GRAVITATIONAL "ANOMALIES" CAUSED BY SHAPIRO DELAYED TRAVELING ENERGY QUANTA AROUND GALACTIC AND COSMIC SCALES STRUCTURES

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Abstract. In 1964, Irwin Shapiro pointed out that electromagnetic waves traveling near a gravitational well of a star were delayed due to relativistic Gravitational Time Dilation (GTD). This paper proposes that traveling energy quanta (mainly vacuum energy and gravitational waves, as well as neutrinos, electromagnetic waves, cosmic rays, stellar winds, and all other kinds of waves and relativistic particles yet to be discovered) accumulate in a Density Wave like mechanism around the galactic and cosmic scale structures because of Shapiro Delay. Ultimately, the accumulative effect is a substantial increase in energy density when seen from frames of reference far from the regions where it occurs. The higher energy density is imperceptible for an observer within its own frame of reference since the proposed mechanism nature is relativistic. The higher concentration of travelling energy quanta around galaxies and galaxy clusters is creating extra gravitational distortion in spacetime with its mass equivalent.

$$M_{\omega(R_o)} = 4\frac{\Omega_\lambda}{c^2} * \left(U_o - \int_0^{R_o} A_{(x)} \frac{T_{(x)}}{T_o} dx \right)$$

The Relativistically Accumulated Mass Equivalent Mechanism (RAMEN), using the equation above, matches without free parameters the tested local group galaxy rotation curves for all orbits using the same traveling energy density value. The paper proposes how all observations of "Dark Matter" can be easily explained by RAMEN. It predicts the existence of a Universe Traveling Energy Density in disagreement by several orders of magnitude with currently accepted Universe Critical Energy Density. The paper discusses how the Casimir Effect experiments directly confirm with less than 5% disagreement with Quantum Field Theory the existence of higher energy densities in the vacuum. It also discusses how we may have misunderstood the nature of the predominant form of energy in the universe and that have prevented us from understanding the gravitational anomalies attributed to "Dark Matter".

1 INTRODUCTION

1.1 The context. The gravitational anomalies around galaxies and cluster of galaxies have been identified and measured since the 30's [1-12]. The initial proposed hypotheses explaining the galactic rotational velocity discrepancies claiming the existence of an over abundance of unseen Baryonic objects [13-22] have been discarded after careful observations. The current explanations: On the one hand the hypotheses derived from Lambda Cold Dark Matter Model (LCDM) [23-27] currently the most accepted cosmological model, have failed to match the observations at the small scale in particular inside the inner galactic orbits (Radius<8 kpcs) in observed galaxies) [28-32]. On the other hand hypotheses derived or somehow related to Modified Newtonian Dynamics (MOND) [33-46] tend to fail to match the big scale observations of cosmic structure formation and in particular the Bullet Cluster Observation.

1.2 The new alternate. On this paper it is proposed a different alternative to the "either it is new matter particles or gravity is wrong" dilemma. As Albert Einstein taught us it is the presence of energy (not necessarily matter) what curves spacetime [49-52]. If the presented hypothesis is correct what needs to be revised is our current understanding of vacuum energy and the calculation for Universe Critical Energy Density an outstanding challenge better known as the Cosmological Constant Problem [53-60].

2 RELATIVISTICALY ACCUMULATED MASS EQUIVALENT MECHANISM (RAMEN) MODEL

2.1 The Mechanism. A higher concentration of traveling energy quanta in a region of space distorts spacetime fabric in the same way that mass would [49-,52]. A traveling energy quanta accumulation mechanism would be required and General Relativity framework, in particular Gravitational Time Dilation [61-65], provides such mechanism. Shapiro Delay [66-68], one of the classical tests of General Relativity, describes and experimentally confirms the delay that a quantum of traveling energy has when passing close to a gravitational well. If we take into account all traveling energy quanta crossing the universe we can infer that these quanta are being Shapiro delayed around galactic and cosmic scale structures [68] in a Density Wave like mechanism [69]. The model does not consider adding longer average path length in 3D space as explained by Irwin Shapiro[66,67] since its actual average effect is negligible with the exception of small regions (compared to galactic scales) close to black holes and neutron stars.

2.1 Calculating Relativistically Accumulated Mass Equivalent with a Given UniverseTraveling Energy Density. For a given Universe Traveling Energy Density (Ω_λ) and Orbital Radius (R_o) we could calculate the Relativistically Accumulated Mass Equivalent ($M_{\omega_{(R_o)}}$) inside R_o based on the observed Rotation Curve described by a velocity function of the radius ($V_{(x)}$). The Relativistically Accumulated Mass Equivalent inside R_o ($M_{\omega_{(R_o)}}$) is the product of the Universe Traveling Energy Density (Ω_λ) and the Volume of Accumulation inside R_o ($U_{\omega_{(R_o)}}$) divided by the speed of light squared(c^2).

$$M_{\omega_{(R_o)}} = \frac{\Omega_\lambda \, U_{\omega_{(R_o)}}}{c^2} \qquad (1)$$

Volume of Accumulation inside R_o ($U_{\omega_{(R_o)}}$) is the product of the Spherical Surface for R_o ($A_{(R_o)}$) times the Distance of Accumulation ($D_{\omega_{(R_o)}}$).

$A_{(R_o)} = 4\pi {R_o}^2$

$$U_{\omega_{(R_o)}} = A_{(R_o)} \, D_{\omega_{(R_o)}} \qquad (2)$$

Distance of Accumulation ($D_{\omega_{(R_o)}}$) is the product of the Average Chord inside R_o ($P_{\mu_{(R_o)}}$) times the differential of Average Time Dilation inside R_o $(1 - T\mu)$.

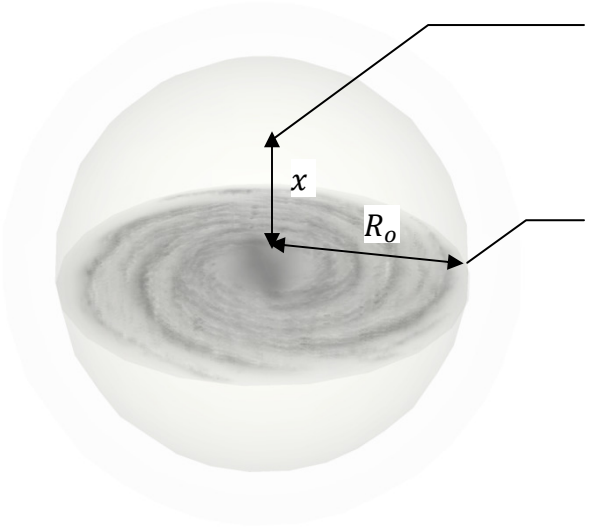
$$P_{\mu_{(R_o)}} = \frac{4}{3} R_o \,, \qquad D_{\omega_{(R_o)}} = P_{\mu_{(R_o)}} * (1 - T\mu) \qquad (3)$$

Also, the Average Delay (Δt_o) is the product of Average Chord Path for R_o sphere (P_μ) and the difference between the unit and the Average Time Dilation inside a $R_o$sphere (T_μ) divided by speed of light(c).

$$\Delta t_o = \frac{P_\mu (1 - T\mu)}{c} \,, \; D_\omega = c \Delta t_o \qquad (4)$$

Average Time Dilation (T_μ) as measured by an observer in the frame of reference orbiting the galaxy R_o is the integral of the product of all spherical surfaces ($A_{(x)}$) , Gaussian Surfaces [65], with equal static time dilation $T_{(x)}$, divided by the time dilation in the observer 's R_o orbital frame of reference (T_o). Our integration variable is the radius ($r = x$) from 0 to R_o. The result will be divided by the volume of the R_o sphere (U_o). This approximation will use the Schwarzschild Solutions [61-65] for Schwarzschild radii and time dilations for hypothetical concentric black holes ($r_{s(x)}$).

Fig. 1



Static Frame of Reference (Non-rotating)

$$\frac{T_{(x)}}{T_f} = \sqrt{1 - \frac{r_{s(x)}}{x}}$$

Orbiting Star Frame of Reference

$$\frac{T_o}{T_f} = \sqrt{1 - \frac{3}{2} \cdot \frac{R_s}{R_o}}$$

$$T_\mu = \frac{1}{U_{(R_o)}} \int_0^{R_o} A_{(x)} \frac{T_{(x)}}{T_{(R_o)}} dx \qquad (5)$$

$$T_\mu = \frac{1}{\frac{4}{3}\pi {R_o}^3} \int_0^{R_o} 4\pi x^2 \frac{\sqrt{1 - \frac{r_{s(x)}}{x}}}{\sqrt{1 - \frac{3}{2} \cdot \frac{R_s}{R_o}}} dx \qquad (6)$$

Moving the constant factors to outside the integration we get:

$$T_\mu = \frac{3}{{R_o}^3 T_o} \int_0^{R_o} x^2 \, T_{(x)} dx \qquad (7)$$

Combining Schwarzchild's solutions $r_s = \frac{2MG}{c^2}$, and orbital velocity $V = \sqrt{\frac{MG}{r}}$ we get $r_s = \frac{2V^2 r}{c^2}$

Now we replace the Schwarzchild radii with a Velocity funtion since that is the directlly measured data.

$$T_\mu = \frac{3}{{R_o}^3 \sqrt{1 - \frac{3{V_o}^2}{c^2}}} \int_0^{R_o} x^2 \sqrt{1 - \frac{2{V_{(x)}}^2}{c^2}} dx \qquad (8)$$

Our calculated Relativistically Accumulated Mass Equivalent can then be also expressed as:

$$M_{\omega(R_o)} = 4 \frac{\Omega_\lambda}{c^2} * \left(U_o - \int_0^{R_o} A_{(x)} \frac{T_{(x)}}{T_o} dx \right) \qquad (9)$$

2.2 Calculating the Traveling Energy Density. The model can be used to calculate the needed Traveling Energy Density needed to match all observed galactic rotation velocity curves by solving for Ω:

$$\Omega_\lambda = \frac{1}{4} M_{\omega(R_o)} \frac{c^2}{U_{\omega(R_o)}} = \frac{1}{4} M_{\omega_{(R_o)}} \frac{c^2}{\left(U_o - \int_0^{R_o} A_{(x)} \frac{T_{(x)}}{T_o} dx \right)} \qquad (10)$$

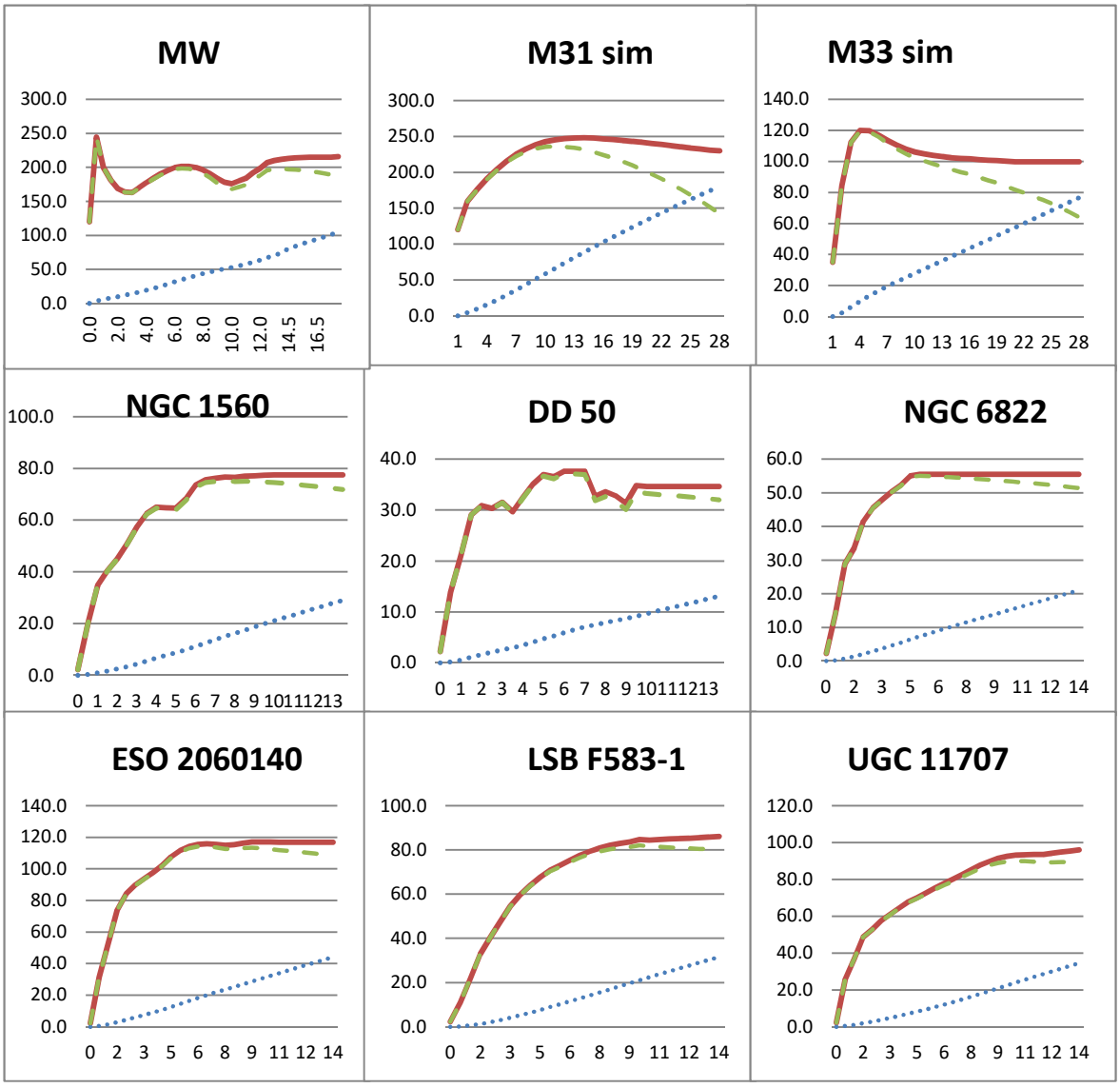
3 TESTING THE MODEL

3.1 Local Group Galactic Rotation Curves. Here it is presented the match with (9) local group galactic rotation curves [70-72] using the same Traveling Energy Density Parameter (it may be time dependent). The calculated Relativistically Accumulated Mass Equivalent Rotation Curves matching observations and the calculated Baryonic Mass Rotation Curve that matches the expected Keplerian curves are plotted using:

$V_\omega = \sqrt{\frac{M_\omega G}{R_o}}$ and $V_B = \sqrt{V_{(x)}{}^2 - V_\omega{}^2}$

Fig. 2

$$\boldsymbol{\Omega_\lambda = 6\, Joules/m^3}$$



Horizontal axes are the radii in kpcs, vertical axes are the rotation velocities in km/s, continuous lines indicate observed rotation curves (input data). Our results: Dotted lines indicate calculated RAMEN only rotation curves. Dashed lines indicate calculated baryonic only rotation curves matching expected Keplerian curves.

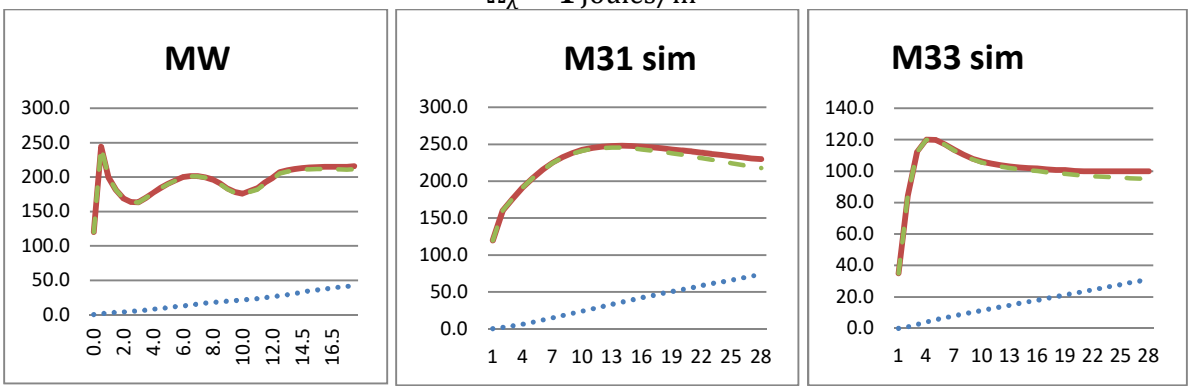
3.2 What the Model Tells. The model input are a given Universe Traveling Energy Density Ω_λ and rotational velocity observational data. The rotation curve described by the continuous line is plotted by statistical analysis of actual measurements of stars and gas velocities at particular orbital radii. Those measurements have been averaged taking into account the asymmetries that each particular galaxy has. From there, the model takes the velocity values $V_{(x)}$ in 0.5 kpcs separation between radii and calculates the total of Relativistically Accumulated Mass Equivalent inside each radius value ($r = x$) starting at the center the galaxy. Finally the model plots the calculated Baryonic only curve (Dotted lines). For worksheet file use this link: https://1drv.ms/w/s!AtzwZU8adFtMhYpwpnOqM6AsQJwJcQ

At $\Omega_\lambda = \mathbf{6}\,\text{Joules/m}^3$ the model shows a nice match with observed galaxy behavior; the expected Keplerian curves and the observed curves start to separate at around 8 kpcs in all galaxies. This is evidence that at this time in the universe the RAMEN phenomenon will be almost impossible to measure with current technology at even smaller radii. Likewise it shows how in Dwarf and Spiral Galaxies the phenomenon barely affects the rotation curves in their cores. Also, the RAMEN mass trend indicates that around 30 kpsc the rotation curves should rise again as has been observed.

If the model is tested with $\Omega_\lambda = \mathbf{1}\,\text{Joules/m}^3$ The expected Keplerian curves and the observed curves start to separate at around 16 kpcs in all galaxies. Likewise the RAMEN mass trend indicates that around 60 kpsc the rotation curves should rise again. Both behaviors contradict observations.

Fig. 3

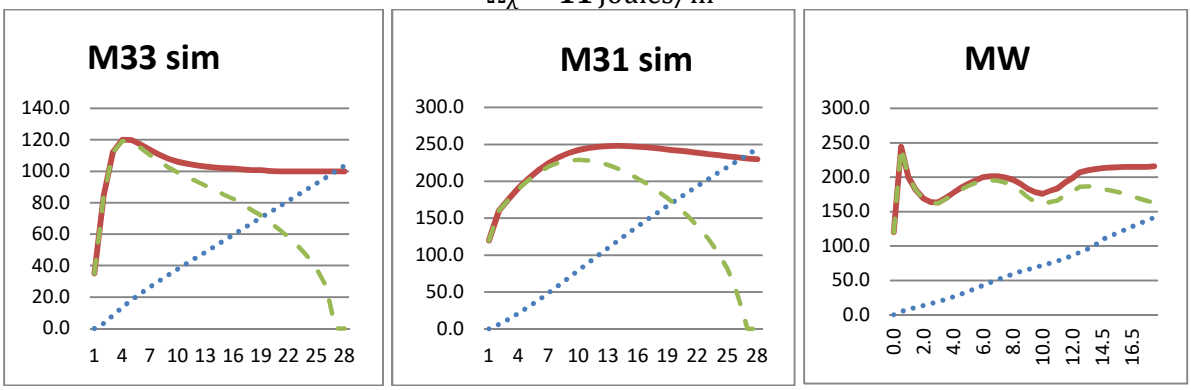
$\Omega_\lambda = \mathbf{1}\,\text{Joules/m}^3$



If the model is tested with $\Omega_\lambda = 11\,\text{Joules/m}^3$ The expected Keplerian curves and the observed curves start to separate at around 6 kpcs in all galaxies. Likewise the RAMEN mass trend indicates that around 25 kpsc the rotation curves should rise again. Both behaviors contradict observations.

Fig. 4

$\Omega_\lambda = \mathbf{11}\,\text{Joules/m}^3$



4 OTHER OBSERVATIONS EXPLAINED WITHIN RAMEN

4.1 Gravitational Lensing. The Relativistically Accumulated Mass Equivalent Mechanism can easily explain Gravitational Lensing Observations, although for the purpose of this paper actual calculations have not been performed. When an observer on Earth calculates mass around galaxies or clusters of galaxies by measuring the bending of light caused by gravitational lensing there are strong discrepancies [73-77] with the observed mass calculated from rotation velocities and/or x-ray redshift measurements evidencing the relativistically nature of the observed gravitational "anomalies". While per this model the mass calculation uses time dilation for the frame of reference of the orbiting probe at radius R; the calculation from gravitational lensing should use static time dilations in relationship the observer's frame of reference time dilation. This is needed since the observer becomes a part of the system (e.g. moving observer-rainbow system [78,79]).

4.2 Small Scale Observations. The model shows how the gravitational anomalies due to the Relativistically Accumulated Mass Equivalent Mechanism in radii < 6 kpcs are imperceptible e.g. galaxies inner orbits [80,81], solar system, stellar open and closed clusters etc. Also, the model explains why Dwarf Galaxies seem to be submerged in huge halos of unseen mass. The rotation velocities are suppose to rise in radius>30 kpcs almost linearly all the way to the Virial Radii [82]. It is unclear at this moment if there is an expanding nature of this type of Energy making the rotation curve deviate from the lineal trend at even bigger radii since it was not taken into account for this model.

4.3 Big Scale Observations. Each clump of Relativistically Accumulated Mass Equivalent is already curving spacetime by itself; it has a center of mass and inertia. A simulation using this model should reproduce the cluster of galaxies collisions as observed in the Bullet Cluster [47,48]. In fact in cosmic scales the described mechanism behaves as if the clumps were made out of matter particles that should match current understanding of cosmic web formation [83,84].

In the space between galaxies energy density gets higher than that of the surrounding space because of both galaxies' gravity dilating time compounded effect [85]. These structures connect galaxies in bridge like structures and galaxy clusters together forming the Cosmic Web [86]. RAMEN concentration ratio is different for different galaxies and galaxy clusters because of differences in mass distribution but and different mass sizes.

4.4 Early Universe Galaxies Rotation Curves Observation. Younger galaxies do have less RAMEN in proportion to regular matter since it is an accumulative mechanism. Hence, it has a compounding effect over time: The higher the energy density ratio; the more mass equivalent relativistic accumulation, the mass equivalent relativistic accumulation; the more gravity, the more gravity; the more mass equivalent relativistic accumulation. Even though in the early universe energy density was higher, that density was more uniformly distributed. That means that the further away we look to younger galaxies, the less influential RAMEN is in rotation velocities observations [87-90].

4.5 Cosmological Scale Factor Oscillations. There are observations of (7) different oscillations in the Expansion of the Universe coupled with oscillations in the measurement of the observed gravitational anomalies [91,92] that are perfectly explained by this model. Some cosmologist had already hypothesized these oscillations on the current Vacuum Energy value as responsible for the creation of "Dark Matter".

4.6 Cosmic Microwave Background Acoustic Oscillations. A similar model could be used to describe the Acoustic Baryon Oscillations pattern in the Cosmic Microwave Background [93-97].. The tiny differences in energy density seeded the primordial plasma (e.g. quantum fluctuations and unknown primordial particles like microscopic black holes, etc…). A simulation using this model should recreate the observations.

5 DISCUSSION

5.1 Vacuum Catastrophe Implications. The misnamed "Dark Matter" phenomenon explained as the Relativistic Accumulation of Mass Equivalent allows us to mathematically calculate an approximation to the Universe Traveling Energy Density for a first time. No other phenomenon had given us the most remote chance to observe a quantifiable manifestation of this energy. Currently accepted Dark Energy Density $\approx 10^{-9} Joules/m^3$, calculated from universe expansion observations, differs greatly with predictions from quantum electrodynamics (QED) and stochastic electrodynamics (SED) where it is required a value 120 orders of magnitude larger $\approx 10^{113} Joules/m^3$ [53-60]. Our calculated Universe Traveling Energy Density value indicates that there is a much higher energy density across the universe. The proposed model matches without free parameters the rotation curves for all orbits in all galaxies regardless size, mass, or mass distribution using the same traveling energy density value in all cases. Evidence of several orders of magnitude higher vacuum energy densities are provided by Casimir Effect experiments [98-110].

5.2 A New Kind of Energy. The universe critical density calculation [53-55] could have misunderstood the nature of the Dark Energy. The universe critical energy density was calculated by solving for mass density (ρ) in one of the Friedmann Equation and then it (ρ) is multiplied by $c^2 (E = mc^2)$. If all terms are carried (not using c=1, natural units) from the Einstein Field Equations (EFE) the correct derivation of the Friedmann Equation is:

$$\left(\frac{\dot{a}}{a}\right)^2 = H^2 = \frac{8\pi G\rho}{3c^2} - \frac{kc^2}{a^2} + \frac{\Lambda c^2}{3} \qquad (11)$$

Then, $k = 0,\ \Lambda = 0$ are set for a flat universe that has reached precisely escape velocity:

$$H^2 = \frac{8\pi G\rho}{3c^2} \qquad (12)$$

From where:

$$\rho = \frac{3H^2c^2}{8\pi G} \qquad (13)$$

This result gives a dimensional inconsistency on the mass density units (kg/s^2m) instead of (kg/m^3). That is the reason why c=1 (natural unit) was used. Maybe we should solve for the Universe Critical Energy Density (Ω) instead of solving for mass density. From the EFE we get$(\Omega = T^{00})$. The rewritten Universe Critical Density Equation should read:

$$H^2 = \frac{8\pi G\Omega}{3c^4} \qquad (14)$$

Solving for Ω:

$$\Omega = \frac{3H^2c^4}{8\pi G} \qquad (15)$$

Since $\Omega = \frac{E}{V}$, $and\ \frac{3H^2}{8\pi G} = \rho = \frac{M}{V}$ we could replace Ω and $\frac{3H^2}{8\pi G}$:

$$\frac{E}{V} = \frac{Mc^4}{V} \qquad (16)$$

$$E = Mc^4 \qquad (17)$$

The dominant form of Energy in the Universe (Dark Energy) filling and expanding the universe is a completely different type of energy. Its energy density magnitude would be c^2 times bigger than the

currently calculated one. Technically the current critical mass density calculation would be right, but its energy equivalence would be wrong. In the case of Universe Critical Density $E \neq mc^2$

5.2 Making Sense of $E = mc^4$. Dark Energy is by far the largest contributor to the universe total energy density. It is radically different to any other phenomenon in nature that we have some familiarity with the exception of Gravity. It is not that we understand gravity but at least we are familiar with it. The Dark Energy quanta that are crossing the universe could be emitted on each quantum of spacetime and its density would be constant in space (it may change in time); likewise Gravity quanta could be "emitted" from any quantum of spacetime but in contrast its "emitted" value varies depending on how much energy that point of spacetime is been crossed by. Lastly, Dark Energy is responsible for the expansion of the universe by stretching in equal proportions the spacetime fabric; it is the creator of new space. On the other hand Gravity opposes the expansion of the spacetime fabric. Hence, we could think of gravity quanta as been absorbed by the quantum of spacetime.

Let' suppose that the quanta of Dark Energy, the hypothesized Darktons, move in the three spatial dimensions simultaneously and the one time dimension (s=3,t=1). Like gravitational waves, their movement can be visualized as expanding spherical objects in spacetime similarly to how pressure waves propagate. The Darkton radius would increase at causality speed (c). In contrast photons, bosons, all matter particles, (galaxies, stars, planets, atoms, fermions) move in one spatial dimension (straight lines on curved spacetime) and one time dimension (s=1,t=1). Even though you can navigate 3 dimensional spaces you do so by moving on just one spatial dimension at a time. Now we could infer that quanta of Gravitational Energy, hypothesized Gravitons, would also move in the three spatial dimensions simultaneously and the one time dimension(s=3,t=1).

Darktons and Gravitons nature would make them almost impossible to detect experimentally with current technology since the detectors are designed to detect particles moving in s=1,t=1. It is uncertain at this time if this idea and others inspired by it will set the bases for a new technology that eventually can detect them. We can propose a derivation for kinetic energy for entities that move in s=3,t=1:

$$K_{(3+1)} = K_{(1+1)} * v_y * v_z \qquad (18)$$

$$K_{(3+1)} = \frac{1}{2} mv^2 \, v_y * v_z \qquad (19)$$

$$K_{(3+1)} = \frac{1}{2} mv^4 \qquad (20)$$

Following the steps to how $E = mc^2$ is derived from the apparent change in mass for an object moving at a constant speed in s=1 and t-=1 we can infer that the mass of an object moving in three spatial dimensions and one time dimension (s=3,t=1) apparently changes as:

$$m = \frac{m_0}{\sqrt{1 - \frac{v_{(3)}^4}{c^4}}} \qquad (21)$$

And the mass equivalence for $E_{(3+1)}$ would be $E= mc^2$ times c in two more spatial dimensions:

$$E_{(3+1)} = E_{(1+1)} * c_y * c_z \qquad (22)$$

$$E_{(3+1)} = mc^4 \qquad (23)$$

This is in agreement with equation (17) for Critical Energy Density ($\Omega = T^{00}$) .

5.3 A Newtonian Analogy. The Universe Critical Density could be derived with Newtonian physics alone by using the newly suggested kinetic energy for entities moving in s=3 and t-=1. Let's suppose a

spherical layer of the universe as one coherent entity expanding uniformly in s=3 and t=1. The Total Energy on that layer can be expressed as the addition of its kinetic energy plus its potential energy:

$$U = K_{(3+1)} + P \tag{24}$$

$$U = \frac{1}{2}mV^4 - \frac{GMm}{r} \tag{25}$$

For a critical energy calculation, that is for a universe that has reached precisely escape velocity, U=0:

$$\frac{1}{2}mV^4 = \frac{GMm}{r} \tag{26}$$

Simplifying and rearranging:

$$V^4 = \frac{2GM}{r} \tag{27}$$

Now let's take a layer where V =c then r= R_c (radius at V = c), M=$\frac{4}{3}\pi {R_c}^3\rho$ (Total mass inside R_c):

$$c^4 = \frac{2 * G * \frac{4}{3}\pi {R_c}^3\rho}{R_c} \tag{28}$$

Simplifying and rearranging:

$$c^4 = \frac{8G\pi {R_c}^2\rho}{3} \tag{29}$$

$$\frac{c^2}{{R_c}^2}c^2 = \frac{8G\pi\rho}{3}$$

$$\frac{c^2}{{R_c}^2} = \left(\frac{c}{R_c}\right)^2 = \frac{8G\pi\rho}{3c^2} \tag{30}$$

We can now introduce the Hubble Parameter $H \equiv \frac{\dot{a}}{a}$:

$$\left(\frac{\dot{a}}{a}\right)^2 \equiv H^2 = \frac{8G\pi\rho}{3c^2} \tag{31}$$

From where:

$$\rho = \frac{3H^2c^2}{8\pi G} \tag{32}$$

The same result for the correctly derived Universe Critical Mass Density from the First Friedmann Equation (13), that we know now can better be understood by $E_{(3+1)} = mc^4$ (17,23).

5.4 Dark Energy Could Have Different "States". Cosmologists agree on an inflationary period in the early universe where similar energy (in nature but not in magnitude) to that of observed Vacuum Energy rapidly inflated the universe exponentially in a very short period of time. It is currently believed that most of the Inflaton Field Energy got transformed into other types of radiation and matter particles which density were diluted by further expansion of the universe. It is not completely ruled out that the remnant of that energy is still been created across the universe in ways that are very difficult to measure experimentally although Casimir Effect experiments have demonstrated the existence of such energy.

Since the calculated Traveling Energy Density is several orders of magnitude smaller than the new suggested nature ($E = mc^4$) it could indicate that Dark Energy maybe composed by different energy fields or sectors and the measured by the RAMEN model is the sector or sectors composed by traveling quanta only. This or these sectors are the ones expanding the universe; they have the capacity of generating the negative pressure attributed to Dark Energy. The rest can be viewed as if spacetime i.e. existence is a form of energy that resides waiting to be emitted as traveling energy in a resonance like mechanism.

5.5 Similarity with Electromagnetism. Similarly to how relativity (length contraction) explains electromagnetism; relativistic particles and waves density is higher in the frames of reference closer to the galaxy than those far from the galaxy. In a way, there is a reservoir of traveling energy around galaxies that is constantly renewed with new energy.

6 Conclusions

6.1 No Cold Dark Matter. It is this paper conclusion that there is no need for particularly special particles forming the misnamed "Dark Matter" substance or even parallel universes' escaped gravity to account for the extra gravity existing around cosmic structures. Also, there is no need to modify Newtonian Mechanics or General Relativity. It is, however, necessary to better understand the nature of Dark Energy to explain the gravitational anomalies attributed to "Dark Matter". In a way, "Dark Matter" is just gravitationally delayed traveling energy. Einstein was right and his findings continue to enlighten our understanding of the universe.

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idque eo ordine, ut color ruber omnium minime refrangibilis sit, reliqui autem colores, aureus, flavus, viridis, cæruleus, indicus, violaceus, gradatim & ex ordine magis magisque refrangibiles.
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