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# Universal Relativity based on Mass-Energy Equivalence Resolves Cosmology and Physics Paradoxes

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## Abstract

This paper presents testable formulations of Universal Relativity (UR) field equations using mass-energy equivalence and conservation of energy/momentum. UR field equations describe physical mechanism for spontaneous conversion of mass to energy and vice-versa representing specific physics for spontaneous creation or deletion of mass in the universe. This formulation eliminates the black hole singularity and provides a new fundamental understanding of the Cosmological Constant and dark energy. The UR relativistic field equations predict the observed Hubble expansion in the near field universe as well as the observed far-field apparent accelerated expansion. UR predictions are testable via observation of mature galaxies in the far-field universe. The recent findings of massive galaxies in the early universe and evolution of their number density vindicate predictions of the UR theory. The UR theory also predicts the results of a recent study [20] that shows the total number of galaxies in the universe up to z=8 is about two trillion, almost a factor of ten higher than would be seen in an all sky survey at Hubble Ultra-Deep Field depth. UR predictions extend much beyond the 14 billions years, the current age of the universe predicted by the standard model limited by the linear Hubble model. Based on an average galaxy size of $10^{10}$ solar mass, the predicted total number of galaxies up to z = 8 falls between the maximum of $3.2 \times 10^{12}$ and minimum of $1.1 \times 10^{12}$ which is in close agreement with the published results, maximum of $2.7 \times 10^{12}$ and minimum of $1.4 \times 10^{12}$, of reference [20]. The predicted results also support other conclusions of the study [20] that the number of galaxies decreases with time after the initial birthing at z < 1 and the possibility of large number of undetected galaxies existing at higher redshifts z > 12.

## 1. INTRODUCTION

The "Elegant Universe" or an unverifiable "Multiverse"? The "Big Bang" or a "Time Invariant" or "Cyclic" Universe"? The "Absurd Universe" as described by Michael Turner [1] represents the consensus characterization of the predictions of the most widely accepted physics and cosmology theories marred by their unresolved contradictions, inconsistencies, and paradoxes. The mission of science to achieve a unified theory is founded on the basic premise that there exists a single universe and one set of universal laws that the theory would reveal to explain the observed universe. This mission is marred by the uncertainty and confusion of the multiverse that presumes parallel universes with their own varying sets of laws. In spite of their demonstrated successes against limited experiments, the two leading theories - general relativity and quantum mechanics, have been unable to explain almost 96% of the universe presumably comprised of the unknown dark energy and dark matter. While general relativity theory suffers from black hole singularities and locality limitations of the constant speed of light, quantum mechanics remains a puzzle due to a serious lack of understandings of its inner workings, quantum gravity, quantum vacuum, and observer paradoxes. In spite of several alternate cosmological theories [2, 3, 4, 5, & 6], there remains a serious lack of a cohesive universe model that resolves the so-called cosmic conundrum.

The purpose of the work presented herein is to demonstrate that the current paradoxes of physics and cosmology are artifacts of the missing physics of the well-known phenomenon of mass-energy equivalence involving spontaneous mass-energy conversion such as observed in the spontaneous decay of quantum particles, wave-particle duality, and Hawking radiation [7] involving the evaporation of black holes mass. Black holes that radiate away more mass than the mass falling in via gravitational pull from outside are expected to shrink and vanish completely due to the spontaneous evaporation or conversion of mass to energy. Hawking forwarded quantum arguments to show that the radiation is similar to the black body radiation governed by thermal effects. However, without a theory of quantum gravity, it is impossible to analyze the detailed thermodynamic state of a black hole. A new Gravity Nullification model (GNM) is proposed to describe the missing (hidden variable) physics of the spontaneous conversion of mass to energy. This is integrated into a simplified form of Universal Relativity (UR) model that predicts both the observed linear Hubble data in the nearby universe and the supernova observations in the distant universe. The integrated model resolves many of the paradoxes haunting physics and cosmology today. The proposed model eliminates singularities from existing GR theory and also resolves its inconsistencies with quantum mechanics. UR provides consistent answers to some key fundamental questions as discussed later in the paper.

The proposed theory is tested against the recent observations of mature galaxies commonly unexpected in the far-field universe. It also explains the results of a recent study [21] that shows the total number of galaxies in the universe up to z=8 is about two trillion, almost a factor of ten higher than would be seen in an all sky survey at Hubble Ultra-Deep Field depth.

## 2. UNIVERSAL RELATIVITY (UR) MODEL

### Gravity Nullification Model (GNM)

As part of the special theory of relativity, Einstein derived the famous law governing conversion of mass to energy - $E = m C^2$, wherein E and m represent equivalent changes in energy and mass respectively. Unstable particles are known to decay instantly [8] and simultaneously exist as waves of energy as per well-established wave-particle complimentarity. In order to represent a kinetic field equation establishing the mass-energy equivalence, it is hypothesized that the energy released during a spontaneous conversion of mass to energy manifests as motion or kinetic energy of the remaining (unconverted) mass of the body or particle. This hypothesis is tested later in the paper to predict the observed stability of non-decaying particles and ordinary objects in the universe. Let us now consider a spontaneously decaying mass $M_o$ at rest (V=0) representing a total relativistic energy, $E_0 = M_0 C^2$. The transformation energy, TE, of a small portion of the mass, Δm, can be described according to the specific theory of relativity as follows:

$$TE = \Delta m \cdot C^2 = (M_0 - m)C^2 \qquad (1)$$

This energy is assumed to propel a radial expansion of the remaining mass m with a radial velocity V. The momentum is conserved via a spherically symmetric radial expansion of the remaining mass. The relativistic kinetic energy (KE) of the remaining unconverted mass m is given by the special theory of relativity as follows:

$$KE = m\,C^2\left(\frac{1}{\sqrt{1-\left(V^2/C^2\right)}} - 1\right) \qquad (2)$$

In the absence of any gravitational force or energy, equating this kinetic energy to the energy from mass transformation given by eqn. (1), we obtain the following:

$$(M_0 - m)C^2 = m\,C^2\left(\frac{1}{\sqrt{1-\left(V^2/C^2\right)}} - 1\right) \qquad (3)$$

Simplifying the above provides the following equation:

$$m = M_o\sqrt{1-(V/C)^2} \qquad (4a)$$

Since the process of conversion of mass into energy is outwardly expansive and opposite to the process of gravitation that is pulling inwardly, we refer to equation (4) as the Gravity Nullification Model (GNM) representing anti-gravity. The corresponding space and time dilation are described by specific relativity equation:

$$S = S_o\sqrt{1-(V/C)^2} \qquad (4b)$$

wherein S is the spatial dimension at V and $S_0$ is spatial dimension at V=0. Similarly, the time dilation is given by:

$$t = t_o\sqrt{1-(V/C)^2} \qquad (4c)$$

GNM predicted mass, space, and time dilations versus V/C are shown in Figure 1.

Figure 1: GNM mass, space, and time dilations.

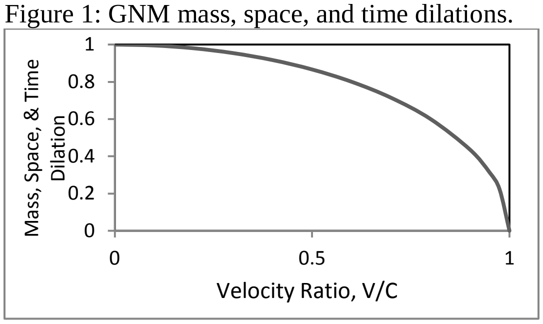
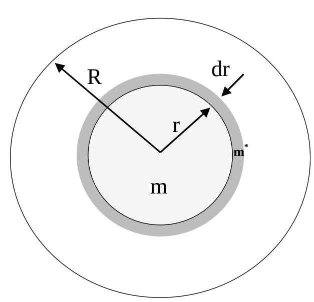



Figure 2: A simplified gravity model of the universe.



**Universal Relativity (UR) Model**

The gravitational effects were neglected in the formulation of GNM eqn. (4a). Extending the model to the whole universe, significant gravitational effects of the large universe mass $M_o$ must be considered. Using a simplified spherical gravitational model of the universe depicted in Figure 2, the following is obtained for estimating the gravitational potential energy (GPE) of the universe:

$$GPE = \int_0^R \frac{Gmm^*}{r} = \frac{3Gm^2}{5R} \qquad (5)$$

Now, from the energy balance equating the transformation energy, TE, from eqn. (1) with the sum of the kinetic energy (2) and the gravitational potential energy (5),

$$(M_0 - m)C^2 = mC^2\left\{\frac{1}{\sqrt{1-(V/C)^2}} - 1\right\} + \frac{3Gm^2}{5R} \qquad (6)$$

Equation (6) represents GNM based Universe Relativity (UR) model including the effects of gravity.

**Cosmological Constant Model based on GNM**

In BBM, Einstein proposed a 'Cosmological Constant' denoted by$\Lambda$, that represents a contribution to the density of the universe from vacuum energy in the GR theory. In the UR universe model eqn. (6), no such extraneous fudge factor exists. However, a mechanistic description of $\Lambda$ can be obtained via equating the vacuum energy equation proposed by Einstein to the kinetic energy (KE, eqn. (2)) as follows:

$$\frac{1}{6}\Lambda mC^2R^2 = mC^2\left\{\frac{1}{\sqrt{1-(V/C)^2}} - 1\right\} \qquad (7) \qquad or, \qquad \Lambda = \frac{6}{R^2}\left\{\frac{1}{\sqrt{1-(V/C)^2}} - 1\right\} \qquad (8)$$

Combining equations (6) and (8) leads to the following:

$$\Lambda = \frac{6}{R^2}\left\{\left(\frac{M_0}{m} - 1\right) - \frac{3Gm}{5RC^2}\right\} \qquad (9)$$

**Relativistic Universe Expansion (RUE) Model based on GNM**

The following equation is obtained via substituting $\Lambda = \frac{3H^2}{C^2}$ in eqn. (8):

$$\frac{V}{C} = \sqrt{1 - \left\{1\Big/\left(1 + \frac{H^2R^2}{2C^2}\right)\right\}^2} \qquad (10)$$

Equation (10) describes a universal model named as the Relativistic Universe Expansion (RUE) model as an alternative to the widely accepted Linear Hubble (LHM) model, V=HR in BBM. It should be noted that for the range of observed galactic distances (up to approximately 5 to 9 billion light-years) wherein the LHM is seen to hold, the RUE eqn. (10) exactly matches the predictions of the LHM, as shown in Figure 3. For values of R larger than approximately 14 billion light-years, the expansion velocity calculated by the Linear Hubble model (LHM) exceeds the velocity of light C and hence, violates the theory of relativity. The velocity predicted by RUE, on the other hand, approaches the speed of light C as R increases indefinitely. Since the RUE predicted V never exceeds C, it never violates relativity theory. It also avoids any singularities in the UR universe model eqn. (6).

Figure 3: LHM and RUE predicted velocity ratios.

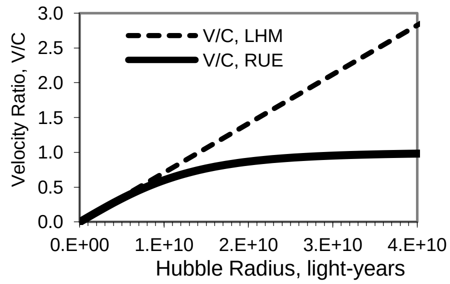
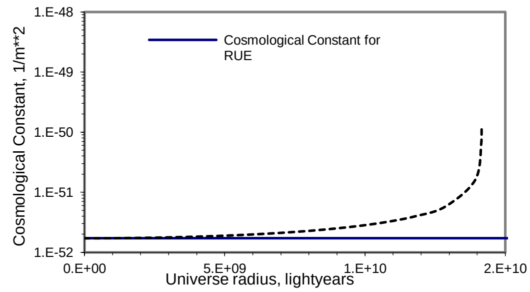



Figure 4: LHM and RUE predicted Cosmo. Constant.




It is important to point out that GNM based RUE provides a relativistic expansion model of the universe, while the LHM represents an empirical fit to the observed Hubble expansion data from the near field galaxies. When compared to the recent far-field Supernova data, LHM leads to the apparent conclusion that the universe expansion is accelerating. However, such a conclusion is merely an artifact of the over-extrapolation (V>C) of the linear expansion predicted by the LHM in the distant universe. It is shown later (Figure 5) in the paper that the observed non-linear expansion from the far-field data is naturally predicted by the RUE vindicating the fact that the universe expansion in the far field is relativistic and not linear as predicted by LHM. RUE thus eliminates the shortcomings of the LHM while providing a mechanistic model of the observed universe expansion.

**Comparison of Cosmological Constants predicted by RUE versus Linear Hubble Model (LHM)**

Figure 4 shows the predicted Cosmological Constant Λ, eqn. (8), using V/C from LHM and RUE models. It should be noted that the Cosmological Constant predicted by RUE remains invariable for all universe sizes, thus representing a universal constant. However, the Cosmological Constant predicted using the LHM increases exponentially to very large values as the universe size increases beyond 2 billion light-years. This explains the reason for why the non-varying universal Cosmological Constant used in widely accepted cosmology theories would underestimate the universe expansion when used in conjunction with the LHM that requires a very large (several orders of magnitude) value of dark energy to match the observed accelerated expansion in the distant universe. The universal Cosmological Constant provided by RUE in conjunction with eqn. (8) is given by:

$$\Lambda = \frac{3H^2}{C^2} \qquad (11)$$

UR, eqn. (6), represents a quadratic equation that can also be simplified to obtain actual mass m of the universe as a function of its size R and Cosmological Constant Λ as follows,

$$m = \frac{5RC^2}{6G}\left[\sqrt{\left\{\left(1+\frac{\Lambda R^2}{6}\right)^2 + \frac{12GM_o}{5RC^2}\right\}} - \left(1+\frac{\Lambda R^2}{6}\right)\right] \qquad (12)$$

## 3. COMPARISON OF UR PREDICTIONS AGAINST SUPERNOVA DATA

By observing distant, ancient exploding stars, physicists and astronomers [9, 10, and 11] have determined that the universe is expanding at an accelerating rate. By comparing the observed distance of type Ia supernovae with the redshifts of their home galaxies, researchers have calculated the rate of expansion of the universe during its historical evolution. The observations of distant type Ia supernovae place them significantly farther away than would be expected from their redshifts, suggesting that the unknown dark energy is pushing the stars and galaxies in the universe farther apart faster than it did in the early universe. In early January 1998 the Supernova Cosmology Project [9] presented the first compelling evidence that the expansion is accelerating and that this acceleration is caused by the unknown dark energy represented by the Cosmological Constant, Λ. The Einstein's theory of specific relativity provides the following relationship between the redshift z and velocity V:

$$z=\sqrt{\frac{1+(V/C)}{1-(V/C)}}-1 \quad (13) \quad \text{or,} \quad \frac{V}{C}=\left[\frac{(z+1)^2-1}{(z+1)^2+1}\right] \quad (14)$$

Combining eqn. (14) with the LHM and RUE leads the following for the respective radii of the universe,

$$R_{LHM}=\left(\frac{C}{H}\right)\left[\frac{(z+1)^2-1}{(z+1)^2+1}\right] \quad (15)\text{ , and } \quad R_{RUE}=\left(\frac{C}{H}\right)\left[\frac{z}{\sqrt{z+1}}\right] \quad (16)$$

The relative brightness B of the supernova can be estimated [16] as follows for LHM and RUE respectively,

$$B_{LHM}=1.92x10^{50}\left(\frac{H}{C}\right)^2\frac{(z+1)^5}{\left[(z+1)^2-1\right]^2\left[(z+1)^2+1\right]^3} \quad (17)$$

$$B_{RUE}=3.84x10^{50}\left(\frac{H}{C}\right)^2\frac{(z+1)^7}{z^2\left[(z+1)^2+1\right]^6} \quad (18)$$

Figure 5 shows comparison of the supernova [9, 10] and other near-field [11] data against the predicted relative brightness for LHM versus RUE by equations (17) and (18) respectively. A good agreement is seen between the predictions of the RUE and the measured values. The LHM under-predicts the trend of the observed data beyond Z=0.4, indicating that it does not accurately account for the relativistic effects that are dominant at large R or redshift values. The relativistic universe expansion eludes us as an accelerated expansion, which in reality is only an artifact of the erroneous linearity imposed by over extrapolation of LHM at large radii. Figure 6 shows the LHM versus RUE predicted distances versus redshift of supernovas. The RUE predictions are consistent with the supernova observations that, at large redshifts (Z>0.4), the supernovas appear to be farther than LHM predictions. Hence, the supernova data vindicates the RUE model predictions.

Figure 5: Comparison of LHM and RUE predictions of Supernova and near field data.

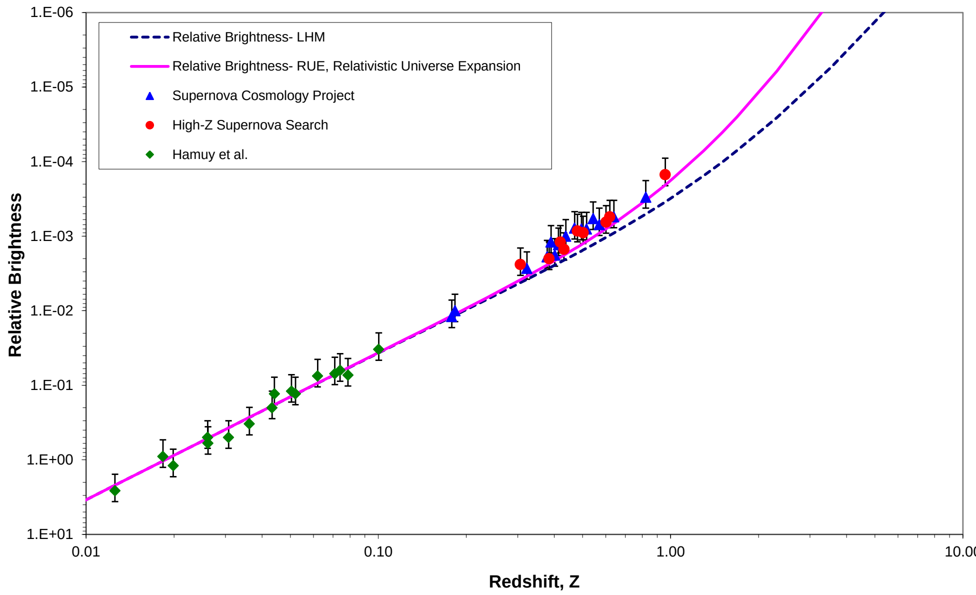
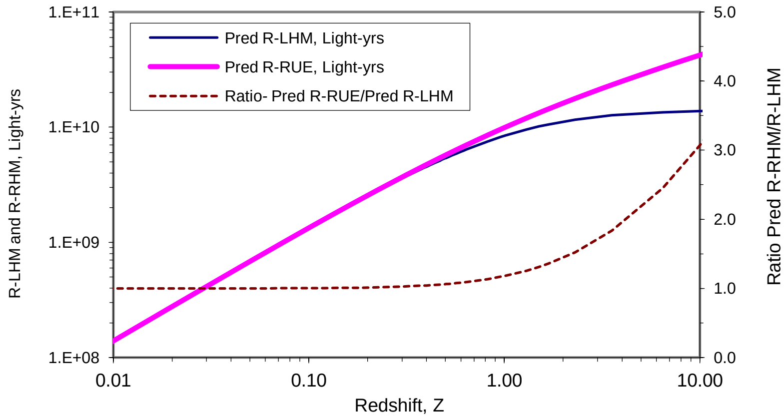


Figure 6: LHM and RUE predicted supernova distances and their ratios.



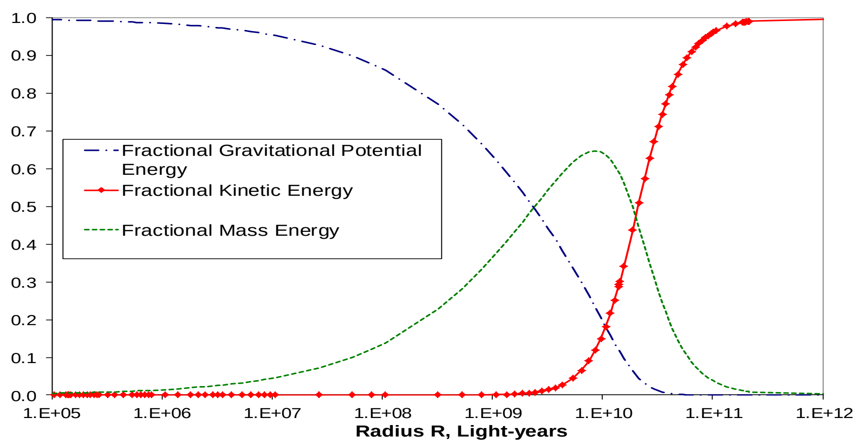

## 4. GNM RESOLVES OTHER KEY PARADOXES AND MYSTERIES OF COSMOLOGY

Predictions of UR, eqns. (6 and 12), using input constants measured from experiments are presented in this section. Based on the observational results from two balloon-borne telescopes, Boomerang and MAXIMA [12] the total mass $M_o$ of the universe is estimated to be 100 trillion trillion trillion trillion tonnes or $10^{53}$ kilograms or $5x10^{22}$ solar masses. The recent 2dF Galaxy Redshift Survey [13] designed to measure the redshifts of 250,000 galaxies and the High-Z Supernova Search Team [14] reported the existence of a low-density universe with the Hubble constant H equal to approximately 70 km $sec^{-1}$ $Mpc^{-1}$ or $2.27x10^{-18}$ $sec^{-1}$. Other constants used in calculations are the speed of light, $C=3x10^8$ m/sec and Universal Gravitational Constant, $G=6.7x10^{-11}$ $m^3/kgm/sec^2$. Using the above value of H, the Cosmological Constant is calculated to be $1.72x10^{-52}$ $m^{-2}$ from equation (11).

### 4.1 UR Solves the Dark Energy Puzzle

Figure 7 shows the predicted fractional mass energy ($mC^2$), gravitational potential energy (GPE), and relativistic kinetic energy (KE) for a range of universe sizes. The sum of the three energies remains constant at $M_0C^2$. During the early universe up to about 2 billion light-years, GPE dominates. At about 9 billion light-years, the GPE and KE even out. Following this period, the increasing KE, commonly referred to as dark energy or vacuum energy, dominates fueling the non-linear relativistic universe expansion, which eludes us as the apparent accelerated expansion as opposed to the linear Hubble expansion. UR thus resolves the puzzle of the elusive dark energy or vacuum energy paralyzing modern physics and cosmology.

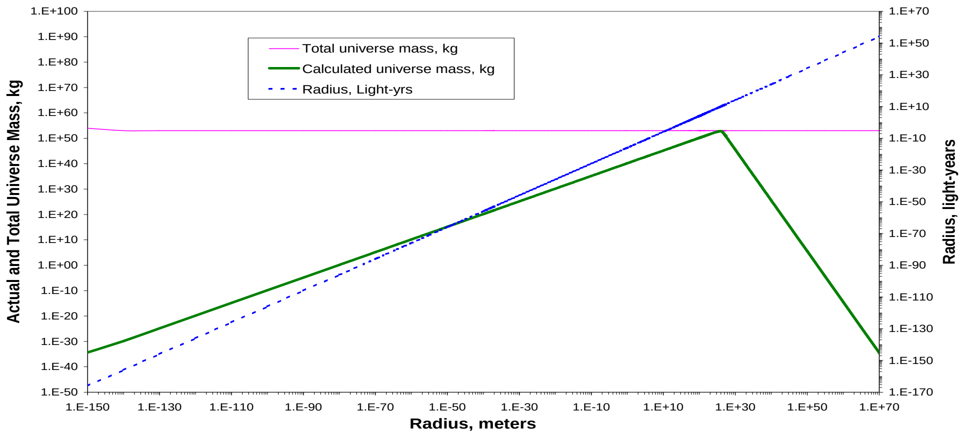
Figure 7: UR predicted fractional mass energy, gravitational potential energy, and kinetic energy.



**4.2 UR Eliminates Black Hole or Big Bang Singularity**

The quantum theory predicts that at densities greater than those supported by any quantum degeneracy, gravity overwhelms all other forces leading to the collapse of the body forming a black hole. All the matter ends up in an infinitely dense singularity at the center of the event horizon. The UR model does not experience any singularities as shown by the predicted results of actual mass versus size shown in Figure 8. The calculated mass is less than the Planck's mass when the radius is of the order of $10^{-100}$ meters. At still smaller radii, the predicted mass of the universe decreases to even smaller values without causing any singularity.

Figure 8: Universe mass versus radius predicted by UR, demonstrating no black hole singularity



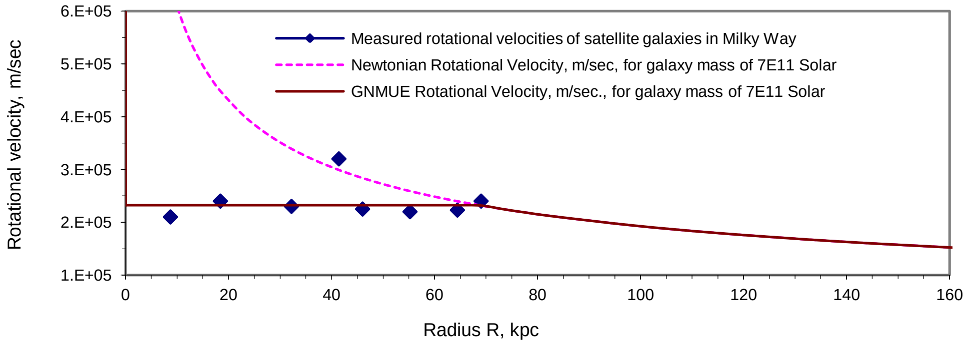

**4.3 UR Predicts Creation and Dilation of Matter in the Universe**

UR, eqn. (12), predicts the creation and dilation of mass m of the universe as a function of its size, as shown in Figure 8. The actual mass increases with increasing size of the universe until a maximum mass is reached at about 10 billion light-years, beyond which, mass decreases again with size. UR thus represents the universe's mass, energy, space, and time as one continuum governed by the relativistic laws without any limits or singularities.

**4.4 UR Dissolves the Dark Matter Myth**

The astronomers have, until now, explained the observed extra-ordinary large rotation velocities of stars in galaxies by claiming existence of large amounts of invisible dark matter predicted by the Newtonian theory. Figure 9 shows a close agreement between the UR predicted versus observed rotational velocities in the Milky Way spiral galaxy without any considerations of the dark matter (A detailed treatise is provided in reference [15]).

Figure 9: UR predicted versus observed rotational velocities in the Milky Way spiral galaxy.

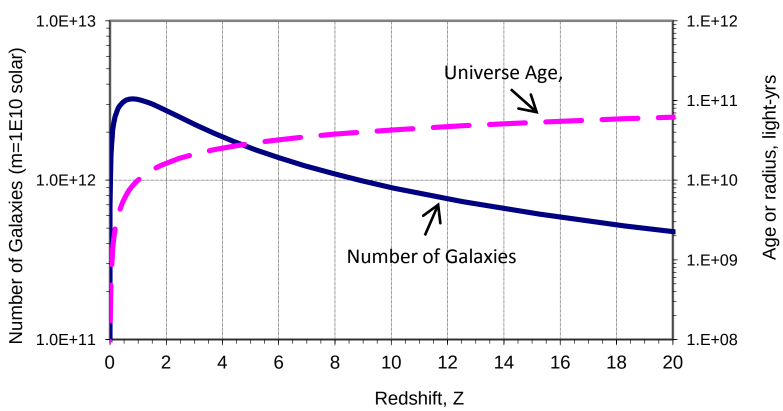


**5. COMPARISON AGAINST RECENT OBSERVATIONS AND GALAXY SURVEYS**

While UR equations (6 & 12) successfully predict the observed near-field and far-field expansion of the universe as shown in fig. 5, it also predicts the universal mass distribution as shown in fig. 8. The standard Big Bang model limited by the linear Hubble model, predicts the birth of the universe at about 14 billion light-years ago and formation of stars and galaxies occurring between 200 to 500 million years after the Big Bang. UR predicts continued mass or galaxy generation up to z =1 (8 billion light-years) followed by a steady decrease with increasing size and still a large mass of the universe extending to 50 billion light years and beyond. These predictions are testable to validate the UR theory as science develops better and farther observational capabilities in future. The farthest object spotted thus far by Hubble telescope is the little cluster of stars, called GN-z1. According to the Big Bang timeline, it existed when the universe was just 400 million years old. As of 2012, there were about 50 possible objects z = 8 or farther, and another 100 z = 7 candidates, ranging up to 13.39 billion light year away, based on photometric redshift estimates released by the Hubble eXtreme Deep Field (XDF) project from observations made between mid-2002 and December 2012 [19]. The Big Bang standard model predictions did not expect to find mature galaxies this bright, this early, in the history of universe. However, the findings of massive galaxies in the far-field universe vindicate predictions of the UR theory.

The UR theory also predicts the results of a recent study [20] that shows the total number of galaxies in the universe up to z=8 is about two trillion, almost a factor of ten higher than would be seen in an all sky survey at Hubble Ultra-Deep Field depth. Using the UR predicted evolution of mass m of the universe as a function of its size (fig. 8) and assuming an average galaxy size of $10^{10}$ solar mass, total number of galaxies and age of the universe versus redshift z predicted by UR are shown in figure 10 below. Please note that UR predictions extend much beyond the 14 billions years, the current age of the universe predicted by the standard model. The predicted total number of galaxies up to z = 8 falls between the maximum of $3.2\times10^{12}$ and minimum of $1.1 \times10^{12}$ which is in close agreement with the published results, maximum of $2.7\times10^{12}$ and minimum of $1.4 \times10^{12}$, of reference [20]. The predicted results also support other conclusions of the study [20] that the number of galaxies decreases with time after the initial birthing at z < 1 and the possibility of large number of undetected galaxies existing at higher redshifts z > 12.

Fig. 10: Evolution of number of galaxies (mass = 1E10 Solar) and universe Age vs. Redshift Z




**8. A NEW PERSPECTIVE ON UNIVERSAL REALITY**

UR equation (6) represents a time-invariant or quasi-static continuum field of various mass/energy states of the universe as a function of size R or velocity potential expressed by ratio V/C. Since the universe, on a large scale, is known to be homogeneous and isotropic, the Relativistic Expansion represented by eqn. (10) holds true for any observer anywhere in the universe i.e. there is no center or edge of the universe nor there is any direction of time i.e. beginning or time evolution as such of the universe. Hence, space is not exactly expanding or galaxies are not really moving in a fixed space and time. This eliminates the current paradoxical questions such as what the universe is expanding into and what was there before the Big Bang.The redshifts and Hubble velocities can be predicted quasi-statically without any time-variant expansion of space and without any explicit consideration of time in the model. No mass-energy is ever lost, it simply gets redistributed in the form of mass, gravitational, or kinetic energy during various relativistic states. UR also predicts an asymptotic Zero-point state at V=C, wherein mass, space, and time are fully dilated and pure relativistic kinetic energy, commonly known as dark energy, fills in the entire universe.

The above predictions of the universe behavior are alternative to the widely known Big Bang standard model that describes the universe beginning at the absolute zero time moment and expanding in real finite time with a time variant evolution leading to a finite age of 14 billion light years. The so-called Big Bang is a singularity at time zero, but UR predicted universe has no singularity.

**9. SUMMARY AND CONCLUSIONS**

The proposed UR model describes this missing physics in a simplified form of universal relativity that resolves many of the current well-known paradoxes of cosmology. UR provides quasi-static or time-invariant mass-energy field equations that predict the observed galaxy and universe expansions. It provides a fresh perspective on the misconceived birth and evolution of the universe, especially the creation and dilation of matter. It eliminates singularities in existing theories and the need for many incredible and unverifiable assumptions including the superluminous inflation, dark energy, dark matter, multiple universes, multiple dimensions, and quantum gravity. UR is vindicated by recent observations of mature galaxies in the far-field or very early universe. As of 2012, there were about 50 possible objects or mature galaxies z = 8 or farther, and another 100 z = 7 candidates, ranging up to 13.39 billion light year away, based on photometric redshift estimates released by the Hubble eXtreme Deep Field (XDF) project from observations made between mid-2002 and December 2012 [19]. The UR theory also predicts the results of a recent study [20] that shows the total number of galaxies in the universe up to z=8 is about two trillion, almost a factor of ten higher than would be seen in an all sky survey at Hubble Ultra-Deep Field depth. UR predictions extend much beyond the 14 billions years, the current age of the universe predicted by the standard model limited by the linear Hubble model. Based on an average galaxy size of $10^{10}$ solar mass, the UR predicted total number of galaxies up to z = 8 falls between the maximum of $3.2\text{x}10^{12}$ x and minimum of 1.1 $\text{x}10^{12}$ which is in close agreement with the published results, maximum of 2.7 $\text{x}10^{12}$ and minimum of 1.4 $\text{x}10^{12}$, in reference [20]. The UR predicted results also support other conclusions of the study [20] that the number of galaxies decreases with time after the initial birthing at z < 1 and the possibility of large number of undetected galaxies existing at higher redshifts z > 12. Finally, a new perspective on the time-invariant universal reality is provided as an alternative to the Big Bang cosmology.

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