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I. Introduction

Modern cosmology is in the process of revising the Big Bang model of space and time, [1,2]. This is due to the fact that based on the general theory of relativity the theoretical predictions do not correspond with observations at far away, i.e., at cosmological distances. The universe that we observe is a surprisingly homogeneous and isotropic in all directions and locations—parameters such as density, brightness, etc., do not differ: so-called cosmological principle holds. Based on this principle, the prediction of the contraction of the universe is not supported. On the contrary, cosmological observations not only confirm the cosmic expansion but the expansion with acceleration, see Nobel prize backgrounds, Saul Perlmutter, Brian Schmidt and Adam Riess [3]. This paper describes an alternative to the Big Bang model based on some speculative equilibrium equation or stable state of matter.

We propose a disputable thesis 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 a new matter formation inside the FLRW[1] *topology*. As a result of this newly created matter, the Universe, on average as a whole, achieves a lower *quasi-density* μ of matter compared to that of the previous state. This violation arises due to gravitational potential energy induced into the topology, providing a theoretical foundation for a stable states evolution, as a dynamics of some speculative equation roots. In view of this thesis, the declining quasi-density serves as an indicator of matter formation. Thus, it provides the means for replacing the time component of metric evolution—typically established by the time dynamics—by quasi-density μ. While this is a far-reaching and highly unconventional assumption, it promotes more diverse ways of understanding of the dynamics of the evolution of matter and energy in the Universe. In view of the aforementioned assumption, the time variable will be omitted from all further considerations.

We have confirmed some of NASA statements regarding the Universe evolution. By calibrating equilibrium equation, the percentages of the visible and dark matter in their proportions to dark energy yielded nearly a 100% overlap with the latest Planck Mission data. Second, the model supported the Big Bang inflation stage. Using our theoretical foundations we have shown that tiny lump of space was first inflated solely by the dark matter. Third, we predicted that after the inflation stage, the topology was expanding, with decreasing quasi-density, but with accelerating quasi-velocity. This has been established from the equation, the outcomes of which confirm that the topology was also expanding more slowly in the past. Next, we posited a critical value of the quasi-density at which the dark energy will be exhausted. In such an event, the space topology would allegedly collapse into a quasi-critical composition. This is likely to occur in line with the standard cosmological LCDM model [4], albeit earlier than typically predicted. In quasi-critical composition, the dark matter will contract rather than expand, in contrast to visible matter, which will continue to expand. Finally, since superposition of dark and visible matter was postulated, albeit separated by cosmological distances in FLRW metric, this provided conditions for the two forms of matter evolution undergoing on opposite sides of topology, analogous to Moebius strip. Each Speculation has been derived graphically.

Before we proceed, we wish to outline our narrative, consisting of seven sections, including introduction. In Section II, via pedagogical exercises, we describe phase transition of a hypothetical dark energy field into the matter inside the FLRW topology. In Section III, we present the equilibrium equation. Section IV is dedicated to fine-tuning the parameters of our

[1] FLRW—Friedmann-Lemaître-Robertson-Walker

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equilibrium equation with regard to the alleged mass-energy composition of the Universe. To consolidate our Speculations with the current data pertaining to cosmological observations, we have implemented a calibration of unconventional parameters that facilitates the use of roots of our speculative equilibrium equation. In Section V, we challenge our Speculations, concluding that their rejection is likely implausible, as they confirm rather than deny NASA statements about the composition of the Universe in the past. The paper ends with concluding remarks, given in Section VI. Finally, in Section VII, we provide mathematical derivation of three-dimensional globes' volumes in the FLRW metric that in accord with our Speculations, are filled with matter.

II. Pedagogical Foundations

In this section, we try to explain our geometric model's foundation using pedagogical exercises relating to three unconventional parameters Λ, λ and μ. We are attempting to explain the basic postulates of our model via plausible examples.

We highlight the view regarding the possibility of describing events implying that one event took place prior or after another. Nuclear physicists can determine the age of a material by noting the average number of atoms that have undergone radioactive decay. In this way, geologists can determine 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. Assume that we are able to count not only of the average number of atoms undergoing the decay but an exact number of atoms belonging, for example, to a Sn isotope in a rock. Assume also that we can do so with an high accuracy by taking into account every single atom remaining after the decay. 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. Looking at 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, we can establish the *quasi-age* of the Universe without recourse to the clock. Suppose we pointed our telescope toward some portion of three-dimensional sky on which we superimposed a grid cell. This would allegedly allow us to count the *quasi-number* of photons, electrons, and all atoms of various types of matter, including galaxies. Once the process is complete, we can focus the same telescope on some other part of the sky. Assuming that the Cosmological Principle [5] is true, we can expect the results to match at the same distances from the centre and in all directions of our observations. In particular, our *quasi-measurements* will be 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 densities measured at closer and longer distances as indicators of the age dynamics of the Universe.

Assume that the density—henceforth denoted as *quasi-density*—of various particles (photons, electrons, etc.) measured in the first observation at closer distances differs from the second, taken at far away distances. We can now assert that, at closer distances, the quasi-density in the grid cell is less than that of the same cell at far away distances. This assumption is in line with the Hubble's law [6]. Thus, we can discover the age dynamics of the Universe because the *quasi-densities* of matter at these two locations are indicating that the areas of lower quasi-density (at closer distances) have emerged later than similar areas with a greater quasi-density (at a far away distances). Our aim is thus to emphasize that the quasi-density of matter can be chosen as an indicator of the age of the Universe. This will allow us to investigate the evolution of the Universe in terms of the quasi-density instead of a time parameter.

Matter exists in four fundamental states—solid, liquid, gas and plasma—and can undergo a transition from one state/phase to another. At normal atmospheric pressure, water turns to ice at temperatures below $0^{\circ}C$, whereby the water state symmetry transforms into crystal symmetry. Super-cooling is the term applied to describe the cooling of a liquid below its freezing point without it becoming solid, e.g., cooling the water below $0^{\circ}C$. Thus, when undergoing a phase transition to ice, a super-cooled water can release a latent heat [7]. As the ice floe can be measured linearly by three-dimensional coordinates, the volume of water must be measured in litres, rather than in cubic meters, etc. Pedagogically speaking, for the *Creatures* in the form of ice crystals, the water undergoing a phase transition is allegedly invisible, as they can neither observe nor measure liquid matter phenomena. They can, however, feel the heat or matter formation effects. From the mathematical perspective, a dark energy can undergo a phase transition from zero to a positive measure state. Measure theory is a way to assign a numerical value to every subset of a set, which allows examining the unions of subsets as a sum of their measures. An example of a positive measure is given by the mass of matter.

In modern cosmology, as previously noted, the Universe corresponds to Cosmological Principle of a homogenous and isotropic space, implying the same distribution of galaxies at each point and in all directions, universality of the laws of physics, etc. The Principle further acknowledges that all the laws of physics are applicable at all points in the Universe with the same precision because there is no point of

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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 [8], implying that flat Creatures cannot imagine a three-dimensional world by walking on the flat surface of a balloon. The case seemingly suggests that we as three-dimensional Creatures inhabit a three-dimensional space. In reality, we are moving in a three-dimensional bounded surface of radius r, $0 \le r \le R$, embedded into four-dimensional hyper-sphere in the form of three-dimensional topology. All topology points are equal in all directions, without a centre and without a terminal point.

Suppose that our three-dimensional topology of radius R—we prefer to denote it as a globe of radius R—comprises of a kind of dark energy field that is not accessible to existing measuring instruments (a case 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 the globe, the energy field transitions into a seed lump of solid matter, which represents a transition of a 0-measure to a positive one. By supposition, lump of matter has to be in a dynamic equilibrium with dark energy field.

Einstein introduced the necessity of so-called cosmological constant Λ into his equations to ensure a static equilibrium of matter. According to the latest data [9], Λ represents the energy density, and equals to $\Lambda = 2.036 \cdot 10^{-35} s^{-2}$ in vacuum. A similar quasi-constant Λ would denote a similar stabilization effect representing the alleged dark energy potential level. We emphasize, that the lump of matter and the potential energy field embedding the lump must preserve the stable state while undergoing rapid inflation from zero and progressing with further expansion similar to [10a, 10b]. However, the matter formation singularity problem—the initial inflation of phase of Big Bang—has not been addressed.

We argue that the singularity does not exist because our equation permits a zero solution. We can thus assume that, starting from a state described by this zero solution, the matter suddenly inflates [11] the topology in phase transition from the aforementioned dark energy field. According to this postulate, when a *"lump of matter"* emerges, it will create an additional pressure on the previously allegedly *frozen energy*, thereby causing an additional *inflating effect*. We assume a presence of further matter formation akin to an "avalanche" rolling down the hill and gaining mass (and thus weight) due to *"potential energy of dark energy field."* The avalanche of the matter formation has to remain in a dynamically stable condition in accordance with our equation. This assumption confirms that the phase transition of dark energy into matter suddenly starts and will begin to move forward if the density of the *frozen energy* is incredibly high. Seemingly, an avalanche has occurred, shaping the matter formation inside the topology. In doing so, 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—depicting its origin and terminal state—it is advisable to examine a more rigorous reasoning next.

III. Equilibrium Equation

In formulating Speculations using our equilibrium equation reflecting the current mass-energy composition in the Universe, we are attempting to identify some stable states resolving equilibrium equation as topologies among three-dimensional globes of radius r, $0 \le r \le R$, embedded into the four-dimensional hyper-sphere of a curvature radius $R >> 0$, given by:

$$x_1^2 + x_2^2 + x_3^2 + x_4^2 = R^2. \tag{1}$$

Cosmological principle is an attribute of two-dimensional surface of a three-dimensional sphere. Extending the principle to three-dimensional slices of a four-dimensional hyper-sphere preserve the same properties. Therefore, the three-dimensional globes embedded into four-dimensional hyper-sphere (1) correspond to "surface slices," which are in accordance with the cosmological principle of homogeneity and isotropy.

According to Newton's laws it is well known that, for a globe of mass M with radius r, if the mass converges into a zero point, the potential energy of a gravitational field, at a distance r from 0, equals $-G \cdot \frac{M}{r}$, where $G = 6.67384^{-11}$ is the gravitational constant. Based on the Cosmological Principle, we can thus assume that our topology embedded into four-dimensional hyper-sphere (1), as a three-dimensional globe of radius r, is embedded into unknown energy field. Hereby, we able to hypothesize the process of matter formation, which occurs on the surface of the topology—that is, at a distance r from some centre. It should be reiterated that one can take any point for the centre, even the location of an observer. Hence, it is plausible to suggest that, at a distance r from the zero point, the matter formation takes place if the potential gravitational field intensity is strong enough—below the value of an universal constant Λ, i.e., at $-G \cdot \frac{M}{r} \le -\Lambda$. The matter formation dynamics, according to our thesis, is thus determined by a speculative equation $-G \cdot M + \Lambda \cdot r = 0$. Once the process of matter formation starts, it cannot be arrested or terminated, because increasing $\mathbf{M}$ requires

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increasing r in order to maintain the equilibrium of the speculative equation.

Given the gravitational constant $G = 6.67384^{-11} \cdot m^3 \cdot kg^{-1} \cdot s^{-2}$, the curvature $R > 0$ and G are supposed to be constrained by $G \cdot R^3 = 1$. Irrespective of the grid scale adopted, i.e., $(km)^3$ or $(light\ year)^3$, etc., the curvature R and constant G must match—e.g., for $(m)^3$ grid, $G = 6.67384^{-11}$ and $R = 2465.32816$ apply, whereas for $(km)^3$ grid, it follows that gravitational constant is $G = 6.67384^{-20}$ and $R = 2465328.16025$, etc. In other words, by imposing the equality $G \cdot R^3 = 1$ we are attempting to eliminate the grid ambiguity for the gravitational constant G. Considering the topology characterized by a positive curvature R, the value $R > 0$ is irrelevant, as choices of R and G are transparent. When constraining the curvature radius R, the validity of $G \cdot R^3 = 1$ is crucial for our further considerations.

Let us now turn our attention to the crucial energy level on the globe surface that forms the FLRW topology of three-dimensional vectors (x_1, x_2, x_3), i.e., to the level of potential energy at the distance r from the centum of the globe of radius r. As already assumed in our speculative thesis, there matter-energy composition undergoes change, which allegedly occurs on the three-dimensional surface embedded into the four-dimensional hyper-sphere denoted by Equation (1). More precisely, we introduce a parameter λ, which will allegedly represent a fine-tuning or calibrating parameter of the dark energy field defined by Newton, and features in the "modified potential energy" $-G \cdot \frac{M}{r^\lambda}$ like in MOND model [12]. In accordance with the Speculation of the matter-energy composition change, let us assume that the change occurs at the energy level equal to $-\Lambda$, i.e., at some universal constant discussed above. Thus, the change occurs by violating the equation $-G \cdot \frac{M(r)}{r^\lambda} + \Lambda = 0$, where $M(r)$ does correspond to the mass of a globe of radius r. This equation represents the stable set equilibrium applied to the matter-energy composition. Below, we will replace M by $M = U(r) \cdot \mu$, where $U(r)$ is the volume of the globe that is allegedly inflating/expanding. Hereby, we refer to the parameter μ as a quasi-density of matter. Consequently, the equilibrium equation might be rewritten in the form $-G \cdot U(r) \cdot \mu + \Lambda \cdot r^\lambda = 0$. Finally, we refer to the mathematical derivation of the latter equation upon our surface globe topology, presented in Section 7. We proceed as follows.

The surface rod ds^2 of three-dimensional globe of radius r, $0 \le r < R$, in accordance with Eq. (1), yields time independent part with the rod length of

$$ds^2 = \left(1 - \frac{r^2}{R^2}\right)^{-1} dr^2 + r^2\left(d\phi^2 + \sin^2\phi d\theta^2\right).$$

By the replacement of radius r in the form of $r = R \cdot \rho \cdot \left(1 + \frac{\rho^2}{4}\right)^{-1}$ [2], the resulting replacement transforms this rod to

$$ds^2 = R^2\left(1 + \frac{\rho^2}{4}\right)^{-2}\left[d\rho^2 + \rho^2\left(d\phi^2 + \sin^2\phi d\theta^2\right)\right],$$

which guarantees that the topology is embedded into a flat metric at short distances. Hereby, the rod volume is given by $ds^3 = R^3\left(1 + \frac{\rho^2}{4}\right)^{-3} \rho^2 d\rho \cdot \sin(\phi) \cdot d\theta \cdot d\phi$, $0 \le \rho < \infty$, $0 \le \phi \le \pi$ and $0 \le \theta \le 2\pi$. Thus, $s(\rho) = \frac{2}{\pi}\int_0^{2\rho}\left(1 + \frac{\xi^2}{4}\right)^{-3} \xi^2 d\xi$ represents a share in respect to the whole hyper-sphere volume $2\pi^2 R^3$, i.e., the volume of three-dimensional globe/topology of radius ρ filled with matter equals $U(\rho) = 2\pi^2 R^3 s(\rho)$. Taking the integral into account, we obtain

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

Hence, with regard to $U(\rho)$, the equilibrium equation can now be rewritten as:

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

assuming that the equality $G \cdot R^3 = 1$ holds.

IV. Current State Calibration

Parameters Λ, λ and μ represent a triplet in Equation (2), where $-\Lambda$ is a mass-energy emerging quasi-level that speculatively characterizes dark energy

[2] This replacement is related to Landau and Lifshits, p. 435, The Field Theory, Russian ed., 1967.

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field, λ is a tuning or calibrating parameter for the allegedly potential energy of the field itself, and μ denotes our speculative quasi-density of the topology. By introducing the constraint $G \cdot R^3 = 1$, we have succeeded in calibrating the roots of the equation, adopting the triplet $\Lambda = 0.91499$, $\lambda = 0.83751$ and $\mu = 0.12457$. The modified potential energy $-G \cdot \dfrac{M}{\rho^{\lambda}}$ declines for $\lambda < 1$ more rapidly at shorter distances (i.e., when $0 < \rho \le 1$) than for far away distances (when $1 < \rho < \infty$). This parameter value set provides the best fit to the Planck Mission Statement.

With respect to roots of the speculative equation (2), in order to calibrate it, the roots must point at the latest Plank Mission data of the mass-energy composition in the Universe with high accuracy. By implementing a ratio scale of quasi-density on the x-axis as a ratio of quasi-density μ to somewhat critical density $\mathcal{C}$, i.e., $\mu \cdot \mathcal{C}^{-1}$, while moving from higher to low quasi-density values, the roots should confirm, or at least not contradict, the already known statements about the Universe dynamics. In fact, Equation (2) can almost always be solved for two roots $\rho_0 < \rho_1$. The case with one root $\rho_0 = \rho_1$, as well as that described by $\rho_s = 0$, exist as well, as do those including no roots at all. For the triplet above, the roots $\rho_0 = 0.67535$ and $\rho_1 = 3.06548$ solve Equation (2). It can thus be verified that:

$$vm\% \,\big|\, s(\rho_0) \approx 26.785\%,$$
$$de\% \,\big|\, s(\rho_1) - s(\rho_0) \approx 68.300\%,$$
$$dm\% \,\big|\, s(\infty) - s(\rho_1) \approx 4.915\%.$$

These percentages, with regard to the Plank Mission Statement, allow us to refer to ρ_1 as a visible matter starting point, which terminates at ∞. We can refer to ρ_0 as the dark energy starting point, whereby the dark energy terminates when it reaches ρ_1. In r-reference system $r = 2R\rho \cdot (1+\rho^2)^{-1}$, $r_0 - r_1$ denotes the dark energy width. From the above, it can thus be inferred that, while the percentages provide almost a 100% overlap with the Planck Mission Statement, the roots ρ_0 and ρ_1 produce a good fit only when $\mu = 0.12457$. Whatever the value $\mu = 0.12457$ of the quasi-density parameter proposes or is interpreted to imply, this Speculation points at $\mu = 0.12457$ as an alleged current state of the Universe.

a) *Comments on Figure-1*

Figure-1 shows the dynamics of dark energy as a function of quasi-density. The scale of the quasi-density on the x-axis extends from its critical value 1, and will continue to reflect the dark energy width while shifting 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 [13] precedes that of the visible matter because the gap between the two forms increases. When the distance

$$2R \cdot \left(\rho_1 (1+\rho_1^2)^{-1} - \rho_0 (1+\rho_0^2)^{-1}\right),$$

which equals $r_1 - r_0$ on the y-axis, reaches some point, it stops increasing, closing the aforementioned gap. The reduction, as indicated in Figure-1, will be most pronounced in the vicinity of 1, where the red circle indicates the end of the evolution of the topology—the moment of reaching the critical density $\mathcal{C}$. 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. One should pay attention to the state of the topology at the current stage—denoted by the green circle—at which the turnaround point of the present state of the topology has already been passed. When the gap started closing, the quasi-density of matter was about three times greater than that at the present state.

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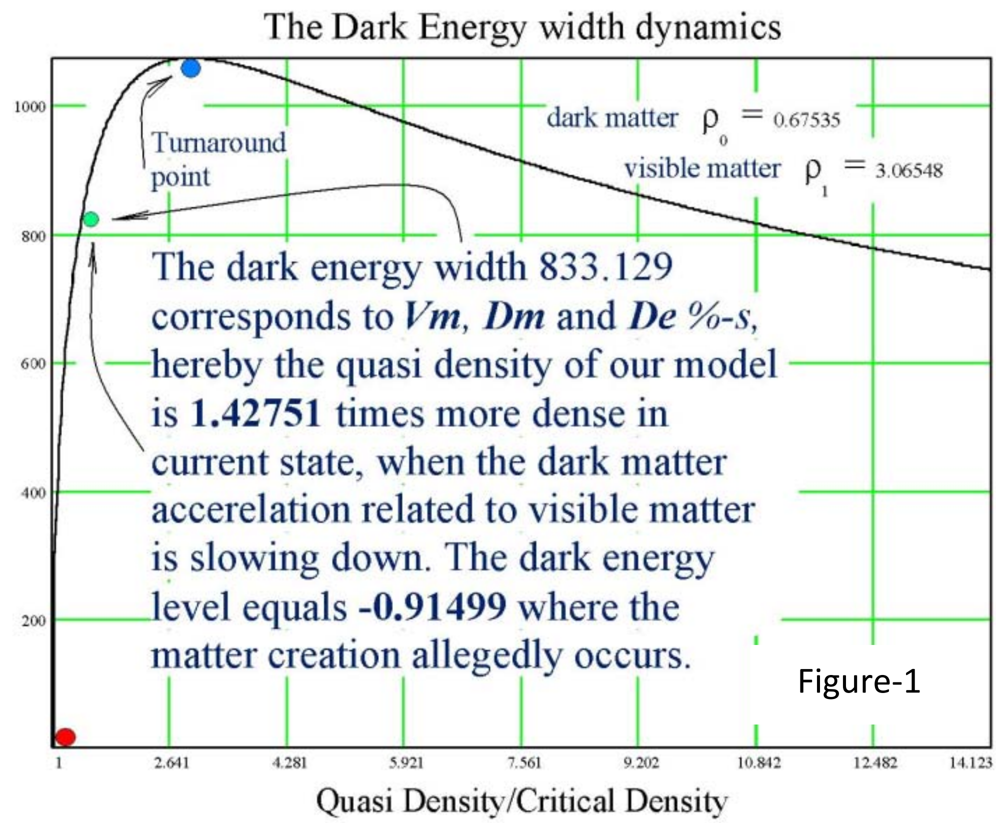

V. Rejection Attempts

a) The Case A. Speculation

The conclusion made here is based on the premise that, in line with this Speculation in question, the topology must stop changing its composition when the quasi-density declines below the threshold $\mu < 0.08727$. In this case, the dark matter will *collapse into or be in contact* with the visible topology when $\mu \approx 0.08727$ because $\rho_0 \approx \rho_1$. Let introduce a scale that commences at the point corresponding to the critical quasi-density ratio $\mu \cdot \mathcal{C}^{-1} \approx 1$, $\mathcal{C} \approx 0.08727$. On this scale, the current composition of the topology points at the ratio ≈ 1.42751. In contrast, when $\mu \cdot \mathcal{C}^{-1}$ exceeds very high values on the quasi-density scale, a negligible or infinitesimally small lump of dark matter suddenly emerges from the zero solution $\rho_s = 0$ of our speculative equation, Eq. (2), yielding

$$dm\% \approx 20.849742 \cdot 10^{-10}\% \text{ and}$$

$$vm\% = 0.00 \cdot 10^{-10}\%$$

for the visible matter. This fits well into the beginning of "*dark ages of the universe*" [14], indicating that dark energy $De\% = 99.99999999791503\%$ constitutes almost the entire topology, as illustrated by Figure-2. At the other end of the scale, when quasi-density decreases, and thus starts approaching the critical level $\mathcal{C} \approx 0.08727$, 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 the equation to have a root is reached when $\mu \cdot \mathcal{C}^{-1} \to 1$, where the dark energy width approaches zero $(\rho_1 - \rho_0 \to 0)$. Thus, the roots of our speculative equilibrium equation, Eq. (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. $\Omega_0 = 1.0010 \pm 0.0065$ away from a conventional critical density $\Omega = 1$, required for it to expand forever, as hypothesized according to the standard LCDM model [4].

i. Comments on Figure-2

Figure-2 depicts the case of quasi-density exceeding a critical value $\mathcal{C} \approx 0.08727$ 22.918.675 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. To paraphrase this statement, we posit that the dark matter was created first, i.e., it preceded the visible matter creation—that is, the inflation Bang of the Big Bang resulted in the emergence of the dark matter only.

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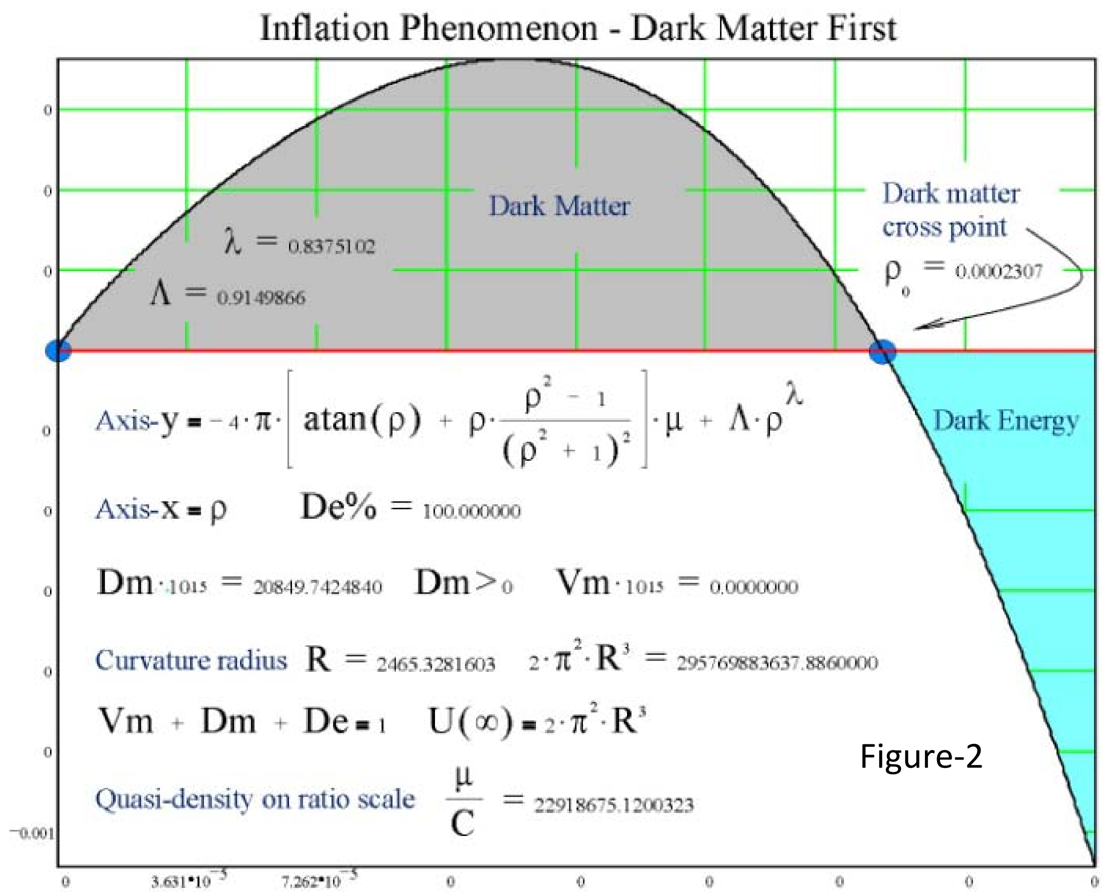

Figure-2

ii. *Comments on Figure-3*

The graphical illustration provided in Figure-3, denoting the link between the FLRW metric space filled with 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 in the coordinate system $r = 2R\cdot\rho(1+\rho^2)^{-1}$ on three-dimensional surface of our four-dimensional hyper-sphere. While moving towards coordinate values $1<\rho\to\infty$ the radius tends to zero $(r\to 0)$. Consequently, there is no one-to-one mapping of $[0,\infty]\to[0,R]$ because $[0,1]\to[0,R]$ and $[1,\infty]\to[R,0]$ and back again to 0 point. The values $0\le\rho\le 1$ of ρ thus correspond to $0\le r\le R$.

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

two roots ρ_0,ρ_1 resolve the equation $\Gamma(\mu,\rho)=0$, at which the formation of matter allegedly occurs. Hence, it can be seen that Figure-2 corresponds to the quasi-density of matter $\mu = 0.12457$ supposedly representing the current state of the topology. While passing through the area highlighted in grey, 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. Positive values $\Gamma(\mu,\rho)$ indicate the region in the FLRW metric space, where the alleged formation of dark and visible matter already occurred. Moving into 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 topology. Reaching the radius r_1, we enter the region of visible matter, occupying about 4.9% and moving away from $\rho_1\le\rho\to\infty$. As depicted in Figure-2, at the radius r_1 and beyond, visible matter cannot be in contact with the dark energy in a coordinate system $\rho\in(0,\rho_1)$. However, as it can be seen, it is superposed 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 available data yielded by the Planck Mission [15-18] measurements.

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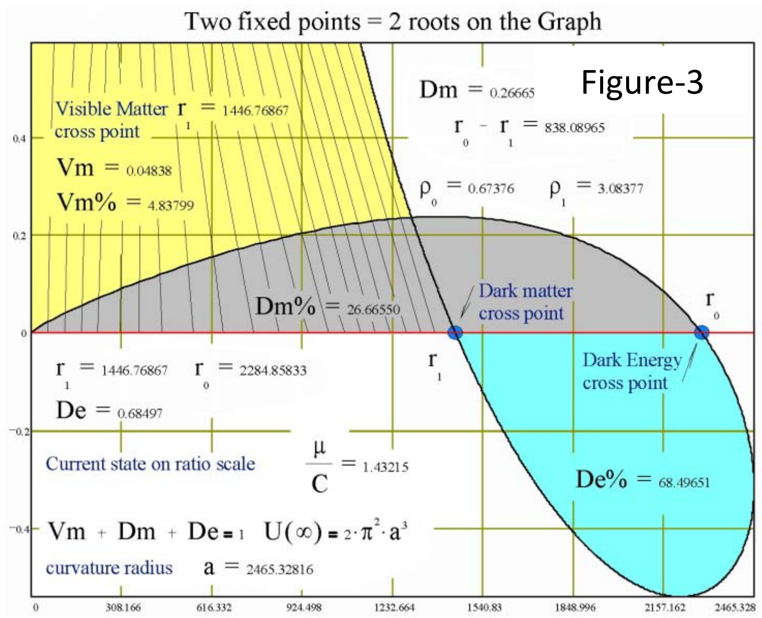
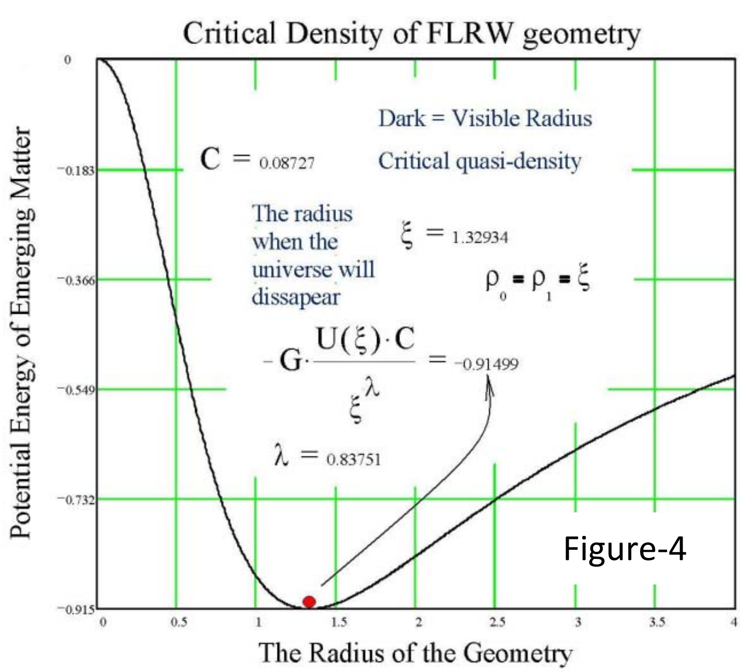


iii. Comments on Figure-4

The case presented by Figure-4 depicts the quasi-potential energy depending on the radius starting point 0 on the x-axis, in the respective coordinate system ρ, when our speculative equation of matter formation allowed only a single root, $\rho_0 = \rho_1$. This is the last *moment* after which the evolution of the topology supposedly ceases, since the formation of the new matter will terminate upon reaching the critical density $\mathcal{C}$. At this last *quasi-moment*, when the radius $\rho_0 = \rho_1 = 1.32934$, as resolved by our equation, the quasi-density of matter in the topology will be critical, $\mathcal{C} \approx 0.08727$. In the current state of the topology, its quasi-density equals $\mu = 0.12457$, which, as already pointed above, is 1.42751 times higher than the critical density $\mathcal{C}$ on the scale with regard to the critical density starting point. The values of the quasi-potential energy $-G \cdot \dfrac{U(\rho) \cdot \mathcal{C}}{\rho^{\lambda}}$ are depicted on the y-axis. The $U(\rho)$ shown in Figure-4 is equal to the volume of a globe of radius ρ multiplied be the critical quasi-density $\mathcal{C}$ 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.



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b) The Case B. Speculation

Note that the topology given by Equation (1), in contrast to that usually adopted in cosmology, does not contain the space-time coordinate. Instead, we utilized the quasi-density parameter μ, which declines from very high values—$1.5 \cdot 10^9$ times greater than $\mathcal{C}$. Next, we attempt to move the quasi-density back towards the critical value $\mathcal{C} \approx 0.08727$. Replacing the evolution of our metric space by the quasi-density μ parameter is intuitive, due to the scale of *densities*, where declining values replicate the dynamics of matter formation within the topology. Our calculus shows that, as the quasi-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 $\mathcal{C} \approx 0.08727$.

The Hubble's law describes a relationship between the genuine velocity v and the redshift of a galaxy at a proper distance ρ over time t. It denotes genuine $v = H_0\rho$, where H_0 is the Hubble's constant, $H_0 \approx \frac{67.15 km/s}{Mpc}$. Thus, in our calculus we reproduced the same effect, albeit on the quasi-density scale. While our *quasi-velocity* highlights the topology dynamics differently, it does so in a quasi-density μ reference system similar to Hubble's law. In doing so, our topology allegedly implies that, in the past, the visible $\dot{v}(\mu) > 0$ and the dark matter $\dot{d}(\mu) > 0$ quasi-velocities were in reverse order relative to the current 1.42751 more *crumbly* composition. This swap leads to a rather unexpected puzzle.

The Speculation suggests that the dark and visible topology are expanding along a *three-dimensional Moebius strip* but from its opposite sides—at the radius $\rho = 0$ and $\rho = \infty$. In other words, if an observer in the past was inside the dark part of the strip, the dark matter would be allegedly shifting away from the visible matter. Yet, at some "turn-around or speeding up point," the visible matter gained speed and started to shift towards the dark matter. Thus, the visible matter started to come increasingly closer to the dark matter because the quasi-velocity of the dark part of the matter might have started to decline in relation to that of the visible matter. While both the visible and the dark matter are still expanding with quasi-velocity, the former will collapse into or be in contact with the latter at some future point, as discussed above. After the collapse, both the dark and the visible matter must complete their expanding evolution. The Speculation implies that, owing to not being far away from the collapse point, the dark matter allegedly changed its dynamics to negative quasi-velocity, i.e., merged back.

Our calculus suggests that the turnaround point allegedly occurred in the past when quasi-density on the ratio scale was, as already noted, approximately three times the critical density $\mathcal{C} \approx 0.08727$. Currently, our geometric equation resolution suggests that $\mu = 0.12457$ and the topology had already passed the turnaround point. This speculative conclusion can neither be rejected nor confirmed by observations. Beyond all these graphical presentations and Speculations, this Speculation does not contradict, but rather supports, the NASA SCIENCE ASTROPHYSICS statement: *"…then came 1998 and the Hubble Space Telescope (HST) observations of very distant supernovae that showed that, a long time ago, the Universe was actually expanding more slowly than it is today."* This indicates that the universe is actually older than implied by a simple calculation using the current Hubble constant.

i. *Comments on Figure-5 and Figure-6*

Our main Speculation, which is illustrated in Figure-5 and Figure-6, reveals the fundamental difference in the dynamics of dark and visible matter. For observers, it is a known puzzle that, in contradiction with the laws of gravity, the visible matter continues to expand. The gravity laws imply that the visible matter should start to contract. Yet, in contrast, the observations suggest that the visible part of the universe continues to expand. On graphs depicted in Figure-5 and Figure-6, this effect is readily apparent—the quasi-velocity of matter formation within the topology continues to accelerate, whereby the topology filled with matter is increasing in size while moving from very high values of the decreasing quasi-density to lower values. When the quasi-density in the vicinity of the critical value is analysed, the alleged dark matter dynamics seem to be better aligned with the laws of gravity. In Figure-5, in the vicinity of the critical value, the dark matter begins to contract. More specifically, the quasi-velocity of the dark matter formation reaches zero and becomes 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-5, the dark matter density continues to decrease as it contracts. We might thus conclude that the dynamics of the evolution of both the dark and visible matter, accounting for the decreasing quasi-density, do not correspond to the known laws of physics. It seems that these laws have been have been violated differently.

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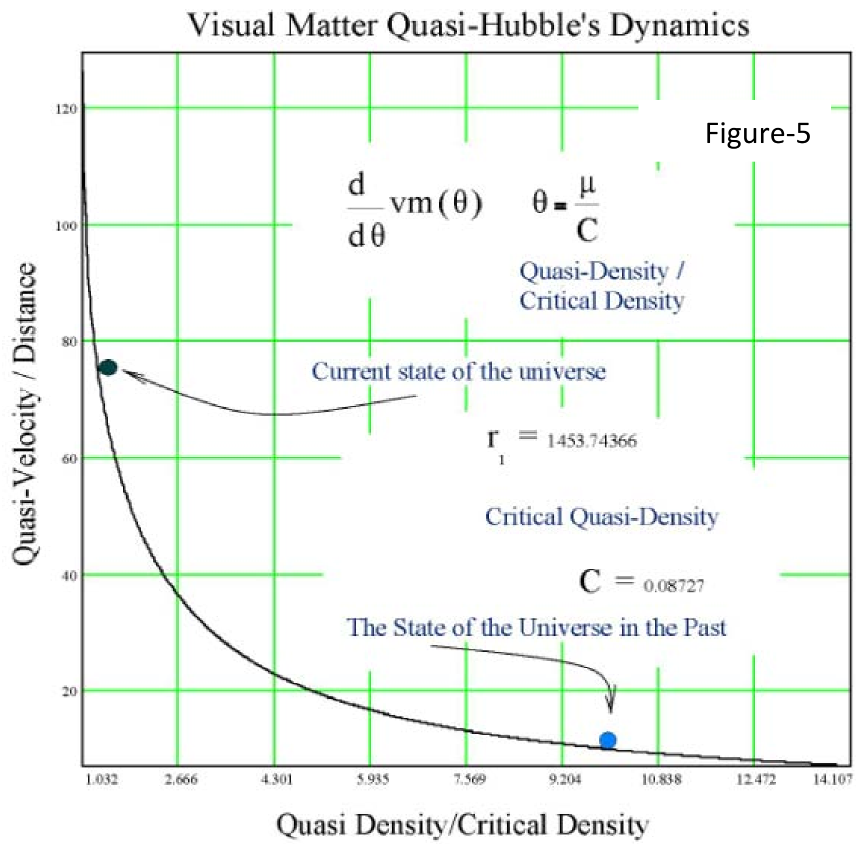

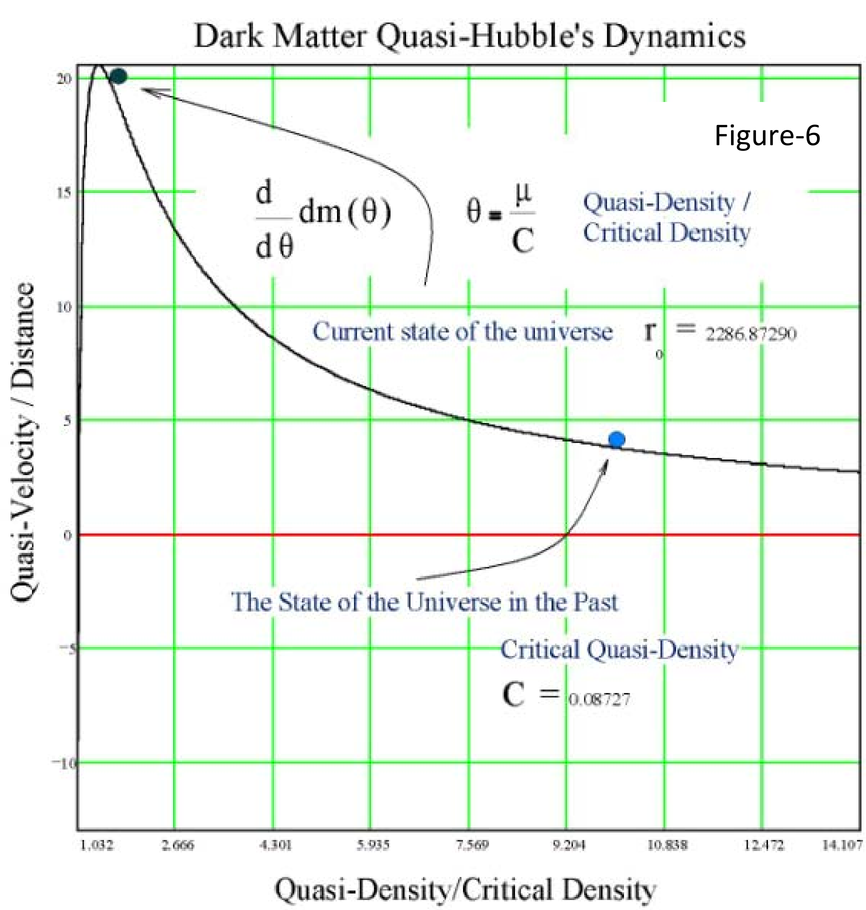

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c) The Case C. Speculation

Here, we examine the relationship between the radial coordinates r and ρ: $r=\dfrac{2\cdot R\cdot\rho}{1+\rho^2}$, $0\le r<R$, $0\le\rho<\infty$. The relationship $\rho\to r$ represents a mapping between $[0,R)$ and $[0,\infty)$. It should be noted that, in accordance with this relationship $\rho\to r$, we observe that $\infty\to 0$, $0\to 0$ and $1\to R$. One can imagine this topology by recalling a three-dimensional Moebius strip. Actually, for an external observer, $\rho=0$ and $\rho=\infty$ point at the same location, albeit at allegedly opposite sides of the strip. Hence, the relationship $\rho\to r$ does not represent a one-to-one mapping. Given two roots ρ_0, ρ_1—which were calculated using the quasi-density $\mu=0.12457$, as explained above—the relationship can be denoted by $\rho_0\to De$, $\rho_1\to Vm$. One can verify that, due to the absence of one-to-one mapping between coordinates r and ρ, the dark energy starting at ρ_0 corresponds to the dark matter ending at ρ_0. Another part of the dark matter globe co-exists with higher values in the radial r reference system, which accounts for the visible matter of radius ρ_1. No area in the r reference system exists in which the dark energy and visible matter can coexist.

According to the NASA Science Astrophysics statement: *One explanation for dark energy is that it is a property of space. Albert Einstein was the first person to realize that empty space is not nothing. Space has amazing properties, many of which are just beginning to be understood. The first property that Einstein discovered is that it is possible for more space to come into existence. Then one version of Einstein's gravity theory, the version that contains a cosmological constant, makes a second prediction: "empty space" can possess its own energy. Because this energy is a property of space itself, it would not be diluted as space expands. As more space comes into existence, more of this energy-of-space would appear. As a result, this form of energy would cause the Universe to expand faster and faster. Unfortunately, no one understands why the cosmological constant should even be there, much less why it would have exactly the right value to cause the observed velocity of the Universe.*

Once again, we cannot conclude that this Speculation contradicts the presently known and observable consequences in regard with the exhibits above.

VI. Concluding Remarks

In this work, we presented a speculative equilibrium equation that described the matter composition at the point of emergence from dark energy and as it continues to emerge. Some speculative conclusions with regard to dark matter dynamics were derived by calibrating the equation in accordance with the current mass-energy composition of the Universe.

Finding the equation roots might have some predicting power, since they are nearly 100% compatible with the Planck Mission Statement. None of our Speculations presented here fundamentally contradict the latest measurements of the data composition between the percentages of visible and dark matter in proportion to the dark energy. The absence of contradictions is achieved due to the calibration and imposing the relationship $G\cdot R^3=1$ between the radius of curvature of the space and the gravitational constant. The latter ensured that we eliminated the ambiguity of outcomes of the visible and dark matter fractions in proportion to the dark energy in case the grid of measurement for gravitational constant G is changed (i.e., the case when the grid guarantees the correct output irrespective of whether G is measured in meters, kilometres, or any other units). Our speculative equation required fine-tuning or calibration of so-called Λ-parameter of speculative mass-energy phase transition level and 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 quasi-density. While acknowledging that the explanation requires more convincing arguments, we proceeded with our analyses by assuming that the quasi-density was in line with the "normal density" of matter. The concept of quasi-density allowed us to interpret, as well as predict, the dynamics and quasi-velocity of matter formation within the FLRW topology. It was also possible to make assertions that essentially coincide with the NASA statement that, in the past, the topology expanded more slowly than it does presently. As our topology implies, only a tiny globe of dark matter solves the equation at high/right side of quasi-density scale. At high quasi-density, the topology comprised solely of dark energy, since the visible matter radius suggested almost a zero solution. At the low/left end of the scale, approaching the critical value, the dark matter, in contrast to the visible matter, will allegedly start to diminish.

VII. Mathematical Derivation

In what follows, we refer to the work of Landau and Lifshits, page. 430, The Field Theory, Russian, M., 1967, describing homogeneous and isotropic, closed model with positive curvature. We use Landau and

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Lifshits modification in transforming the FLRW metric to a flat metric at short distances.

The FLRW metric—the Friedmann-Lemaître-Robertson-Walker metric—starts with the assumption of homogeneity and isotropy. It also assumes that the spatial component of the metric can be time dependent. The generic metric that meets these conditions is given by:

$$ds^2 = dt^2 - s(t)^2\left[\frac{dr^2}{1-\kappa\cdot r^2} + r^2\left(d\theta^2 \sin(\phi)\right)^2 + d\phi^2\right],$$

where κ describes the curvature and is constant in time, and $s(t)$ is the scale factor, which is explicitly time dependent. We do not use the grid in which the speed of light is set to unity. Instead, we adopt the grid factor $s(t) = const = 1$, curvature $\kappa = \frac{1}{R^2}$, where R is the radius of positive curvature. Thus, we eliminate time from all considerations. Our derivation follows.

$$(x_1)^2 + (x_2)^2 + (x_3)^2 + (x_4)^2 = R^2$$

The equation of hyper-sphere in four-dimensional space upon grid = 1 (if $R > 0$, the curvature is positive).

$$ds^2 = (dx_1)^2 + (dx_2)^2 + (dx_3)^2 + (dx_4)^2$$

The lengths of a rod on the sphere

$$(x_4)^2 = R^2 - (x_1)^2 + (x_2)^2 + (x_3)^2$$

Using this equation, we obtain

$$x_4 \cdot dx_4 = -(x_1dx_1 + x_2dx_2 + x_3dx_3)$$

Where

$$dx_4 = -\frac{(x_1dx_1 + x_2dx_2 + x_3dx_3)}{x_4}$$

$$(dx_4)^2 = \frac{(x_1dx_1 + x_2dx_2 + x_3dx_3)^2}{(x_4)^2}$$

$$(dx_4)^2 = \frac{(x_1dx_1 + x_2dx_2 + x_3dx_3)^2}{R^2 - [\ (x_1)^2 + (x_2)^2 + (x_3)^2\ ]}$$

Finally, we obtain:

$$ds^2 = (dx_1)^2 + (dx_2)^2 + (dx_3)^2 + \frac{(x_1dx_1 + x_2dx_2 + x_3dx_3)^2}{R^2 - [\ (x_1)^2 + (x_2)^2 + (x_3)^2\ ]} \tag{7.1}$$

$r = \sqrt{(x_1)^2 + (x_2)^2 + (x_3)^2}$. The spherical coordinates x_1, x_2, x_3 are related to the flat coordinates by $\theta = \tan^{-1}\left(\frac{x_2}{x_1}\right)$, $\phi = \cos^{-1}\left(\frac{x_3}{r}\right)$,

where $0 \le r < R$, $0 \le \theta \le 2\cdot\pi$, and $0 \le \phi \le \pi$, and the inverse tangent, $\tan^{-1}$ must be suitably defined to take the correct quadrant of (x_1, x_2) into account.

In terms of spherical coordinates, $x_1 = r\cdot\cos(\theta)\cdot\sin(\phi),\ x_2 = r\cdot\sin(\theta)\cdot\sin(\phi),\ x_3 = r\cdot\cos(\phi).$

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$$dx_1=\left[\frac{d}{dr}\left(r\cdot\cos(\theta)\cdot\sin(\phi)\right)\right]dr+\left[\frac{d}{d\theta}\left(r\cdot\cos(\theta)\cdot\sin(\phi)\right)\right]d\theta+\left[\frac{d}{d\phi}\left(r\cdot\cos(\theta)\cdot\sin(\phi)\right)\right]d\phi$$

$$dx_1=\cos(\theta)\cdot\sin(\phi)\cdot dr-r\cdot\sin(\theta)\cdot\sin(\phi)\cdot d\theta+r\cdot\cos(\theta)\cdot\cos(\phi)\cdot d\phi$$

$$dx_2=\left[\frac{d}{dr}\left(r\cdot\sin(\theta)\cdot\sin(\phi)\right)\right]dr+\left[\frac{d}{d\theta}\left(r\cdot\sin(\theta)\cdot\sin(\phi)\right)\right]d\theta+\left[\frac{d}{d\phi}\left(r\cdot\sin(\theta)\cdot\sin(\phi)\right)\right]d\phi$$

$$dx_2=\sin(\theta)\cdot\sin(\phi)\cdot dr+r\cdot\cos(\theta)\cdot\sin(\phi)\cdot d\theta+r\cdot\sin(\theta)\cdot\cos(\phi)\cdot d\phi$$

$$dx_3=\left[\frac{d}{dr}\left(r\cdot\cos(\phi)\right)\right]dr+\left[\frac{d}{d\theta}\left(r\cdot\cos(\phi)\right)\right]d\theta+\left[\frac{d}{d\phi}\left(r\cdot\cos(\phi)\right)\right]d\phi$$

$$dx_3=\cos(\phi)\cdot dr-r\cdot\sin(\phi)\cdot d\phi$$

We can thus substitute all the above expressions into $x_1dx_1+x_2dx_2+x_3dx_3$

Finally, by collating the sub-expressions, and after performing simplifications, we obtain

$$x_1dx_1+x_2dx_2+x_3dx_3=r\cdot dr$$

$$\left(x_1\right)^2+\left(x_2\right)^2+\left(x_3\right)^2=r^2$$

$$\left(dx_1\right)^2+\left(dx_2\right)^2+\left(dx_3\right)^2=dr^2+r^2\cdot\left(d\theta^2\cdot\sin^2(\phi)+d\phi^2\right)$$

Substituting the last expressions into Eq. (7.1) yields

$$ds^2=dr^2+\frac{r^2\cdot dr^2}{R^2-r^2}+r^2\cdot\left(d\theta^2\cdot\sin^2(\phi)+d\phi^2\right)$$

It can be verified that

$$dr^2+\frac{r^2\cdot dr^2}{R^2-r^2}=dr^2\cdot\left(1-\frac{r^2}{R^2-r^2}\right)=dr^2\cdot\frac{a^2}{R^2-r^2}=\frac{dr^2}{1-\left(\frac{r}{R}\right)^2}$$

This results in $ds^2=\dfrac{dr^2}{1-\left(\frac{r}{R}\right)^2}+r^2\cdot\left(d\theta^2\cdot\sin^2(\phi)+d\phi^2\right)$

Let us make a substitution $r=\dfrac{a}{1+\dfrac{a^2}{4\cdot R^2}}$ in order to ensure

that the surface rod ds^2 is proportional to a flat space at short distances, $0\le a<\infty$, $0\le r<R$. When $a=0$, then $r=0$; when $a=2\cdot R$, then $r=R$; when $a=\infty$, then $r=0$ once again. The replacement maps two points $a=0$ and $a=\infty$ into one point $r=0$ akin to a *three-dimensional Moebius strip* (Please refer to the example given at p. 435, Landay and Lifshits, The Theory of Field, Russian edition, 1967).

$$dr=\left[\frac{d}{dR}\left(\frac{a}{1+\frac{1}{4}\frac{a^2}{R^2}}\right)\right]da$$

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$$ds^2 = \frac{\left\{\left[\frac{d}{dR}\left(\frac{a}{1+\frac{1}{4}\frac{a^2}{R^2}}\right)\right]da\right\}^2}{1-\frac{\left(\frac{a}{1+\frac{1}{4}\frac{a^2}{R^2}}\right)^2}{R^2}} + \left(\frac{a}{1+\frac{1}{4}\frac{a^2}{R^2}}\right)^2 \cdot \left(d\theta^2 \cdot \sin^2(\phi) + d\phi^2\right)$$ We continue

$$ds^2 = \left[\frac{1}{\left(1+\frac{1}{4}\frac{a^2}{R^2}\right)} - \frac{1}{2}\frac{a^2}{\left(1+\frac{1}{4}\frac{a^2}{R^2}\right)^2 R^2}\right]^2 \frac{da^2}{1-\frac{a^2}{\left(1+\frac{1}{4}\frac{a^2}{R^2}\right)^2 R^2}} + \frac{a^2}{\left(1+\frac{1}{4}\frac{a^2}{R^2}\right)^2}\left(d\theta^2 \cdot \sin^2(\phi) + d\phi^2\right)$$

$$ds^2 = 16 \cdot R^4 \cdot \frac{\left(da^2 + a^2 \cdot d\theta^2 \cdot \sin^2(\phi) + a^2 \cdot d\phi^2\right)}{16 \cdot R^4 + 8 \cdot a^2 \cdot R^2 + a^4} = \frac{da^2 + a^2 \cdot d\theta^2 \cdot \sin^2(\phi) + a^2 \cdot d\phi^2}{\frac{16 \cdot R^4 + 8 \cdot a^2 \cdot R^2 + a^4}{16 \cdot R^4}}$$

$$ds^2 = \frac{da^2 + a^2 \cdot d\theta^2 \cdot \sin^2(\phi) + a^2 \cdot d\phi^2}{1+\frac{1}{2}\left(\frac{a}{R}\right)^2 + \left(\frac{1}{4}\right)^2\left(\frac{a}{R}\right)^4} = \left[1+\frac{1}{4}\left(\frac{a}{R}\right)^2\right]^{-2}\left(da^2 + a^2 \cdot d\theta^2 \cdot \sin^2(\phi) + a^2 \cdot d\phi^2\right)$$

$$ds^2 = R^2\left(1+\frac{\xi^2}{4}\right)^{-2}\left[d\xi^2 + \xi^2\left(d\phi^2 + \sin^2(\phi) \cdot d\theta^2\right)\right]$$

after implementing the replacement

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

$$ds^3 = R^3\left(1+\frac{\xi^2}{4}\right)^{-3} \xi^2 d\xi \cdot \sin(\phi) d\phi$$

within a coordinate triple:

$$0 \le \xi < \infty \; ,$$

$$0 \le \theta \le 2 \cdot \pi \quad \text{and}$$

$$0 \le \phi \le \pi \; .$$

$$R^3 \int_0^{2\pi} \int_0^{\pi} \int_0^{d} \left(1+\frac{\xi^2}{4}\right)^{-3} \xi^2 d\xi \cdot \sin(\phi) d\phi$$

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The hyper-sphere globe of a diameter d. N.B. The di-ameter d makes sense as a new dimension, by which the space volume is proportional to the flat space at short distances. it should be noted that it is not equivalent to twice the $2\cdot r$, where r is the original radius of our four-dimensional hyper-sphere.

Taking the integral into account, we can derive the expression for a volume

$$4\cdot R^3\cdot\pi\cdot\frac{\left(-8\cdot d+16\cdot\tan^{-1}(\tfrac{1}{2}d)+\tan^{-1}(\tfrac{1}{2}d)\cdot d^4+2\cdot d^3+8\cdot\tan^{-1}(\tfrac{1}{2}d)\cdot d^2\right)}{\left(4+d^2\right)^2} \tag{7.2}$$

After accounting for the sub-expression $\tan^{-1}(\tfrac{1}{2}d)$, we obtain

$$4\cdot R^3\cdot\pi\cdot\frac{\left(16+d^4+8\cdot d^2\right)}{\left(4+d^2\right)^2}\cdot\tan^{-1}(\tfrac{1}{2}d)+4\cdot a^3\cdot\pi\cdot\frac{\left(-8\cdot d+2\cdot d^3\right)}{\left(4+d^2\right)^2},\quad \left(16+d^4+8\cdot d^2\right)=\left(4+d^2\right)^2$$

It should be noted that $\dfrac{\left(-8\cdot d+2\cdot d^3\right)}{\left(4+d^2\right)^2}=4\cdot\dfrac{d}{2}\cdot\dfrac{d^2-4}{\left(d^2+4\right)^2}=4\cdot\dfrac{d}{2}\cdot\dfrac{4\cdot\left(\frac{1}{4}d^2-1\right)}{4\cdot\left[\left(\frac{1}{4}d^2+1\right)\cdot\left(d^2+4\right)\right]}$.

Finally, we arrive at

$$\frac{d}{2}\cdot\frac{\left(\frac{1}{4}d^2-1\right)}{\left(\frac{1}{4}d^2+1\right)\left(\frac{1}{4}d^2+1\right)}=\frac{d}{2}\cdot\frac{\left(\frac{1}{2}d\right)^2-1}{\left[\left(\frac{1}{2}d\right)^2+1\right]\cdot\left[\left(\frac{1}{2}\cdot d\right)^2+1\right]}$$

Let us now make a substitution $\rho=\frac{1}{2}d$,

which yields $\rho\cdot\dfrac{\rho^2-1}{\left(\rho^2+1\right)^2}$

In conclusion, we obtain the form of the expression for the volume of a radius ρ globe as a three-dimensional globe within four dimensional hyper-surface of radius R, given by Eq. (7.2).

$$4\cdot\pi\cdot R^3\left(\tan^{-1}(\rho)+\rho\cdot\frac{\rho^2-1}{\left(\rho^2+1\right)^2}\right)$$

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