To be Published in the Journal of Physics Essays, Vol. 20 No. 3

A Solution to the Cosmological Constant, Dark Matter, and Dark Energy Problems

Avtar Singh, Sc. D.

Center for Horizons Research
11608 Birch Spring Court, Cupertino, CA 95014, USA
E-mail: avsingh@alum.mit.edu

Keywords
Dark Matter, Relativity, Dark Energy, Big Bang Model, Universe

Abstract

A new mathematical model, the Gravity Nullification model (GNM), is proposed that integrates the missing physics of the spontaneous relativistic conversion of mass to energy into the existing physics theories, specifically a simplified general theory of relativity. Mechanistic mathematical expressions are derived for a relativistic universe expansion, which predict both the observed linear Hubble expansion in the nearby universe and the accelerating expansion exhibited by the supernova observations. The integrated model addresses the key questions haunting physics and cosmology due to the missing physics from existing theories. It also provides a fresh perspective on the misconceived birth and evolution of the universe, especially the creation and dissolution of matter. The proposed model eliminates singularities from existing models and the need for the incredible and unverifiable assumptions including the superluminous inflation scenario, multiple universes, multiple dimensions, and quantum gravity. Predictions of the model show a close agreement with the recent observations of the universe. The integrated model is shown to resolve the singularities, paradoxes and inconsistencies related to the current theories – quantum mechanics and general relativity.

1. **INTRODUCTION**

The Big Bang model (BBM has been successful in explaining a number of features of the observed universe only in an irksome marginal way. However, some big questions still remain unanswered and inconsistencies persist that could potentially invalidate the BBM. Three dozen physicists and astronomers reviewed [1] the evidence for and against the Big Bang theory of the universe and alternatives to it in light of the new data. Observation on globular clusters analyzed by Riccardo Scarpa of the European Southern Observatory cast doubt on the existence of dark matter, a key component of the Big Bang theory. The very basis of the Big Bang, the expansion of the universe, was called into serious question by data presented by Eric Lerner of Lawrenceville Plasma Physics. New data from the Hubble Ultra Deep Field images, which show the most distant known galaxies up to a redshift of 6, seems to be in accord with the prediction of the non-expanding universe model. The Big bang predictions that distant galaxies would appear to have hundreds of times less surface brightness was completely contradicted. Lerner comments - “This also means that the universe that we can see is not limited in space or time—the most distant galaxies we see right now are 70 billion years old, much older than the supposed age of the Big Bang, and we will be able to see older and more distant ones with future telescopes.

To address these and other issues related to the Big Bang model, alternative cosmology theories have been forwarded. It is generally believed that the superluminous inflation of the Big Bang model during the early universe explains the isotropy, large scale homogeneity and flatness as well as the deviations from homogeneity of the universe. The quasi-steady state cosmology (QSSC) has been proposed by Hoyle, Burbidge and Narlikar (2) as an alternative to the standard hot Big Bang model. This cosmology does away with the initial singularity, and does not have any cosmic epochs such as inflation when the universe was very hot. However, its focus was limited to explaining the observed fluctuations in the microwave background.

Other alternate cosmological theories suggest variable universal constants. Some [3, 4] have proposed the variable speed of light (VSL) cosmology as a viable alternative to standard inflationary models. In recent years there has been a growing interest to study cosmological models [5] with variable cosmological constant and gravitational constant. The interest stems from the observational analysis of type Ia supernova that provides evidence that the present universe is accelerating and may contain dark matter and dark energy.

The latest and supposedly the state of the art development in cosmology is the string theory. However, it is best described [6] by Wolfgang Pauli's famous phrase, "It's not even wrong." String theory not only makes no predictions about physical phenomena at experimentally accessible energies, it makes no precise predictions whatsoever. At the moment string theory cannot be falsified by any conceivable experimental result. A simple argument in string theory indicates that the cosmological constant should be at least around 55 orders of magnitude larger than the observed value. This is perhaps the most incorrect experimental prediction ever made by any physical theory that anyone has taken seriously.

In spite of the fact that these alternate cosmological models may try to explain some selected observations or features of the observed universe, there remains a serious lack of a cohesive universe model that resolves the above puzzles or the so-called cosmic conundrum and the outstanding paradoxes of the widely accepted theories of science. These well known paradoxes and inconsistencies have diminished the elegance of the so-called “Elegant Universe”.

The objective of this paper is to present a cohesive model that integrates the missing physics of the spontaneous decay into the theory of relativity to resolve these outstanding paradoxes and inconstancies from existing theories.

2. THE BIG BANG MODEL

The ‘Big Bang’ model [7] of the universe is based on the observed expansion of the universe. According to the Hubble law, each distant galaxy is receding from us with a velocity proportional to its distance. The Linear Hubble law gives the velocity of recession V at a distance R as follows:

$$V = HR \tag{1}$$

H in the above equation represents the expansion rate of the universe and is known as the Hubble constant.

In its current form, the Big Bang model is based on mathematical solution of the equations of general relativity, originally obtained by Friedman in the 1920s. The model is based on the general cosmological principle that on large scales, the universe is homogeneous (uniform density of matter), looks the same in every direction (isotropic) with each particle moving according to equation (1). The total energy E_T of a particle of mass m at a distance R from the center is then given [7] by,

$$E_T = \frac{1}{2} mV^2 - \frac{GMm}{R} \tag{2}$$

wherein, G is the Universal Constant of Gravitation and mass M is given in terms of the uniform mass density ρ as follows,

$$M = \frac{4\pi}{3} R^3 \rho \qquad (3)$$

The above model applies to a universe with empty space containing no inherent energy. Einstein proposed a 'Cosmological Constant' denoted by Λ, which represented a contribution to the density of the universe from vacuum energy. If Λ is greater than zero, then a spatially flat (Ω_k=0 or E_T=0) universe with a low matter density can exist due to the contribution from the vacuum energy. An accelerating universe [8] can exist only when Λ is greater than zero. For a non-zero Λ, Einstein proposed the following modification to equation (2):

$$E_T = \frac{1}{2} m V^2 - \frac{GMm}{R} - \frac{1}{6} \Lambda m C^2 R^2 \qquad (4)$$

Combining equations (1), (3), and (4) leads to:

$$\frac{2E_T}{mH^2 R^2} + \frac{8\pi G\rho}{3H^2} + \frac{\Lambda C^2}{3H^2} = 1 \qquad (5)$$

$$\Omega_k + \Omega_m + \Omega_\Lambda = 1 \qquad (6)$$

wherein, $\Omega_k = \frac{2E_T}{mH^2 R^2}$ represents non-dimensional curvature of the universe, $\Omega_m = \frac{8\pi G\rho}{3H^2}$ represents the critical mass density ratio, and $\Omega_\Lambda = \frac{\Lambda C^2}{3H^2}$ represents the vacuum energy density ratio.

3. GRAVITY NULLIFICATION MODEL (GNM)

What is the physical cause that initiates a motion in the universe? In Newtonian or classical mechanics, an external force is required to cause motion of a body. The external force comes from an independent entity external to and separate from the body itself. Such a motion is defined as a non-spontaneous motion of a classical body, since it is caused by factors (forces) external to the body. As part of the special theory of relativity, Einstein derived the famous law governing conversion of mass to energy according to the equation: $E = m C^2$, wherein E and m represent equivalent changes in energy and mass respectively. In the case of elementary particles such as electrons, protons and neutrons such a mass-energy conversion may involve a substantial amount of energy prohibiting their spontaneous decay. Such particles are known to be stable over long times. In contrast, unstable particles are known to decay instantly [9]. To represent such observed spontaneous decay of particles, the particle theory presumes existence of anti-particle partner for each existing particle, which can be annihilated by the anti-particle and spontaneously converting to energy. Particles that decay instantly cannot be easily detected and hence, it is not known how many such particles may exist in the universe. An example of the spontaneous mass-energy conversion is evident in the observed wave-particle behavior of small particles, such as photons, wherein a particle behaves like energy (wave) in free space and converts to a mass (particle) when its motion is constrained.

It is hypothesized in the model described herein that the energy released during a spontaneous conversion of mass to energy via a spontaneous decay can cause motion of the remaining (unconverted) mass of the body or particle. This hypothesis is tested later in the paper to assure that it does predict the observed stability of stable particles such as a proton. The motion caused via such a postulated internal process of an unstable particle or a self-decaying mass is defined as a spontaneous motion as opposed to the non-spontaneous motion of a classical non-decaying mass. Let us now consider a self-decaying mass M_o at rest (V=0) representing a total relativistic energy, $E_0 = M_0 C^2$. A small portion of the mass, Δm, spontaneously transforms to energy (TE) according to the specific theory of relativity as follows:

$$TE = \Delta m \cdot C^2 = (M_0 - m)C^2 \qquad (7)$$

This energy propels the remaining mass m causing a spontaneous motion with a radial velocity V. The momentum is conserved (a zero net momentum) via assuming an spherically symmetric expansion of the remaining mass. The relativistic kinetic energy (KE) of the remaining mass m is given by the following equation of the special theory of relativity:

$$KE = m\ C^2 \left(\frac{1}{\sqrt{1 - \frac{V^2}{C^2}}} - 1 \right) \qquad (8)$$

In the absence of any gravitational force or energy, equating this kinetic energy to the energy from mass transformation given by equation (7), we obtain the following:

$$(M_0 - m)C^2 = m\ C^2 \left(\frac{1}{\sqrt{1 - \frac{V^2}{C^2}}} - 1 \right) \qquad (9)$$

Simplifying the above provides the following equation:

$$m = M_o \sqrt{1-(V/C)^2} \tag{10}$$

Since the process of dilation of the mass is opposite to the process of gravitation that causes formation or growth of mass, we refer to equation (10) as the Gravity Nullification Model (GNM).

<u>GNM based Model of the Universe</u>

The gravitational effects were neglected in the formulation of GNM equation (10), which is a valid assumption only for small masses such as quantum particles like photons. However, for the whole universe the total mass M_o is very large and the gravitational effects are significant especially when the size of the universe is small. Using a simplified gravitational model of the universe depicted in Figure 1, the following integration is obtained for estimating the gravitational potential energy (GPE) of the universe:

$$GPE = \int_0^R \frac{Gmm^*}{r} = \frac{3Gm^2}{5R} \tag{11}$$

Now, from the energy balance equating the transformation energy from equation (7) with the sum of the kinetic energy and the gravitational potential energy, we get,

$$(M_0 - m)C^2 = mC^2 \left\{ \frac{1}{\sqrt{1-\left(\frac{V}{C}\right)^2}} - 1 \right\} + \frac{3Gm^2}{5R} \tag{12}$$

Equation (12) represents GNM based universe model including the effects of gravity. It should be noted that while the total energy E_T in BBM equation (2) is unknown and assumed to be zero for a flat universe, the total energy in GNM based universe model is equal to the transformed mass-energy TE given by equation (7).

The above model, equation (12) represents a universe with empty space containing no inherent energy. In BBM, Einstein proposed a ‘Cosmological Constant’ denoted by Λ, that represents a contribution to the density of the universe from vacuum energy. In the GNM universe model equation (12), no such extraneous fudge factor exists. However, to represent equation (12) in terms of Λ and equating the vacuum energy equation proposed by Einstein to the kinetic energy one obtains the following relationship between Λ and R:

$$\frac{1}{6}\Lambda mC^2R^2 = mC^2\left\{\frac{1}{\sqrt{1-\left(\frac{V}{C}\right)^2}}-1\right\} \qquad (13)$$

or,

$$\Lambda = \frac{6}{R^2}\left\{\frac{1}{\sqrt{1-\left(\frac{V}{C}\right)^2}}-1\right\} \qquad (14)$$

Combining equations (12) and (13) leads to the following:

$$\Lambda = \frac{6}{R^2}\left\{\left(\frac{M_0}{m}-1\right)-\frac{3Gm}{5RC^2}\right\} \qquad (15)$$

<u>Relativistic Hubble Model</u>

In order to achieve a simplified closed form solution of the GNM universe model equations (12) through (15), we can use the Linear Hubble model (LHM), V=HR, given by equation (1). However, at large values of R, V predicted by LHM can exceed the speed of light C violating the relativity theory and resulting in singularities in equation (12). To avoid these problems, the following alternate equation is obtained via substituting $\Lambda = \frac{3H^2}{C^2}$ in equation (14):

$$\frac{V}{C} = \sqrt{1-\left\{\frac{1}{1+\frac{H^2R^2}{2C^2}}\right\}^2} \qquad (16)$$

Equation (16) describes the Relativistic Hubble model (RHM) as an alternative to the more commonly known Linear Hubble model, V=HR. The justification for this relationship is 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 RHM equation (16) closely matches the predictions of the LHM equation (1), as shown in Figure 2. The expansion velocity calculated by the Linear Hubble model exceeds the velocity of light C and hence, violates the theory of relativity for values of R larger than approximately 14 billion light-years. The velocity predicted by RHM approaches the speed of light C as R increases indefinitely. Since the RHM predicted V never exceeds C, it never violates Einstein's theory of specific relativity. It also avoids any singularities in the GNM universe model equation (12) and is consistent with the observed accelerated expansion of the universe depicted by the recent supernova observations.

The impact of the LHM versus RHM on the Cosmological Constant Λ is shown in Figure 3. It should be noted that the Cosmological Constant predicted by equation (14) using the RHM remains invariable for all sizes or ages of the universe. However, the Cosmological Constant predicted using the LHM increases exponentially to very large values as the universe increases in size or age beyond 2 billion light-years. Hence, the assumption of a non-varying universal Cosmological Constant is not consistent with the LHM commonly used in BBM. The universal Cosmological Constant provided by RHM in conjunction with equation (14) is given by:

$$\Lambda = \frac{3H^2}{C^2} \qquad (17)$$

Equation (15) represents a quadratic equation that can be solved to obtain mass m of the universe as a function of its size R as follows,

$$m = \frac{5RC^2}{6G}\left[\sqrt{\left\{\left(1+\frac{\Lambda R^2}{6}\right)^2 + \frac{12GM_o}{5RC^2}\right\}} - \left(1+\frac{\Lambda R^2}{6}\right)\right] \qquad (18)$$

In BBM, the dark matter is generally referred to as the invisible mass in the universe. In GNM, the dark mass m_{dm} is defined as the transformed mass, $\Delta m = (M_o - m)$ that spontaneously decays or converts to energy to compensate for the gravitational energy and kinetic energy of the universe in accordance with equation (12). The dark mass is given as follows,

$$m_{dm} = M_o - m \qquad (19)$$

Rearranging equation (12) and dividing by $E_o=M_oC^2$, the following is obtained:

$$1 = \frac{mC^2}{E_0} + \frac{mC^2}{E_o}\left\{\frac{1}{\sqrt{1-\left(\frac{V}{C}\right)^2}} - 1\right\} + \frac{3Gm^2}{5RE_0} \tag{20}$$

Now, the non-dimensional relativistic mass energy Ω_{ME}, kinetic energy Ω_{KE}, gravitational potential energy Ω_{GPE}, and dark mass energy Ω_{DME} are defined as follows:

$$\Omega_{ME} = \frac{mC^2}{E_0} \tag{21}$$

$$\Omega_{KE} = \frac{mC^2}{E_o}\left\{\frac{1}{\sqrt{1-\left(\frac{V}{C}\right)^2}} - 1\right\} = \frac{\frac{1}{6}\Lambda mC^2 R^2}{E_0} \tag{22}$$

$$\Omega_{GPE} = \frac{3Gm^2}{5RE_0} \tag{23}$$

$$\Omega_{DME} = \frac{(M_0 - m)C^2}{E_0} = (1 - \Omega_{ME}) = (\Omega_{KE} + \Omega_{GPE}) \tag{24}$$

4. GNM RESOLVES PARADOXES AND MYSTERIES OF COSMOLOGY

GNM equation (18) is solved for the actual mass m of the universe as a function of its size or radius R, and input constants measured from recent experiments. Based on recent observational results from two balloon-borne telescopes, Boomerang and MAXIMA [10] 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 [11] designed to measure the redshifts of 250,000 galaxies and the High-Z Supernova Search Team [12] 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 (17).

4.1. Elimination of Black Hole or Big Bang Singularity

The results of predicted actual mass versus the size or radius R of the universe are shown in Figure 4. The actual mass increases with increasing size or age of the universe until a maximum mass is reached at about 10 billion light-years. The mass decreases with size during later years as the universe expands to bigger sizes. As shown in Figure 4, the calculated mass of the universe is less than the Planck's mass when the universe radius is of the order of 10-100 meters. At still smaller radii, the predicted mass of the universe decreases to even smaller values. GNM thus has no singularity at small values of radius of the universe and does not have an absolute time moment of the beginning of the universe representing time t =0 in the Big Bang model.

4.2. GNM Predicts Creation of Matter in Stars and Galaxies in the Early Universe

GNM equation (18) predicts the evolution and creation of mass m of the universe as a function of its size or radius R, as shown in Figure 4. The actual mass increases with increasing size or age of the universe until a maximum mass is reached at about 10 billion light-years. The mass decreases with size during later years as the universe expands to bigger sizes. Thus, GNM represents the universe's mass, energy, space, and time as one continuum interconnected and governed by the relativistic laws of conservation.

4.3. GNM Explains Away the Dark Matter Myth

Stars in the spiral galaxies are observed to rotate with a finite tangential velocity around the center of the galaxy due to the attractive pull of the gravity of the matter. The observed tangential velocities of the stars in nearby galaxies are so fast that the centrifugal force of rotation ought to make them fly off into the intergalactic space. The astronomers have, until now, explained such large rotation velocities by claiming existence of large amounts of invisible dark matter.

The dark matter theories invariably assume that the Newton's laws hold in the inner and outer galactic regions. Although the proof of the assumption of the Newton's law is lacking, most scientists prefer this explanation as compared to the alternative that Newtonian gravitational theory needs modification for application over galactic distances. The gravitational attraction of the non-luminous dark matter assumed to be extending far beyond the visible limits of the galaxy leads to the flat rotation curves. There has been growing acceptance by the mainstream scientists of the idea that majority of the matter that exists in the universe is dark. Understanding the physics and origin of the dark matter, both in black holes and halos of galaxies is currently a major open challenge to elementary particle physicists and astronomers in explaining the observed expansion of the universe from recent observations.

GNM provides the missing relativistic physics complementing the Newtonian laws for explaining the nature of the observed characteristic star velocities in spiral galaxies. A detailed treatise of the predicted and observed galactic star velocities is provided in reference [13]. GNM predictions indicate that the dark matter may be a mere artifact of the incorrect application of the Newtonian laws at galactic scale. The relativistic effects of the dark mass energy or vacuum energy become significant at these large scales and cannot be ignored to predict dynamics of stars at galactic distances.

4.4. GNM Eliminates the Need for Super-luminous Inflation

Inflation is not necessary to explain the existence of uniformity in the microwave background radiation, which can be explained by GNM as follows. As shown in Figure 5, at very large radii or size, space dilation predicted by GNM leads to the coherence or uniformity observed in background radiation. The degree of coherence or uniformity is represented by the amount of space dilation predicted by the specific relativity equation: $S = S_o\sqrt{1-(V/C)^2}$, wherein S is the special dimension at V and S0 is special dimension at V=0. The space dilation is shown on the ordinate axis in Figure 5 as a function of the universe radius or age (calculated as the ratio R/C) on the abscissa. The key argument against the super-luminous inflation scenario is that there is no independent experimental evidence that it did occur. Also, the extraordinarily dense matter at the beginning of the universe could not possibly move at a super luminal speed without violating laws of relativity and conservation of mass-energy.

4.5. GNM Resolves the Cosmological Constant Problem

The recent supernova observations exhibiting the accelerating expansion of the universe strongly support a non-zero Cosmological Constant. So far no credible physical theory has been advanced that could predict even the right order of magnitude of the vacuum energy. Particle physics theories put forward only a partial explanation for existence of vacuum energy and a non-zero Cosmological Constant, but the values predicted by these are several orders of magnitude greater than the recent observations. If the vacuum energy of such magnitude were to exist, an acceleration of almost infinite magnitude would rip apart atoms, stars and galaxies. Clearly, the current understanding of the vacuum energy provided by particle physics is incorrect.

There are other unanswered questions regarding the Cosmological Constant. One question is whether the Cosmological Constant is really a universal constant that does not change with the time evolution of the universe. Recently, some scientists have proposed a variable (Quintessence [14]) Cosmological Constant to account for the behavior of the observed data.

GNM provides a physical model, equations (14) and (15), for the Cosmological Constant, , which compliments its current understanding as the energy of the vacuum. Figure 3 shows the Cosmological Constant values predicted by equation (14), when used in conjunction with the widely accepted linear Hubble's model (LHM), V=HR, as well as with the proposed Relativistic Hubble model (RHM), equation (16). The predictions of the proposed RHM model support a non-zero and time-invariant constant value of Cosmological Constant given by equation (17).

GNM also solves another key puzzle that has been haunting scientists as to why the Cosmological Constant is observed to dominate at about the epoch of galaxy and star formation and not earlier. This observation is counter-intuitive to the notion that prime mover for galaxy and star formation is the pull of gravity rather than the expansion induced by the vacuum energy signified by the Cosmological Constant. GNM predicts an epoch lasting up to 10 billion light-years as shown in Figure 8, of mass (stars and galaxies) formation (as depicted by the fractional mass-energy curve in Figure 8) coincident with an equal dominance of the vacuum or kinetic energy and the gravitational potential energy. Further, GNM predictions show that the maximum mass in the universe occurs when the gravitational energy equals vacuum energy represented by the Cosmological Constant.

4.6. GNM Provides a New Perspective on the Birth and Evolution of the Universe

The most widely accepted history of the evolution of the universe assumes that the universe started with a Big Bang at the beginning of the time followed by an inflation scenario involving a "superluminal expansion." The Hubble expansion dominated the later evolution of the universe that led to the formation of cold molecular things such as stars, galaxies, terrestrial planets, and life forms when the universe starting from a hot Big Bang, had expanded and cooled. Now the universe expansion is accelerating due the mysterious dark energy that may lead to an ultimate demise of the universe as it cools down to its near death.

GNM results provide a different perspective on time and evolution of the universe. GNM predicts the observed expansion of the universe without any explicit consideration of time as a governing parameter. GNM represents the universe as a set of states of varying mass, energy, space, and time as a function of its size. Time in GNM is only an after-the-fact entity calculated as the ratio (R/C) of the universe radius to the speed of light. The universe as such does not have an assigned clock with an absolute time. From this point of view, the moment of the beginning, the period of evolution, and the future time history of the universe evolution becomes an absurd question or concept from a physical perspective. As far as the universe is concerned, it does not entail a time or clock involving an absolute synchronicity over the span of the universe. This vindicates Einstein's famous viewpoint: "To those of us who believe in physics, this separation between past, present, and future is only an illusion, even if a stubborn one."

4.7 Comparison of GNM Predictions against Supernova Data and Dark Energy

By observing distant, ancient exploding stars, physicists and astronomers [15, 16, and 17] 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 [15] presented the first compelling evidence that the expansion is accelerating and that this acceleration is due to the cosmological constant, Λ. The best fit to the data implies that the ratio of the vacuum energy density to the total energy density of the universe, equation (25) below, may equal 0.7, while the mass density ratio, equation (26), may equal 0.3. Subsequently, the High-Z Supernova Search Team [16] announced that they had found the same result in their data.

$$\Omega_\Lambda = \frac{\Lambda C^2}{3H^2} \qquad (25)$$

$$\Omega_m = \frac{8\pi G\rho}{3H^2} \qquad (26)$$

The redshift is defined as the fractional amount by which, features such as frequency and amplitude peaks in spectra of an astronomical object are shifted to longer wavelengths or lower frequencies. The Einstein’s theory of relativity provides the following relationship between the redshift z and velocity V:

$$z = \sqrt{\frac{1+(V/C)}{1-(V/C)}} - 1 \qquad (27)$$

Simplifying the above equation in terms of z gives the following,

$$\frac{V}{C} = \left[\frac{(z+1)^2 - 1}{(z+1)^2 + 1}\right] \qquad (28)$$

Combining equation (28) with the linear Hubble model (LHM) represented by V=HR, provides the following equation for the radius of the universe,

$$R_{LHM} = \left(\frac{C}{H}\right)\left[\frac{(z+1)^2 - 1}{(z+1)^2 + 1}\right] \qquad (29)$$

Similarly, combining equation (28) with the Relativistic Hubble model (RHM), equation (16), leads to the following,

$$R_{RHM} = \left(\frac{C}{H}\right)\left[\frac{z}{\sqrt{z+1}}\right] \qquad (30)$$

The relative brightness, B, of the supernova stars can now be estimated as follows. The intrinsic luminous energy of the star is assumed to be proportional to its density and its relative brightness or surface luminosity per unit surface area as observed from earth can be represented as below:

$$B \;\alpha\; \frac{Density}{(Surface\ Area)\,(Dis\tan ce)^2}$$

Or,

$$B \;\alpha\; \frac{Mass}{(Surface\ Area)(Volume)(Dis\tan ce)^2}$$

Now, according to the GNM equation (10), mass dilates into energy in proportion to the dilation factor, $\sqrt{1-(V/C)^2}$. Similarly, as the mass dilates into energy the size of the star expands inversely with approximately the same dilation factor according to the special theory of relativity. This leads to the following,

$$B \;\alpha\; \frac{\left\{1-(V/C)^2\right\}^3}{R^2} \qquad (31)$$

Substituting equations (29) and (30) for R (expressed in light-years) and a proportionality constant for best fit to the near-field Hubble expansion data [17] leads to the following relationships for predicting the relative brightness B for the Linear Hubble Model (LHM) and Relativistic Hubble model (RHM) respectively,

$$B_{LHM} = 1.92x10^{50}\left(\frac{H}{C}\right)^2 \frac{(z+1)^5}{\left[(z+1)^2-1\right]^2\left[(z+1)^2+1\right]^3} \qquad (20)$$

$$B_{RHM} = 3.84x10^{50}\left(\frac{H}{C}\right)^2 \frac{(z+1)^7}{z^2\left[(z+1)^2+1\right]^6} \qquad (21)$$

Figure 6 shows comparison of the supernova [15,16] and other near-field [17] data against the predicted relative brightness for both the linear and Relativistic Hubble Model by equations (32) and (33) respectively. A good agreement is seen between the predictions of the Relativistic Hubble Model and the measured values. The Linear Hubble Model under-predicts the trend of the observed data beyond Z=0.4, indicating that it does not represent accurately the relativistic effects that are dominant at large R or redshift values. Figure 7 shows the predicted distances of supernovas and their ratio for both the linear and Relativistic Hubble Model at different values of the observed redshift. The predictions are consistent with the supernova observations in that, beyond Z=0.4, the Relativistic Hubble Model predicts the distance of the supernova far greater than the linear model indicating an accelerated expansion of the universe by the dark energy.

Figure 8 shows the predicted fractional dark energy, gravitational potential energy, kinetic energy, mass density ratio, and vacuum energy density ratio during the epoch of the observed supernova. The dark energy during the early universe, up to about 2 billion years, consists primarily of the gravitational potential energy. At about 9 billion years, the gravitational energy and kinetic energy even out. Following this period, the dark energy again dominates in the form of the increasing kinetic energy fueling the accelerated universe expansion. As expected, the vacuum energy density ratio remains constant at 1 and the mass density ratio deceases continuously as the universe expands. Quantum theory is internally inconsistent in predicting a tremendous amount of energy in the vacuum space, ironically off from reality by up to120 orders of magnitude. A vacuum energy of this magnitude would rip apart every atom and particle in the universe and hence is far off the observed structure of the universe. The vacuum energy density predicted by GNM equation (25) is of the same order and consistent with the supernova and other observations of the universe.

At small age or size, the universe is dominated by the gravitational potential energy that requires a substantial amount of the total maximum mass M_o to convert to the gravitational potential energy leading to a decreased actual mass of the universe. As the size of the universe increases, the gravitational energy decreases and the kinetic energy increases. The dark energy dominates at very small and very large sizes. As the size R increases from small values, the dark energy first decreases and then increases with a minimum occurring at around 9 billion years, which coincides with the time when the maximum universe mass occurs.

4.8 GNM Predicts Stability Limits of Masses Ranging from Quantum Particles to the Universe

AS described earlier, GNM is based on the hypothesis of the spontaneous mass-energy conversion during the spontaneous decay of an unstable particle. The following GNM calculations show that this hypothesis also predicts the observed stability of stable particles such as a proton.

As discussed earlier, Figure 4 shows the actual mass m of the universe as a function of its size or radius R, as predicted by GNM equation (18). The actual mass m is less than the total rest mass M_o, since some of the mass is required to convert to energy to contribute to the non-zero gravitational potential energy and kinetic energy. The ratio of the actual mass predicted by equation (18) to the rest mass M_o is shown in Figure 9 for not only the rest mass M_o of the universe of 10^{53} kilograms ($5x10^{22}$ solar) used in Figure 4, but also for the rest masses of a proton, Planck's mass, galaxy ($1x10^{12}$ solar), and parametrically varying Universe masses of $5x10^{19}$ solar and $5x10^{23}$ solar. Each of the masses has a lower gravitational stability limit governed by the increasing gravitational potential energy at smaller sizes and an upper kinetic stability limit governed by the increasing kinetic energy at large sizes. A proton is shown to be stable between the lower gravitational stability limit of $1x10^{-52}$ meters and an upper kinetic stability limit of $1x10^{25}$ meters. The gravitational limit for Planck's mass is same as the Planck's length of $1x10^{-35}$ meters. The gravitational limits predicted for different masses are listed in Table 1 below:

Table 1: Gravitational and kinetic stability limits for various masses.

Mass	Gravitational Stability Limit	Kinetic Stability Limit
Proton	$1x10^{-54}$ meters	$1x10^{25}$ meters
Planck's mass	$1x10^{-35}$ meters	$1x10^{25}$ meters
Solar mass	$1x10^{3}$ meters	$1x10^{25}$ meters
Galaxy mass	$1x10^{15}$ meters	$1x10^{25}$ meters

It is to be noted that the kinetic stability limit for a proton, Plank's mass, solar mass, and galaxy is constant and equal to about $1x10^{25}$ meters, since the kinetic stability limit for these masses is independent of mass and primarily governed by the vacuum energy or the cosmological constant. The gravitational energies for these masses at sizes close to their respective kinetic limit are much smaller and negligible compared to the kinetic energies, and hence, the ratio of actual to total mass remains constant at the kinetic limit. However, as the rest mass increases to $5x10^{19}$ solar, both the gravitational and kinetic stability limits approach to $1x10^{25}$ meters. As the mass increases further, it becomes unstable and the maximum actual mass becomes much smaller than the rest mass as seen in Figure 9 for the rest mass values of $5x10^{22}$ solar and $5x10^{23}$ solar. The maximum mass, which is smaller than the rest mass, for these rest masses occurs at sizes of $1x10^{26}$ meters (10 billion light-years) and $1.4x10^{26}$ meters (14 billion light-years) respectively.

4.9 GNM Eliminates the Need for Incredible and Unsupportable Assumptions

GNM eliminates [13, 18, and 19] the need for invoking the following unfounded assumptions, which cannot be supported by theoretical arguments, experimental observations, or common human experience:

- Anthropic principle
- Time variation of the following universal constants to explain paradoxes of the universe evolution:
    - Universal Gravitational constant
    - Speed of light
    - Hubble constant
- Mysteries regarding the illusive quantum particles and forces
- Multiple dimensions beyond the ordinary 3 space and a time dimension
- Parallel universes

As described in detail in references [13, 18, and 19], GNM provides mechanistic and mathematical descriptions that explain the inner workings of quantum mechanics and resolves its well-known paradoxes. It also resolves the outstanding inconsistencies and controversies between the relativity theory and quantum mechanics.

5. SUMMARY AND CONCLUSIONS

A new mathematical model, the Gravity Nullification model (GNM), is proposed that integrates the missing physics of the spontaneous relativistic conversion of mass to energy into the existing physics theories, specifically a simplified general theory of relativity. Mechanistic mathematical expressions are derived for a relativistic universe expansion, which predict both the observed linear Hubble expansion in the nearby universe and the accelerating expansion exhibited by the supernova observations. The integrated model addresses the key questions haunting physics and cosmology due to the missing physics from existing theories. It also provides a fresh perspective on the misconceived birth and evolution of the universe, especially the creation and dissolution of matter. The proposed model eliminates singularities from existing models and the need for the incredible and unverifiable assumptions including the superluminous inflation scenario, multiple universes, multiple dimensions, and quantum gravity. Predictions of the model show a close agreement with the recent observations of the universe. The integrated model is shown to resolve the singularities, paradoxes and inconsistencies related to the current theories – quantum mechanics and general relativity.

The theory presented in this paper extends the validity of the theory of relativity to the universal observations, restores simplicity and beauty to physics and cosmology, and enhances their credibility, comprehensibility, and acceptance. It also restores the once lost elegance to the “Absurd Universe” [20] predicted by the current theories.

References

[1] *Proceedings of the First Crisis in Cosmology Conference (CCC-I)*, Monaco, Portugal June 23-25; http://www.cosmology.info/press/2005.06.30-CCC-I_followup.pdf

[2] F. Hoyle, Burbidge, G. and Narlikar, J.V. 2000, *A Different Approach to Cosmology*, Cambridge: Cambridge University Press

[3] J. W. Moffat, *Variable Speed of Light Cosmology: An Alternative to Inflation*, arXiv:hep-th/0208122 v3 19 Sep 2002.

[4] Ruggero Maria Santilli, *Universality of the Isospecial Relativity for the Invariant Description of Arbitrary Speeds of Light*, arXiv:physics/9812052v1

[5] P. S. Debnath and B. C. Paul, *Cosmological Models with Variable Gravitational and Cosmological constants in R2 Gravity*, arxiv.org/abs/gr-qc/0508031v2

[6] Peter Woit , *Is String Theory Even Wrong?*, American Scientist, March-April 2002 Volume: 90 Number: 2 Page: 110.

[7] P. Davies, *The New Physics*, Cambridge University Press, 1998.

[8] D. Goldsmith, *The runaway universe – the race to find the future of the cosmos*, Perseus Publishing, 2000.

[9] D. C. Giancoli, *Physics for Scientists and Engineers with Modern Physics*, Prentice Hall, ed. 3, 2000.
[10] "Universe in Balance," *New Scientist*, 26, December 2000.
[11] J. A. Peacock et.al. , *Nature* **410**, 169, 2001.
[12] J. L. Tonry, *arXiv:astro-ph/0105413 v2* at (xxx.lanl.gov), May 2001.
[13] A. Singh, The Hidden Factor: *An Approach for Resolving Paradoxes of Science, Cosmology and Universal Reality*, AuthorHouse, 2003.
[14] L. Krauss, *Quintessence- The Mystery of Missing Mass in the Universe*, Basic Books, 2000.
[15] S. Perlmutter, *Supernova, Dark Energy, and the Accelerating Universe*, Physics Today, 53 (April 2003).
[16] A. Riess et al., Astron. J. 116, 1009 (1998).
[17] M. Hamuy et al., Astron. J. 106, 2392; and 1995 Astron. J. 109, 1 (1993).
[18] A. Singh, *A New Theory of Spontaneous Decay Resolves Paradoxes of General Relativity, Quantum Mechanics, and Cosmology*, The XXII Texas Symposium on Relativistic Astrophysics, Stanford University, CA 2004.
[19] A. Singh, *Quantum Non-Locality Explained by Theory of Relativity*, Physics Essays Vol. 19 No. 1, 2007.
[20] M. S. Turner, *Absurd Universe*, Astronomy Special Cosmology Issue, 8, Nov 2004.

List of Figures

Figure 1: A simplified gravity model of the universe.

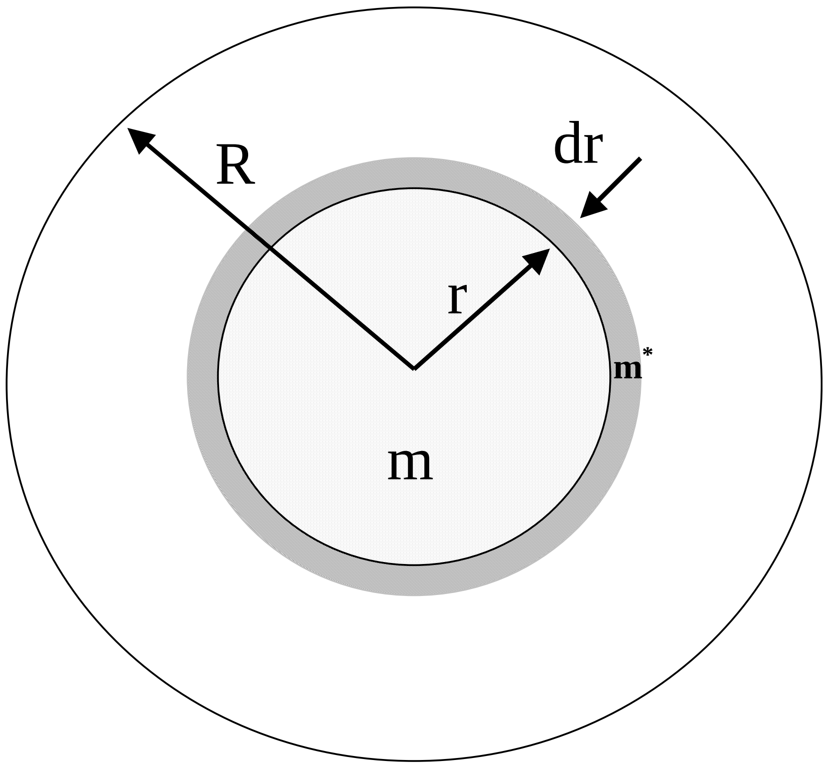


Figure 2: LHM and RHM predicted velocity ratios, V/C.

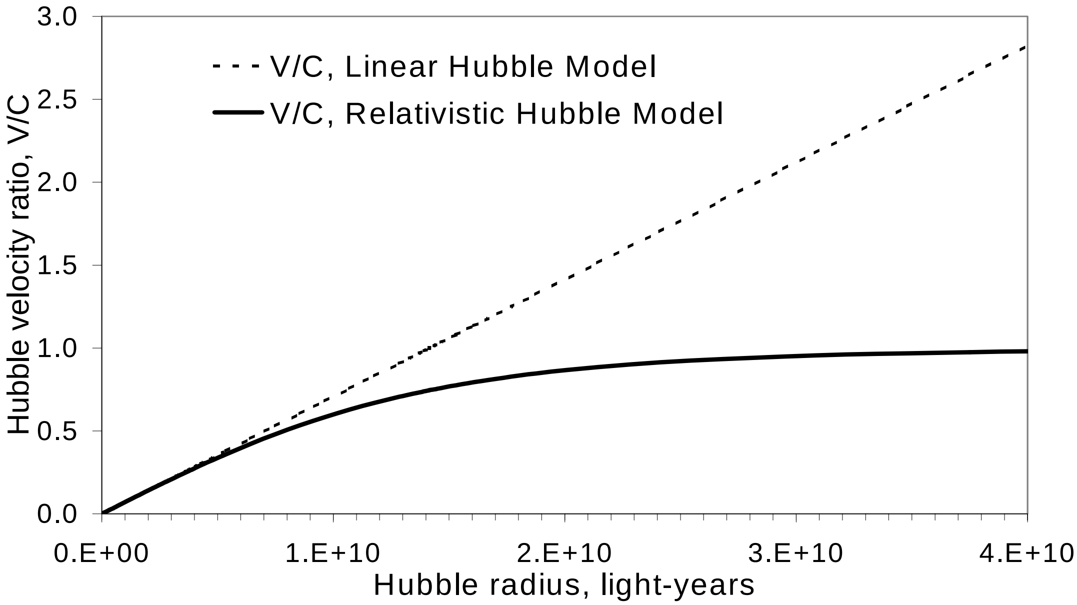


Figure 3: LHM and RHM predicted Cosmological Constants.

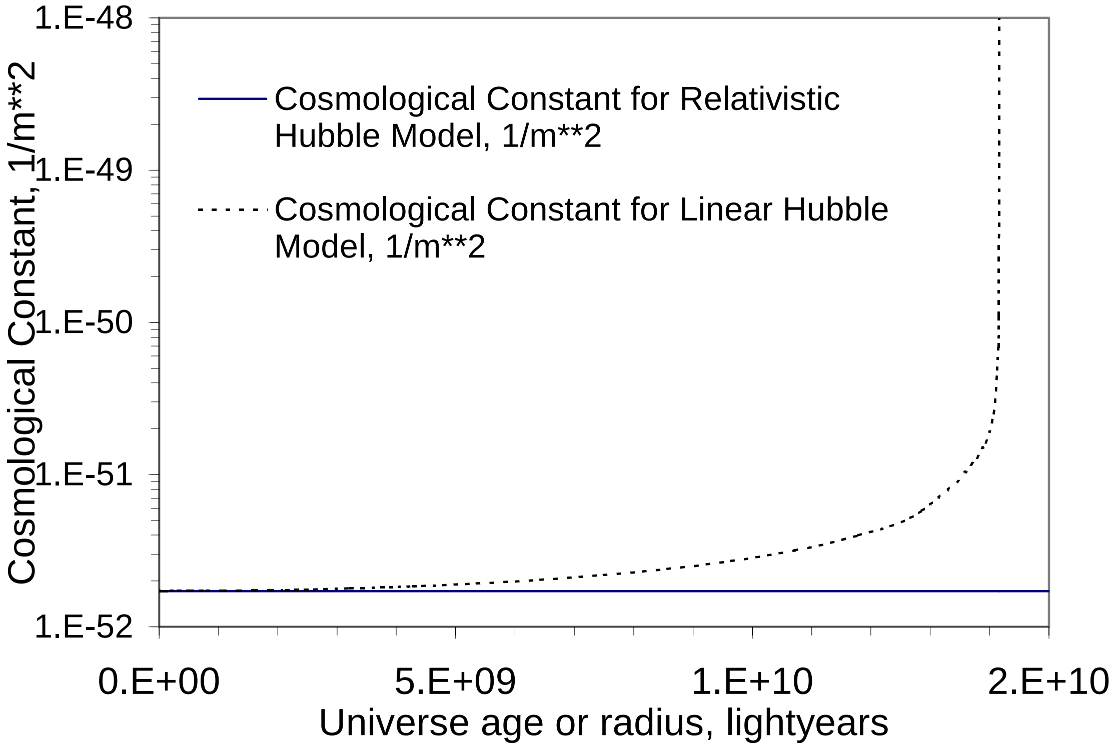
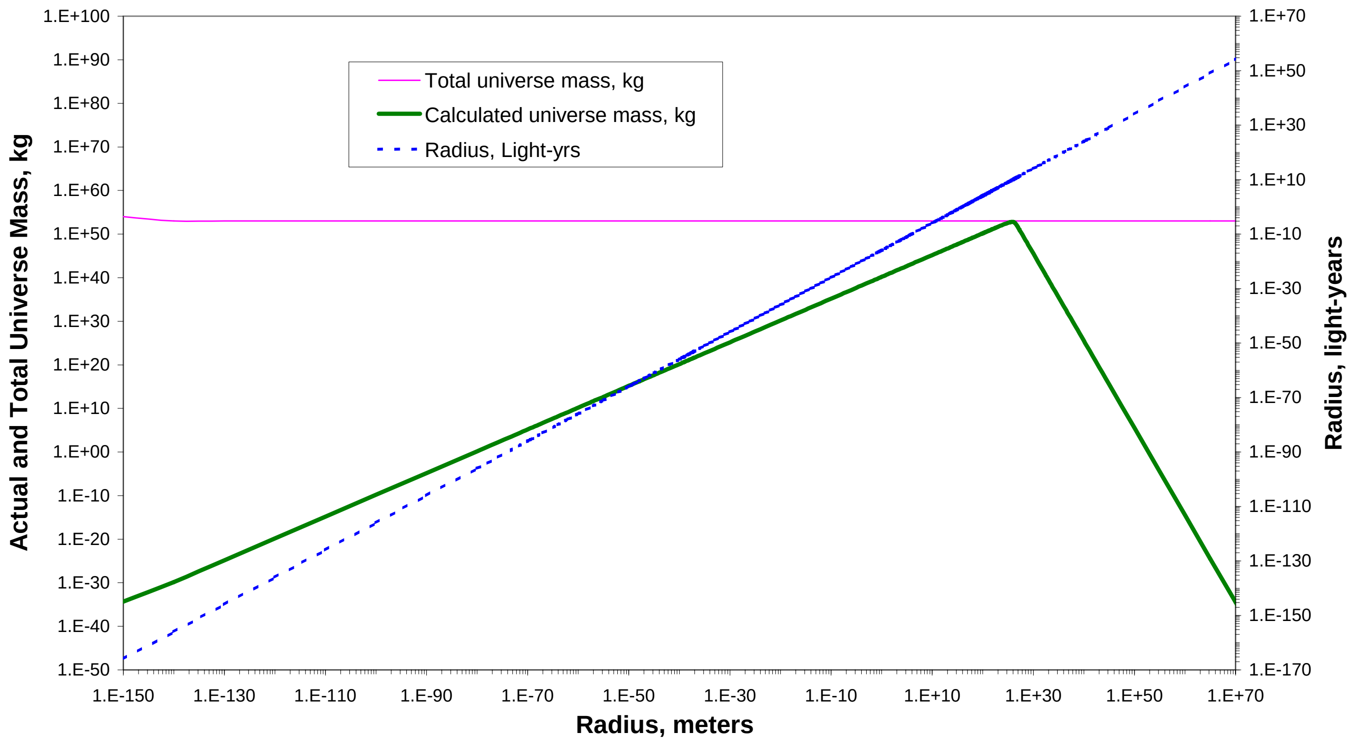


Figure 4: Universe mass versus radius predicted by GNM, demonstrating no black hole singularity.



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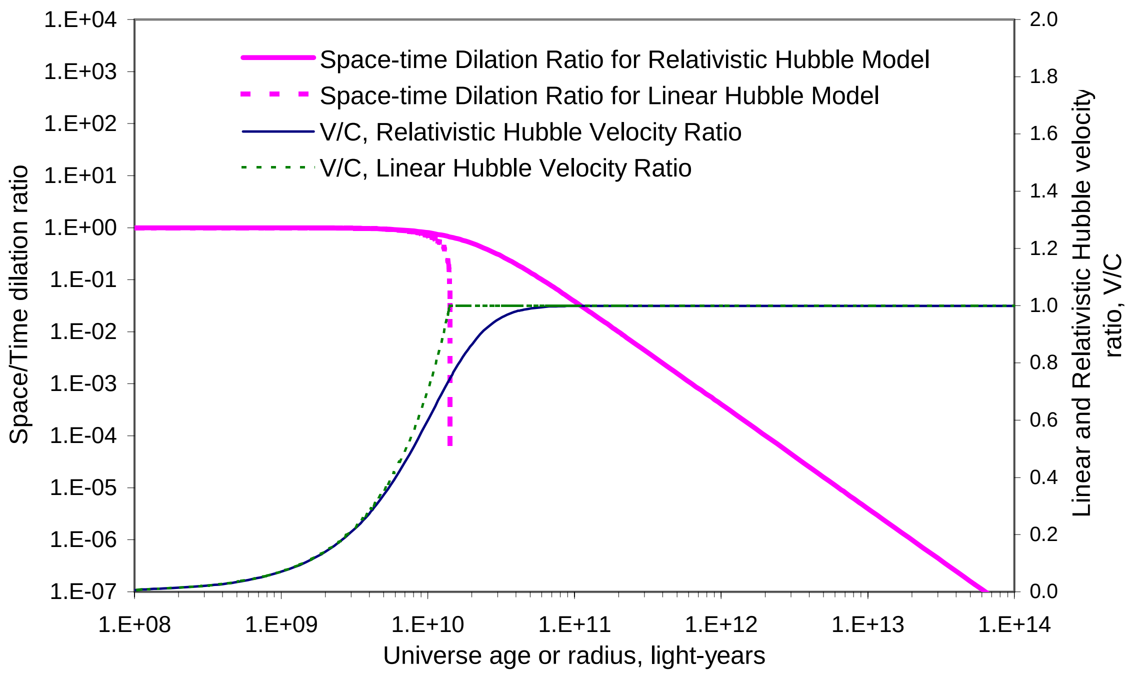

Figure 6: Comparison of GNM predictions against Supernova and other data using Linear and Relativistic Hubble models.

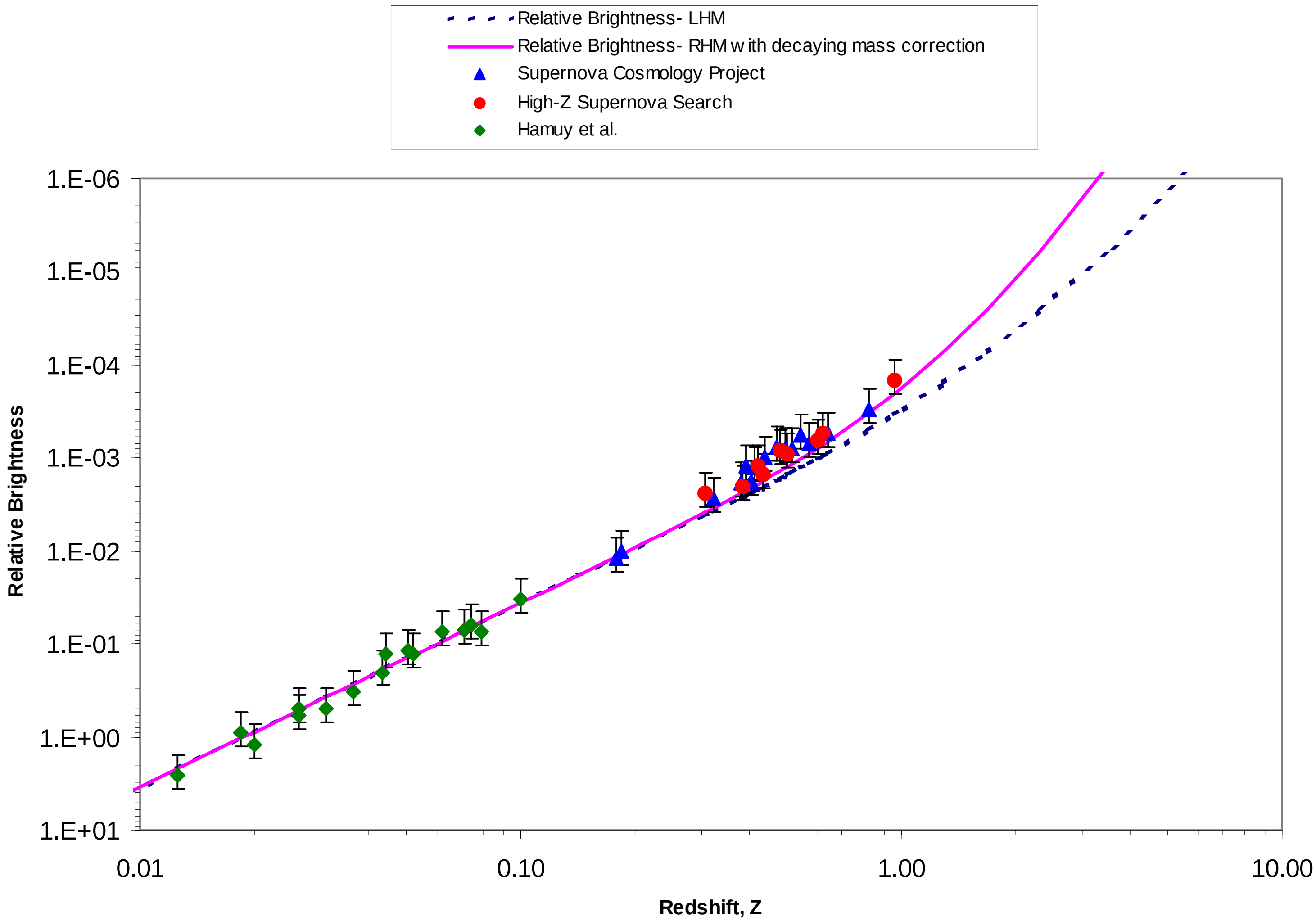

Figure 7: LHM and RHM predicted supernova distances and their ratios.

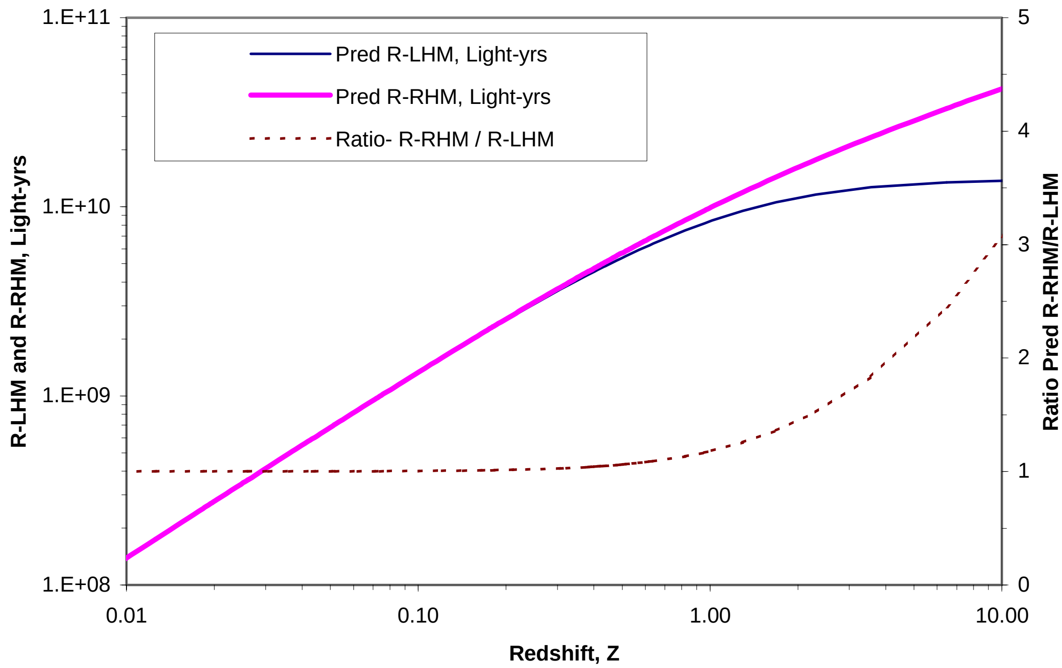

Figure 8: GNM predicted fractional dark energy, gravitational potential energy, kinetic energy, mass density ratio, and vacuum energy density ratio.

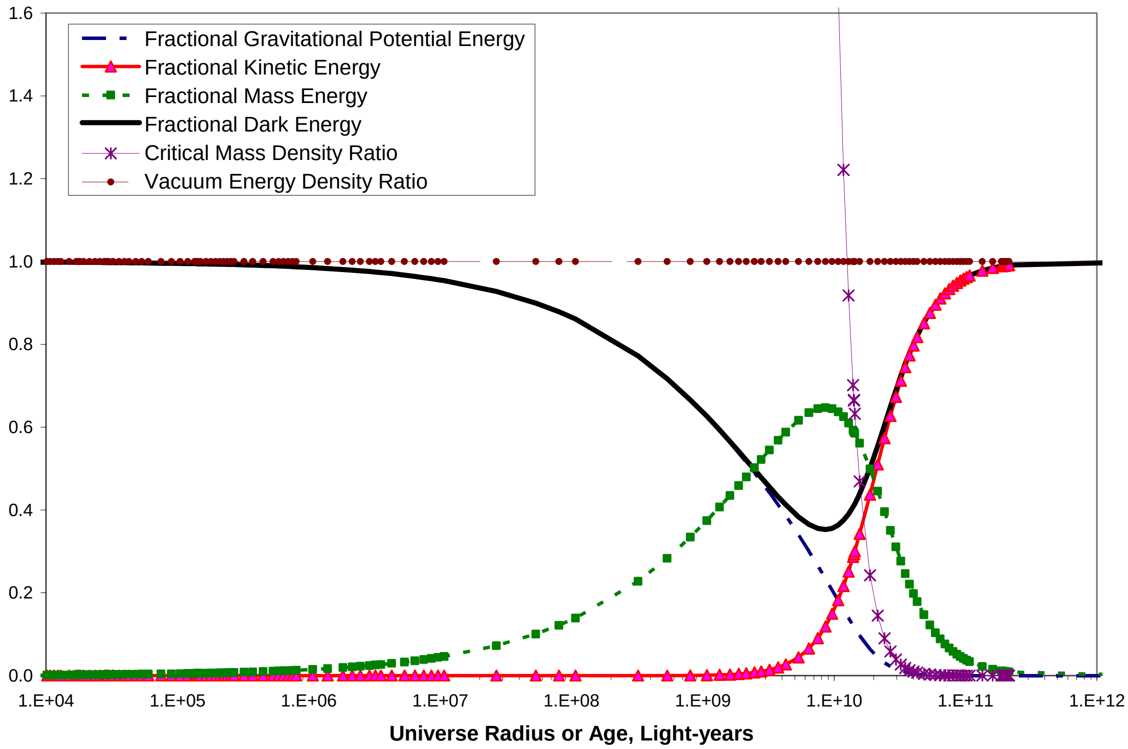

Figure 9: The ratio of the actual mass predicted by GNM to the rest mass $M_{o.}$