaching the critical density κ. Thus, as indicated by the blue circle, at the much later stages of evolution, the gap between the visible matter and the dark matter starts to close. The state of the manifold at the current stage—denoted by the green circle—is particularly relevant here, as it indicates that the turnaround point of the present state of the manifold has already been passed. When the gap started closing, the density was about three times greater than that at the present state.



Radius of stereographic projection

Figure 5 depicts the case of density exceeding a critical value $\kappa \approx 0.08727$ by more than $96{,}116 \cdot 10^{11}$ times. Based on the zero solution $\rho_s = 0$ of the equation, while moving to the right along the x-axis, the Speculation states that a positive root $\rho_0 > 0$ can be interpreted as a creation of a small lump of dark matter. We can paraphrase this statement, positing that the dark matter was created first. As it preceded the visible matter creation, the inflation Bang of the Big Bang resulted in the emergence of the dark matter only.

Two roots on opposite poles of S^3 geometry/bubble



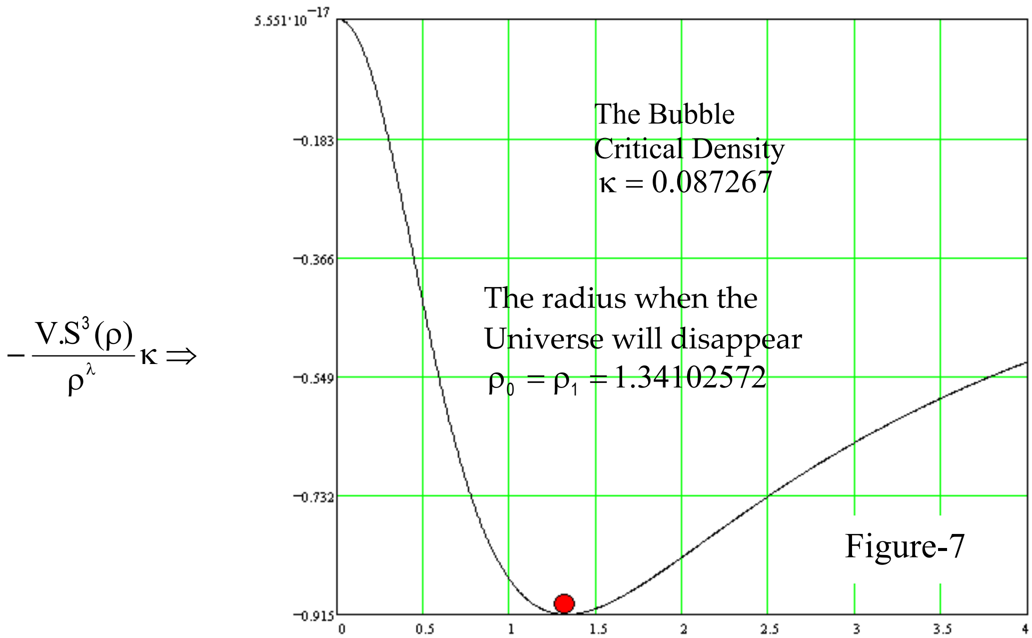
Inverse stereographical mapping of the current phase

The graphical illustration provided in Figure 6, denoting the link between the S^3 manifold and its stereographical projection into Euclidian topology E^3 filled by dark and visible matter with regard to dark energy, is the foundation for the study of the essence of all of our Speculations. On the x-axis, the radius r is given by an inverse stereographic mapping $r = \frac{2\rho}{1+\rho^2}$ while the y-axis corresponds to

$$\Gamma(\mu,\rho) = -4\pi \cdot \left[\tan^{-1}(\rho) + \rho \cdot \frac{-1+\rho^2}{\left(1+\rho^2\right)^2} \right] \cdot \mu + \Lambda \cdot \rho^{\lambda}.$$

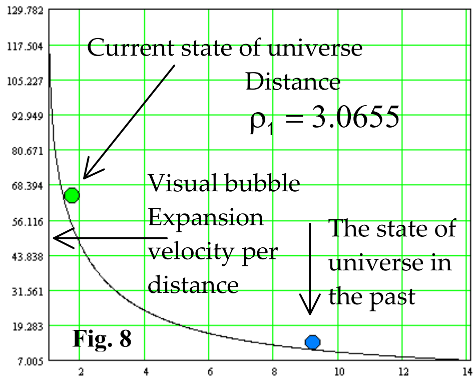
The interval $[0 \le \rho \le 1]$ in r-coordinates corresponds to $[0 \le r \le 1]$, whereby the coordinate $r \to 0$ when moving further from 1 corresponds to $\rho \to \infty$. Thus, in the r-coordinate system used in Figure 6, presence of *double curves* on the x/y-axis for $\Gamma(\mu,\rho)$ makes sense.

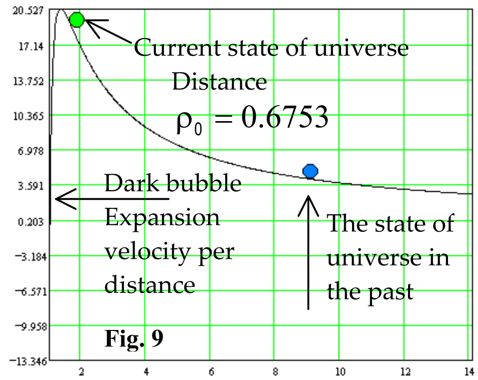
Two roots (ρ_0, ρ_1) at which the formation of matter allegedly occurs solve the equation $\Gamma(\mu,\rho) = 0$. Hence, it can be seen that the graph shown in Figure 6 corresponds to the density $\mu = 0.12457$ supposedly representing the current state of the manifold S^3. While passing through the area highlighted in gray, we move from $0 \to r_0$. In the ρ coordinate system, when using $0 \to \rho_0$, we are moving along the positive portion of $\Gamma(\mu,\rho)$, which corresponds to 26.8% of dark matter in the Universe composition. Positive $\Gamma(\mu,\rho)$ values indicate the region in the manifold S^3 where the alleged formation of dark and visible matter already occurred. Similarly, entering the region $\Gamma(\mu,\rho)$ denoting negative values (depicted in blue), we move through the dark energy, which accounts for about 68.3% of the total energy, and is sufficient for further evolution of the manifold. Reaching the radius r_1, we enter the region of visible matter, contributing about 4.9% to the Universe composition and moving away from $\rho_1 \le \rho \to \infty$. As depicted in Figure 6, at the radius r_1 and beyond, visible matter cannot be in contact with the dark energy in the coordinate system $\rho \in (0, \rho_1)$. However, as it can be seen, it is superimposed on the dark matter at $0 \le r_1$. In conclusion, the scenario depicted in this figure should be understood as an attempt to visualize the current state in calibrating of the Universe according to the latest data yielded by the Planck Mission [1-3] measurements.[iii]



The case presented by the graph shown in Figure 7 depicts the potential energy governed by the radius starting point 0 on the x-axis, in the respective coordinate system ρ, when our speculative equation of matter creation allowed only a single root, $\rho_0 = \rho_1$. This is the *moment* after which the evolution of the manifold supposedly ceases, since the formation of the new matter will terminate upon reaching the critical density κ. At this last *energy-moment*, when the radius $\rho_0 = \rho_1 = 1.34102572$, as indicated by the solution of our equation, the density in the manifold will be critical, $\kappa \approx 0.087267$. The manifold in its current state is characterized by density $\mu = 0.12457$, which is, as already pointed above, 1.42751 times greater than the critical density κ on the scale with regard to the critical density starting point. The values of the potential energy $-\frac{V.S^3(\rho)}{\rho^\lambda}\kappa$ are depicted on the y-axis in Figure 4. In this graph, $V.S^3(\rho)$, equal to the volume of a manifold $S^3(\rho)$ of radius ρ, is multiplied be the critical density κ at which the potential energy reaches its minimum with respect to the critical condition—*i.e.*, the level when only a single root of the equation exists.

Note that the manifold given by Equation (1), in contrast to that usually adopted in cosmology, does not contain the time coordinate. Instead, we utilized the density parameter μ, which declines from very high values that are $96{,}115 \cdot 10^{11}$ times greater than κ. Next, we attempt to shift the density back towards the critical value $\kappa \approx 0.087267$. Replacing the evolution of the manifold given by Equation (1) by the density μ parameter is purely a mathematical exercise, due to the scale of *densities*, where declining values replicate the dynamics of matter creation within the manifold. However, our mathematical calculations indicate that, as the density μ declines towards the current mass-energy composition, it accounts for the μ value pertaining to the current composition, which is only 1.42751 times denser than $\kappa \approx 0.087267$.





Figures 8 and 9 reveal the fundamental difference in the dynamics of dark and visible matter. According to our analyses, which contradict the laws of gravity implying that the visible matter should start to contract, it allegedly continues to expand. This effect is readily apparent in the graphs depicted in Figures 8 and 9. Indeed, they indicate that the matter creation velocity within the manifold continues to accelerate, whereby as the manifold $S^3(\rho)$ filled with matter increases in size, the average density also decreases. When the density in the vicinity of the critical value κ is analyzed, the alleged dark matter dynamics seem to be better aligned with the laws of gravity. As shown in Figure 8, in the vicinity of the critical value, the dark matter begins to contract. More specifically, the quasi-velocity of the dark matter creation reaches zero value before becoming negative, *i.e.*, the radius of the dark matter begins to decrease and its volume begins to contract. In contrast to thermodynamic laws, in the vicinity of the critical value, as evident from Figure 8, the dark matter density continues to decrease as it contracts. We might thus conclude that the dynamics of the evolution of dark and visible matter, accounting for the decreasing density, do not correspond to the known laws of physics. It seems that these laws have been violated differently.

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[i] Scientific Background on the Nobel Prize in Physics, **2011**. The accelerating universe. The Royal Swedish Academy of Sciences has as its aim to promote the sciences and strengthen their influence in society.

[ii] This was recognized early on by physicists and astronomers working in cosmology in the 1930s. The earliest Layman publication describing the details of this correspondence is Eddington, Arthur (**1933**). The Expanding Universe: Astronomy's 'Great Debate', 1900–1931. Cambridge University Press. (Reprint: ISBN 978-0-521-34976-5).

[iii] Planck captures a portrait of the young Universe, revealing the earliest light. University of Cambridge (March 2013). 21. Retrieved 21 March **2013**.

[iv] Overview of products and scientific results – Table 9. Astronomy and Astrophysics, 1303, 5062. arXiv:1303.5062. Bibcode:2014A&A...571A...1P. doi:10.1051/0004-6361/201321529.

[v] "...dark matter: An invisible, essentially collision-less component of matter that makes up about 25 percent of the energy density of the universe... it's a different kind of particle... something not yet observed in the laboratory..."