Origin of motion. I. Spontaneous mass-energy equivalence model resolves current physics and cosmology paradoxes

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Abstract: Current widely accepted understanding of the origin of motion is based on the Newtonian, Special (SR), and General Relativity (GR) theories wherein an external force or agency is required to impart motion to a classical mass. Similarly, quantum theories assume a pre-existing field or quantum fluctuations (wave-functions) as a fundamental reality. Maxwell's theory also assumes a photon having an inherent speed the speed of light and zero mass at its birth and throughout its lifetime. Part-1 of this paper describes the missing physics of the origin of motion based on the well-established principle of mass-energy equivalence that requires a nonzero rest mass for originating nonzero kinetic energy or motion. The proposed Universal Relativity Model (URM) based on special relativity theory describes a universal model predicting classical as well as quantum behaviors of both massive and massless particles in a single model that is shown to remove prevailing deficiencies/inconsistencies and paradoxes of the current widely accepted physics and cosmology theories. The proposed model describes a spontaneous (no external force or agency required) relativistic mass creation/dilation process allowing a nonzero photon mass at rest (emission and absorption), which dilates to zero as it expands and accelerates to the speed of light through uninterrupted space. The model thus bridges gaps between relativity and Maxwell's theories. Integrating gravity into the model leads to a fundamental universe model that is shown to predict the observed universe/galaxy behavior and resolves paradoxes of the big bang cosmology including dark energy, dark matter, cosmological constant, and big bang (GR) singularity without the need for superluminous inflation. The model also makes testable predictions for falsification via future observations and provides a new fundamental understanding of universal constants such as c, commonly known as the speed of light. The results may have significant implications for the current standard model, big bang cosmology, and fundamental understanding of the universe. Part-2 of the paper extends the relativistic model to describe the physics of the observed spontaneous complementary or dualistic wave-particle behavior of quantum particles as an alternative to the well-known de Broglie model. It explains the inner workings of quantum mechanics resolving its major paradoxes including the collapse of the wave function, parallel universes, vacuum energy, and nonlocality (spooky action-at-distance).
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Résumé: La compréhension actuelle largement acceptée de l'origine du mouvement est basée sur les théories newtonienne, relativité restreinte (SR) et relativité générale (GR) dans lesquelles une force ou une action externe est requise pour conférer un mouvement à une masse classique. De même, les théories quantiques supposent un champ préexistant ou des fluctuations quantiques (fonctions d'onde) comme une réalité fondamentale. La théorie de Maxwell suppose également un photon ayant une vitesse inhérente la vitesse de la lumière et masse zéro à sa naissance et tout au long de sa vie. La première partie de cet article décrit la physique manquante de l'origine du mouvement basée sur le principe bien établi de l'équivalence masse-énergie qui exige une masse au repos non nulle pour produire une énergie ou un mouvement cinétique non nul. Le modèle de relativité universelle (URM) proposé basé sur la théorie de la relativité restreinte décrit un modèle universel prédisant les comportements classiques et quantiques des particules massives et sans masse dans un modèle unique qui est montré capable d'éliminer les déficiences/incohérences et les paradoxes des théories courantes largement acceptées de la physique et de la cosmologie. Le modèle proposé décrit un processus de création/dilatation de masse relativiste spontanée (aucune force externe ou organisme requis) permettant une masse de photons non nulle au repos (émission et absorption), qui se dilate à zéro au fur et à mesure de son expansion et accélère vers la vitesse de la lumière au travers d'espace ininterrompu. Le modèle comble ainsi les écarts entre la relativité et les théories de Maxwell. L'intégration de la gravité dans le modèle conduit à un modèle d'univers

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fondamental qui prédit le comportement univers/galaxie observé et résout les paradoxes de la cosmologie Big Bang, y compris l'énergie sombre, la matière noire, la constante cosmologique et la singularité Big Bang (GR) sans besoin d'inflation superlumineuse. Le modèle fait également des prédictions testables pour la falsification par le biais d'observations futures et fournit une nouvelle compréhension fondamentale des constantes universelles telles que *c*, communément appelée vitesse de la lumière. Les résultats peuvent avoir des implications significatives pour le modèle standard actuel, la cosmologie Big Bang et la compréhension fondamentale de l'univers, La deuxième partie de l'article étend le modèle relativiste pour décrire la physique du comportement spontané ou dualiste des particules quantiques observées, en tant qu'alternative au modèle de Broglie bien connu. Il explique le fonctionnement interne de la mécanique quantique en résolvant ses principaux paradoxes, y compris l'effondrement de la fonction d'onde, les univers parallèles, l'énergie du vide et la non-localité (action effrayante à distance).

Key words: Gravity; Mass-Energy Equivalence; Expanding Universe; Dark Energy; Hubble's Constant; Cosmological Constant; Theoretical Physics; Relativity.

I. INTRODUCTION

Photons are fundamental particles. All electromagnetic radiation is quantized as photons. The smallest amount of electromagnetic radiation that can exist is one photon, whatever its wavelength, frequency, energy, or momentum. The very abundance of photons in the universe raises the question as to how the photons came to existence. Photons are produced by atoms when a bound electron moves from one orbital to another orbital with less (more negative) energy. Photons can also be emitted by an unstable nucleus when it undergoes some types of nuclear decay. Furthermore, photons are produced whenever charged particles are accelerated.

All quantum particles have nonzero rest mass except the known massless particles (e.g., photon, graviton, and gluon). The prevailing assumptions of the Maxwell's theory are that a photon has zero rest mass since the special relativity would require an infinite energy to accelerate a nonzero mass to the speed of light. Hence, a massless particle is treated differently from massive quantum particles, such as electrons, protons, and atoms, and always assumed to travel at the speed of light from the instant it is born or emitted. Speed of light c is presumed as a cosmic speed limit based on the assumption of zero photon mass that could be stable forever. If photons have a little nonzero mass, they would travel at speed less than c, would be unstable, and eventually decay into lighter particles. Then c would essentially become a fixed universal constant rather than the constant speed of light as widely accepted. A nonzero photon mass would also require modifications to the Standard Model of particle physics (which posits a zero photon mass), the Maxwell equations describing EM waves/fields, and Coulomb's inverse-square law for electrical attractions of charged particles.

Apart from the fact that only massless particles can attain the speed of light, all quantum particles with or without mass exhibit spontaneous wave-particle behavior pointing to the spontaneous mass-energy conversion during their motion thru space. There exist some claims[1] to show that the principle of conversation of mass and the principle of conservation of energy deny the possibility of converting mass into energy. However, this conclusion in Wang's paper[1] is proven incomplete, inaccurate, and unjustified by direct measurements in experiments vindicating Einstein's mass-energy relationship - $E = mc^2$. Scientists at the Massachusetts Institute of Technology (MIT), the Commerce Department's National Institute of Standards and Technology (NIST), and the Institute Laue Langevin, Grenoble, France (ILL) who conducted the most precise direct test ever of what is perhaps the Einstein's formula in science proving the accuracy of Einstein's theory $E = mc^2$ as described in Ref. 2. Another conclusion by Wang's paper[1] that "$E = mc^2$ is not compatible with potential energy and electrodynamic energy" is premature and hence incorrect since it fails to include the relativistic kinetic energy along with mass and gravitational energy. Singh's current paper equation (13a) describes a complete description of mass-energy conservation including the relativistic kinetic energy that eliminates the shortcomings of Wang's equations and ensuing incorrectly deduced incompatibilities among Einstein's formula, gravitational potential energy, and electromagnetic energies. Wang[1] also wrongly assumes that mass conservation law and energy conservation law that are proven for classical Newtonian fixed mass, energy, space, and time isolated-ly hold true at relativistic speeds (V close to c) and in quantum regimes. The well-established empirical observations of the Double slit experiments and the quantum nonlocality experiments (see Refs. 7 and 8 in Paper II of Singh's paper—"Spontaneous Mass-Energy Equivalence Model Unravels Quantum Mysteries and Paradoxes") prove the mass-energy equivalence and mutual convertibility. Singh's paper provides further clarifications and physical basis for the Heisenberg's uncertainty principle and invalidity of the creation ex nihilo in conjunction with it.

This paper integrates the missing physics of spontaneous mass-energy equivalence into the total mass-energy conservation to eliminate the paradoxes of the modern physics theories and cosmology including dark energy, dark matter, quantum gravity, etc. It also provides a bridge between Maxwell's electromagnetic theory via allowing a nonzero photon rest mass achieve the speed of light by spontaneous mass-energy conversion without violating special relativity theory that would predict an infinite mass at $V = c$. How is it

possible for any quantum particle to act both as wave and particle without a nonzero mass? Further, heavier quantum particles (e.g., electrons) and massive galaxies at the farthest part of the universe are also known to move at or close to the speed of light; where does the massive energy required to attain such high speeds of large masses come from? Part-2 of the paper provides possible answer to these fundamental questions behind the unexplained mysteries of the inner workings quantum mechanics.

II. ISSUES AND INCONSISTENCIES RELATED TO MAXWELL'S PHOTON MODEL

A. Observed experimental limits on photon mass and lifetime

There are no measurements to prove that the photon mass is exactly zero. Experiments do not determine exact quantities because of small errors inherent in making measurements. Scientists have, however, put an upper limit[3–5] on the photon rest mass. In 1994, the Charge Composition Explorer spacecraft measured the Earth's magnetic field and physicists used this data to define an upper limit of 0.0000000000000006 eV for the mass of photons, with a high certainty in the results. This number (3.55×10^{-52} kg, the lightest particle) is close to zero; it is equivalent to 0.00000000000000000000039 times the mass of an electron. The work[6] carried out by Luo and his colleagues at Huazhong University of Science and Technology in Wuhan, China establishes a new limit on photon mass as less than 10^{-54} kg or 7×10^{-19} eV. This was established by an experiment in which light is aimed at a sensitive torsion balance; if light had mass, the rotating balance would suffer an additional tiny torque. This represents a 20-fold improvement over previous limits on photon mass.

A recent study[7] analyzed observations of the cosmic microwave background radiation (CMBR) from the NASA's COBE satellite (1989) to calculate the limit on the photonic lifetime. The results of the study found no indication of missing low-energy light and a perfect black body behavior of the CMBR. This led to the conclusion that the minimum lifetime of a photon is 10^{18} years much greater than the 13.7×10^{9} years of universe age predicted by the Big Bang model.

B. Inconsistencies related to the zero photon mass and fixed speed (c)

Maxwell's theory hypothesis is that the photon rest mass is zero and it moves at exactly the speed of light. However, this hypothesis is in direct conflict with the principle of wave-particle duality and theory of relativity as discussed below:

1. The complementary wave-particle behavior of a photon is well established by scientific experiments and theories. If a photon has no rest mass, it cannot act as a particle. The concept of a photon as a particle was proposed by Einstein to explain the observed photoelectric effect wherein the energy of absorbed light quanta can cause an emission of electrons from a surface. Einstein showed that the wave nature of light could not lead to the observed photoelectric effect.
2. Photons are deflected by a gravitational field by the same amount as a nonzero mass traveling at the speed of light with the same momentum as the photon.
3. When a photon is created from an atom at rest, its initial velocity of emission from the atom must be zero to satisfy the stationary boundary condition. Hence, the assumption of a photon having its velocity equal to the speed of light at the instant of its birth or emission is not valid.
4. While the Maxwell's theory assumes a zero rest mass, it still ascribes a nonzero momentum to the photon. Since the momentum of an entity is physically defined as the product of its mass and velocity, a nonzero momentum is internally inconsistent in conjunction with a zero rest mass. The relativistic energy E of a particle is described by Special Relativity theory as follows:

$$E^2 = \left(M_0 c^2\right)^2 + (pc)^2, \tag{1}$$

wherein M_0 is the rest mass and p is the momentum of the particle, and c is the speed of light. Maxwell's theory assumes that a photon rest mass is zero and it has a nonzero positive momentum p. This leads to $E = pc$, or $p = E/C = hf/c$, wherein h is Planck's constant and f is frequency.
5. A nonzero photon rest mass is inconsistent with special relativity (SR) because it would require an infinite amount of kinetic energy (KE) and infinite increase in mass when a rest mass M_o is accelerated to the speed of light as predicted by the following equations of special relativity:

$$KE = M_0 C^2 \left(\frac{1}{\sqrt{1 - (V/C)^2}} - 1 \right) \tag{2}$$

and

$$m = \frac{M_o}{\sqrt{1 - (V/C)^2}}. \tag{3}$$

However, what is forgotten or ignored that the special relativity (SR) theory only addresses the increase in rest mass of a particle as it is accelerated via external force or magnetic field such as in the classical particle accelerators that add energy to the particle. The SR theory lacks the physics as to how a particle could be accelerated to the speed of light without an external force or addition of energy. The mass-energy equivalence principle, on the other hand, requires a nonzero rest mass to initiate a nonzero kinetic energy or motion. A zero rest mass would not be equivalent to a nonzero kinetic energy of the same particle since it would violate the fundamental principle of mass-energy equivalence. This is also evidenced by an equivalent rest

mass (E/c^2) decrease when a particle of energy E is emitted from a mass.

If the rest mass of the photon were nonzero, the theory of quantum electrodynamics would also be "in trouble" primarily through loss of gauge invariance, which would make it nonrenormalizable; also, charge-conservation would no longer be absolutely guaranteed. In order to avoid the above difficulties related to relativity and Maxwell's theories, physicists have accepted the hypotheses of photon having a zero rest mass and fixed speed of light as a compromise consensus position irrespective of its serious inconsistencies.

This paper puts forward below a new model based on SR theory and the spontaneity of the mass-energy equivalence principle that removes the above dilemmas and inconsistencies among the current mainstream theories. Such spontaneous mass-energy conversion is evidenced by the well observed phenomena of wave-particle duality, spontaneous decay of quantum particles, and spontaneous expansion of the universe. Hence, the origin of motion and achieving the speed of light requires a nonzero rest mass, howsoever small and negligible.

C. Recent studies results support nonzero photon rest mass

It is almost certainly impossible to do any experiment, which would establish that the photon rest mass is exactly zero. However, a recent study[8] investigates the theory that photons from a light source are transformed into axions, hypothetical elementary particles, on interacting with an extragalactic magnetic field. Axions could then be transformed back into photons by interacting with other magnetic fields. Test results[8] provide the evidence of the existence of heavy photons with nonzero rest mass and a velocity much less than the speed of light outside of the boundary of matter, howsoever only for a small distance and time. When light hits a semiconductor material and is absorbed, its photons can become "excitons," sometimes referred to as "heavy photons" because they carry energy, like photons, but have mass, like electrons. Excitons typically exist for only a short time—trillionths of a second—and travel only a few microns before turning back into photons, which are then emitted from the material. Scientists from the University of Pittsburgh and Bell Labs, the R&D arm of Lucent Technologies, report[9] that they have designed and demonstrated a two-dimensional semiconductor structure in which excitons exist longer and travel farther than previously recorded. They report a system in which excitons move freely over distances of hundreds of microns. The researchers "stretched out" the excitons by pulling them apart with an electrical field. This extended the excitons' lifetimes by a million (up to 30 ms) and expanded the distances the excitons traveled (up to a millimeter). They were able to "see" the excitons by observing emitted photons. Recent analytical results[10] show that all free physical fields should have a nonzero rest mass according to the field theory of gravitation. This general physical conclusion is in good correspondence with the basic Minkowski axiom:[11] "A substance being at any worldpoint can be always considered as staying at rest under reasonable definition of space and time. The axiom tells us in other words that at any worldpoint any velocity v is always less than c. According to this, c is the upper limit for supersubstantial velocities and this is a more profound meaning of quantity c."

III. A SOLUTION TO THE NONZERO REST MASS AND SPEED OF LIGHT DILEMMA

The proposed model provides a mathematical representation of the postulated mass creation/dilation process allowing spontaneous conversion of the photon mass to kinetic energy and vice versa that is consistent with the recent experimental observations. It allows a nonzero photon mass at its emission and absorption, which dilates to zero as it travels thru empty space at the speed of light predicting the observed photon variable mass and speed behavior as well as a stable lifetime of the order of the universe age.

Following its emission from the stationary surface, a photon is assumed to accelerate away to the speed of light when its motion is not constrained by the medium of propagation. Since, there are no external forces acting on the photon, its acceleration to the speed of light has to be internally induced. If the mass of a photon were nonzero due to its finite nonzero energy, then according to the theory of relativity, Eq. (2), it would take an infinite amount of energy to accelerate it to the speed of light c as its KE increases infinitely. Hence, mass of the photon must decrease as its speed increases such that the total energy is conserved. In summary, since there is no external source of force/energy to move the photon, the kinetic energy for its motion must be internally induced via conversion of the rest mass to kinetic energy. And this leads the following hypothesis or postulate regarding the spontaneous self-converting (mass to energy) nature of the photon:

Postulate I: The motion of the photon is induced by the spontaneous conversion of its rest mass to the kinetic energy of the remaining mass. As mass decreases, the kinetic energy increases in accordance with the theory of special relativity and conservation of total mass-energy

References 12–18 propose an alternative photon model, described below, based on the postulate above. Let us now consider a mass M_o at rest ($V = 0$) representing a total relativistic energy, $E_0 = M_0c^2$, wherein c is the speed of light. Transformation of a small portion of the mass, Δm, to energy, also defined as the transformation energy (TE), can be described by the special theory of relativity as follows:

$$TE = \Delta m \cdot C^2 = (M_o - m)C^2. \tag{4}$$

As per postulate above, TE is utilized in inducing spontaneous expansive motion V within the remaining photon mass m. The total energy of the photon, $E_0 = M_0c^2$, is conserved and maintained throughout the emission, free travel, and absorption at impact with a surface. The relativistic kinetic energy (RKE) of the remaining mass, m, is given by the following equation of the special theory of relativity:

$$\text{RKE} = mC^2\left(\frac{1}{\sqrt{1-(V/C)^2}} - 1\right). \tag{5}$$

In the absence of gravitational force or energy, equating this kinetic energy to TE, we obtain the following:

$$(Mo - m)C^2 = mC^2\left(\frac{1}{\sqrt{1-(V/C)^2}} - 1\right). \tag{6}$$

Simplifying the above provides the following:

$$m = M_o\sqrt{1-(V/C)^2}. \tag{7}$$

The relativistic mass energy of the photon is given by

$$RME = mc^2, \tag{8}$$

and, the relativistic momentum is described as

$$p_r = mV. \tag{9}$$

The relativistic frequency f_r is given by

$$f_r = mc^2/h. \tag{10}$$

Combining Eqs. (7) and (10) leads to the following:

$$f_r = (M_oC^2/h)\sqrt{1-(V/C)^2}. \tag{11}$$

The relativistic wavelength is then given by

$$\lambda_r = V/f_r = Vh/\left(M_oC^2\sqrt{1-(V/C)^2}\right). \tag{12}$$

Figure 1 shows the actual mass of the microwave photon with a rest mass of 10^{-40} kg, calculated by Eq. (3) for a non-decaying photon and Eq. (7) for a self-decaying photon as a function of its velocity. At the boundary of emission when the photon velocity is zero, its actual mass is equal to the rest mass. As velocity increases, the mass calculated by Eq. (3) increases; while the mass calculated by Eq. (7) decreases to zero as V approaches C.

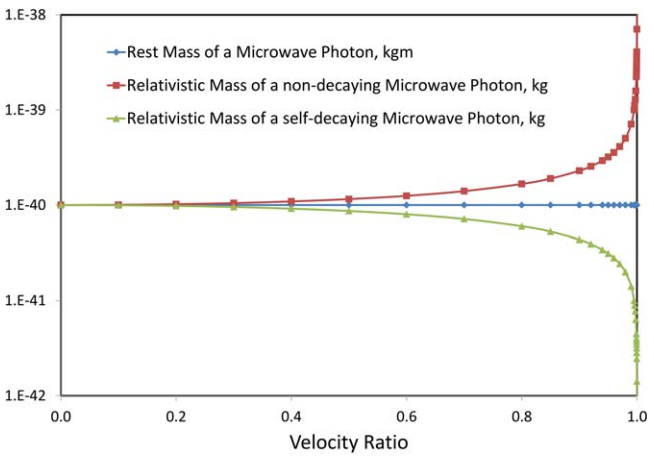

FIG. 1. (Color online) Mass of a microwave photon with a rest mass of 10^{-40} kg vs velocity.

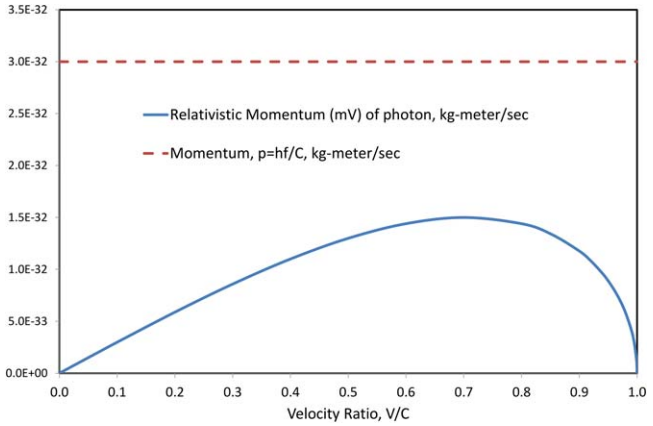

FIG. 2. (Color online) Momentum (p = hf/c) vs relativistic momentum (mV) of a microwave photon with a rest mass of 10^{-40} kg vs velocity.

Figure 2 shows the photon momentum calculated by standard model Eq. (1) with zero rest mass and relativistic momentum calculated by the proposed model Eq. (11). While the standard model momentum ($p = hf_0/c$) remains constant, the relativistic momentum decreases to zero at the time of emission due to the zero velocity and at V = c due to zero mass. The maximum relativistic momentum (mV) is approximately half of the standard model momentum and occurs around 70% of the speed of light. The proposed model eliminates the earlier described inconsistencies of Maxwell's photon model.

IV. UNIVERSAL VINDICATION OF THE FUNDAMENTAL SPONTANEOUS MASS-ENERGY CONVERSION MODEL

An integrated model including the effects of gravity is proposed in Refs. 13–18, which extends the above model to predict the observed universe behavior. It provides quasi-static or time-invariant mass-energy field equations that predict the observed galaxy and universe expansions. Integrating gravity in Eq. (6), the following Universal Relativity Model (URM) Eq. (13a) is obtained for relativistic universe mass m as a function of size or radius R describing the universe as a spontaneously decaying/forming mass with rest mass M_o,

$$(M_0 - m)C^2 = mC^2\left\{\frac{1}{\sqrt{1-(V/C)^2}} - 1\right\} + \frac{3Gm^2}{5R}. \tag{13a}$$

The above equation can be rewritten to describe relativistic mass m in terms of Einstein's Cosmological constant Λ, gravitation constant G, and the speed of light c as follows:

$$m = \frac{5RC^2}{6G}\left[\sqrt{\left\{\left(1+\frac{\Lambda R^2}{6}\right)^2 + \frac{12GM_o}{5RC^2}\right\}} - \left(1+\frac{\Lambda R^2}{6}\right)\right]. \tag{13b}$$

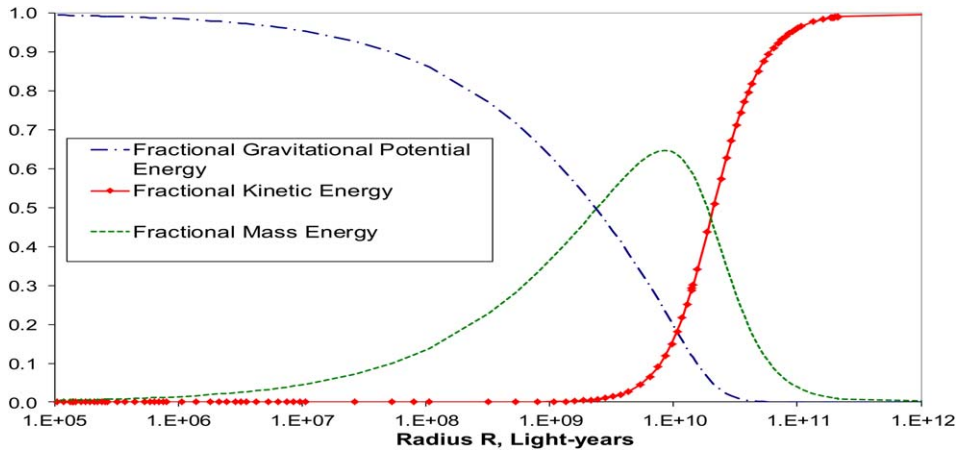

FIG. 3. (Color online) URM predicted fractional mass energy, gravitational potential energy, and kinetic energy.

URM Eq. (14) below, derived in Ref. 17, describes the time-invariant or quasistatic Relativistic Universe Expansion (RUE) model as an alternative to the Linear Hubble (LHM) model, $V = HR$ in the standard Big Bang Model (BBM). It is shown[17] that for the range of observed galactic distances (up to approximately $5–9 \times 10^9$ light-years) wherein the LHM is seen to hold, the RUE equation (14) matches the predictions of the LHM. For values of R larger than approximately 14×10^9 light-years, the expansion velocity calculated by the 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 asymptotically as R increases indefinitely. Since the RUE predicted V never exceeds c, it never violates relativity theory

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

URM Solves[18] the Dark Energy Puzzle as shown in Fig. 3, which depicts the predicted fractional mass energy (mc^2), gravitational potential energy (GPE), and relativistic kinetic energy (RKE) 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 2×10^9 light-years, GPE dominates. At about 9×10^9 light-years, the GPE and RKE even out. Following this period, the increasing RKE, commonly referred to as dark energy or vacuum energy, dominates fueling the nonlinear relativistic universe expansion, which eludes us as the apparent accelerated expansion as opposed to the linear Hubble expansion. URM thus resolves the puzzle of the elusive dark energy or vacuum energy paralyzing modern physics and cosmology. There is no singularity (Big Bang) as R approaches zero since mass also tends to zero. URM also predicts uniformity of the observed microwave background radiation and stability of classical masses and quantum particles.[13]

Figure 4 shows comparison of the supernova[19,20] and other near-field[21] data against the predicted relative brightness for LHM versus RUE. A good agreement is seen between the predictions of the RUE and the measured values. The LHM underpredicts the trend of the observed data beyond $Z = 0.4$, as it does not accurately account for the relativistic effects that are dominant at large R or redshift

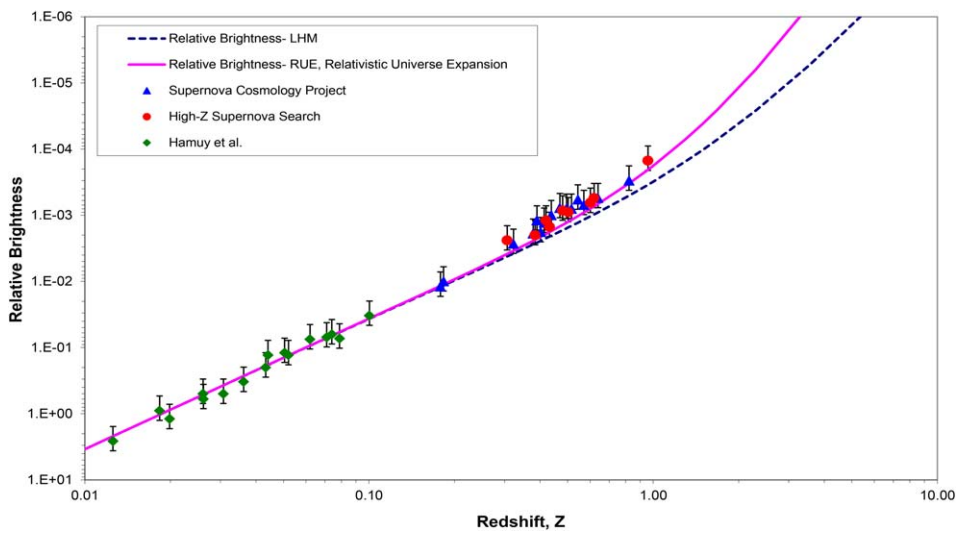

FIG. 4. (Color online) Comparison of LHM and RUE predictions of Supernova and near field data.

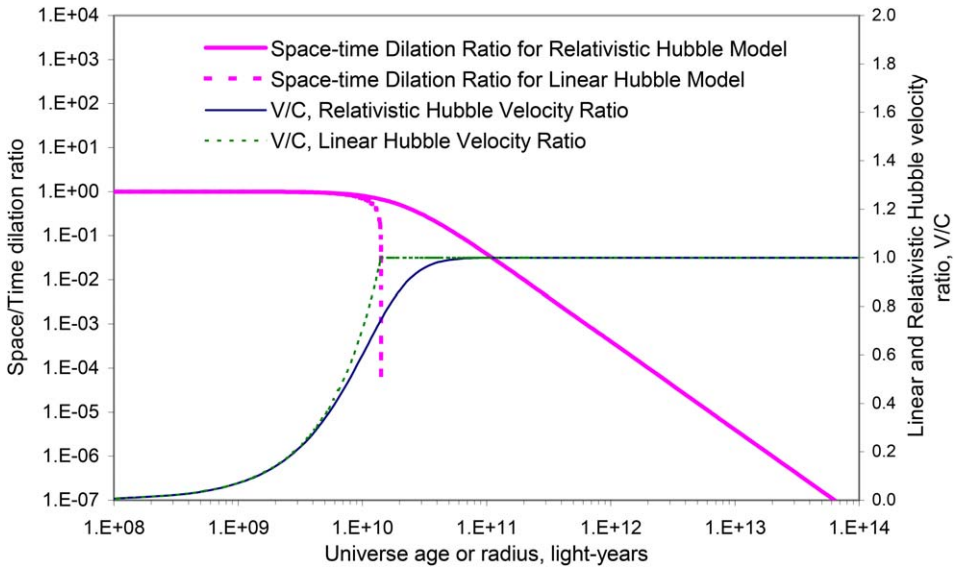

FIG. 5. (Color online) LHM and RUE predicted space dilation and velocity ratios.

values. The relativistic universe expansion leads to the observed accelerated expansion. Hence, the supernova data vindicate the RUE model predictions.

A. URM predicts uniformity in microwave background radiation (MBR) without superluminous inflation

Inflation is not necessary to explain the existence of uniformity in the microwave background radiation (MBR), which can be explained by URM as follows. As shown in Fig. 5, at very large radii or size, space dilation predicted by URM 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. The space dilation is shown on the ordinate axis in Fig. 5 as a function of the universe radius or age (calculated as the ratio V/c) on the abscissa. The key argument against the superluminous 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.

B. URM 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 URM does not experience any singularities as shown by the predicted results of actual mass versus size shown in Fig. 6. The calculated mass is less than the Planck's mass when the radius is of the order of 10^{-100} m. At still smaller

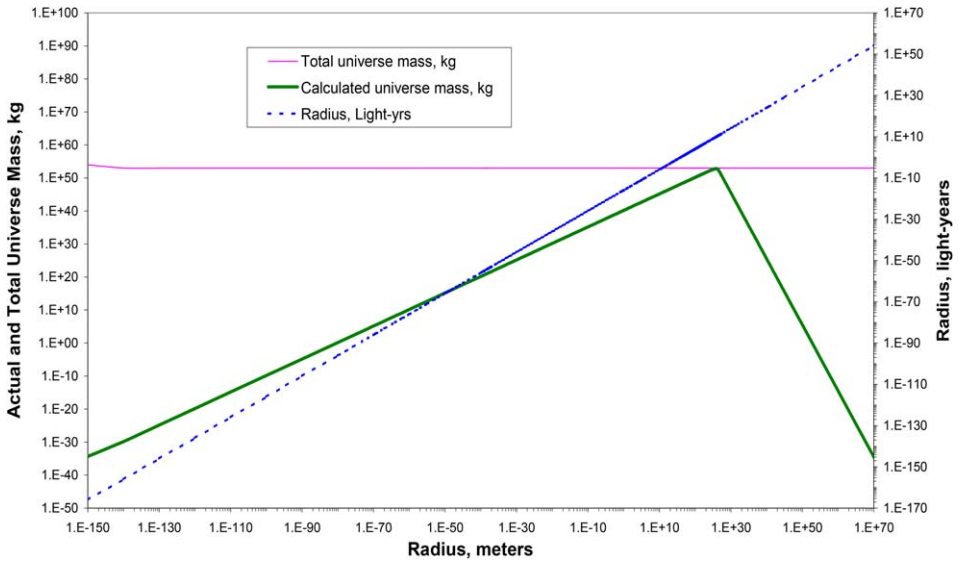

FIG. 6. (Color online) Universe mass vs radius predicted by URM, demonstrating no black hole singularity. [From A. Singh, Phys. Essays **20**, 346 (2007). Reprinted by permission of Physics Essays Publication].

radii, the predicted mass of the universe decreases to smaller values without any singularity.

C. URM predicts creation and dilation of matter in the universe

URM predicts the creation and dilation of mass m of the universe as a function of its size, as shown in Fig. 6 while the total energy of the universe stays constant at M_0c^2. The actual mass increases with size until a maximum mass is reached at about 10×10^9 light-years, beyond which, mass decreases again with size. URM thus represents the universe's mass, energy, space, and time as one continuum governed by the relativistic laws without any limits or singularities.

D. URM dissolves the dark matter mystery

The astronomers have, until now, explained the observed extraordinary large rotation velocities of stars in galaxies by claiming existence of large amounts of invisible dark matter predicted by the Newtonian theory. The current theory says that the stars, planets, dust, and other matter are observed to spin at speeds at which they should be flung off into space lacking the inward gravitational pull of the hypothesized undetectable dark matter. Such dark matter is also said to account for about 23% of the universe. URM explains the observed large rotational velocities of stars without the existence of any so-called dark matter, wherein the kinetic energy of rotation (KER) is directly related to the GPE as follows. The mechanism of luminous radiant energy (LRE) represents a direct extraction of energy from the rapidly spinning central region of the galaxy as described in Ref. 22. It corresponds to an earlier theory, suggesting that rotational energy could escape from the central rotating regions when it is in a strong magnetic field, which exerts a braking effect. In order to properly account for the large luminous radiant energy emanating from a galaxy, the gravitational potential energy in the URM equation (13a) is assumed to represent (details provided in Ref. 13) the sum of luminous radiant energy (LRE) and the kinetic energy of rotation (KER), as follows:

$$\mathrm{GPE} = \frac{3Gm^2}{5R} = \mathrm{LRE} + \mathrm{KER}. \tag{15}$$

The rotational velocity observed at galactic distances of thousands of lightyears from the center is much smaller than the speed of light and KER is approximated by

$$\mathrm{KER} = \frac{1}{2} m {V_T}^2. \tag{16}$$

Combining Eqs. (15) and (16), the rotational velocity in the galaxy can be determined as follows:

$$V_T = \sqrt{\frac{6Gm}{5R} - \frac{2\mathrm{LRE}}{m}}. \tag{17}$$

The limit of optical visibility of a galaxy is obtained when LRE approaches zero. Hence, the rotational velocity at the optical edge at the radius of R_e of the galaxy is given by

$$V_{\mathrm{TRE}} = \sqrt{\frac{6Gm}{5R_e}}. \tag{18}$$

Alternatively, the limiting radius of visibility of a galaxy is given by

$$R_e = \frac{6Gm}{5{V_{\mathrm{TRE}}}^2}. \tag{19}$$

Figure 7 from Ref. 13 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. Hence, URM explains the commonly known Dark Matter (an artifact of Newtonian mechanics) as the equivalent of GPE/RKE following the relativistic mass-energy equivalence principle.

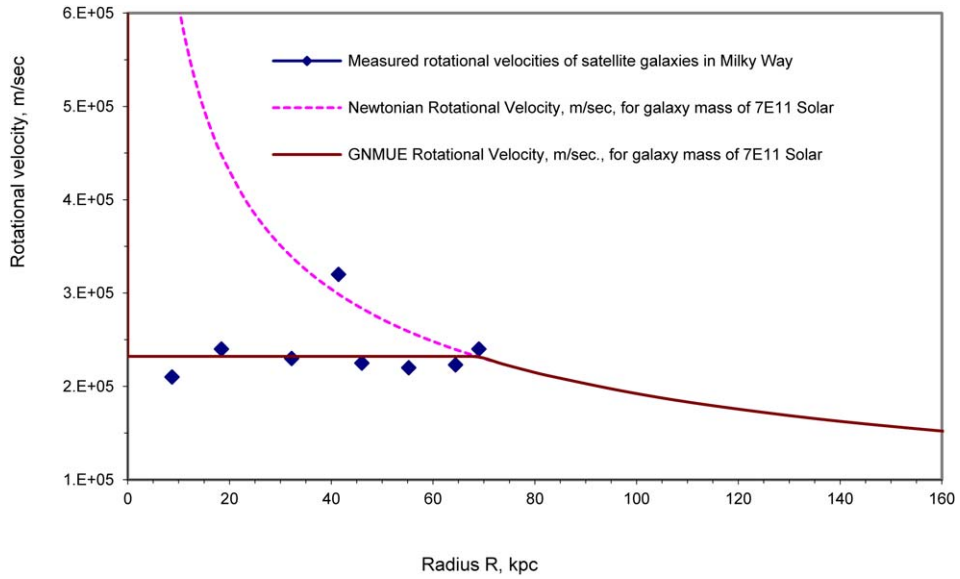

FIG. 7. (Color online) URM predicted vs observed rotational velocities in the Milky Way spiral galaxy.

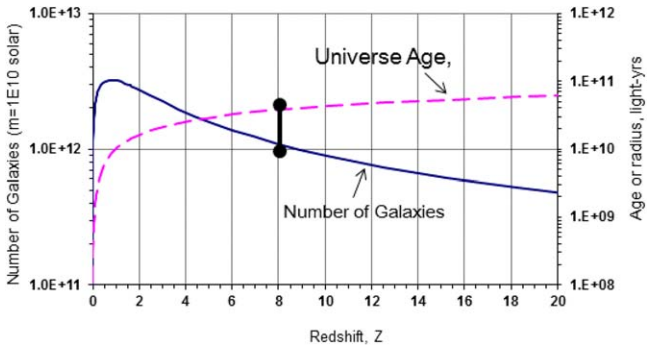

FIG. 8. (Color online) Evolution of number of galaxies (mass $= 1 \times 10^{10}$ Solar) and universe Age vs Redshift Z.

E. URM predicts recent observations of mature distant galaxies

1. The model is also 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 13.39×10^9 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 [https://en.wikipedia.org/wiki/List_of_the_most_distant_astronomical_objects#cite_note-GN-z11-39]. The model also predicts the results of a recent study[23] 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. The model predictions extend much beyond the 14×10^9 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 1010 solar mass, the UR predicted total number of galaxies up to $z = 8$ falls between the maximum of 3.2×1012 and minimum of 1.1×1012 which is in close agreement with the published results, maximum of 2.7×1012 and minimum of 1.4×1012, in Ref. 23. The predicted results also support other conclusions of the study 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 $z > 12$ as shown in Fig. 8. These URM predictions are testable via future observations of mature galaxies in the still unexplored far-field universe beyond 14×10^9 light-years as the cosmological observational capabilities improve in the near future.

V. IMPLICATIONS OF URM FOR THE FUNDAMENTAL UNIVERSAL UNDERSTANDING

1. Origin of nonzero motion requires a nonzero rest mass, howsoever small and negligible. While SR theory requires infinite energy to accelerate a mass to the speed of light via external force, URM shows that even an infinitesimally small mass particle has enough energy of its own to accelerate itself to the speed of light via spontaneous decay.
2. C, commonly known as the speed of light, represents a universal fundamental constant of conservation of mass-energy ($c = \sqrt{\Delta E/\Delta m}$). Speed of a photon of light could vary from zero to a maximum limit equal to c. However, at $V = c$, space and time dilate to zero and hence, speed V becomes indeterminate and physically meaningless. Hence, V is always $<c$ for a physical entity. This general physical conclusion is in good correspondence with the basic Minkowski axiom.[11]
3. Photon or universe rest mass is nonzero, $M_0 = E/c^2$, wherein E represents energy. Photon or universe total energy, $E = M_0c^2$, remains constant while mass spontaneously dilates or converts to equivalent relativistic kinetic energy with increasing V during accelerated expansion.
4. URM allows nonzero photon rest mass at emission and absorption as required by relativity while allowing Maxwell's theory mandated V approaching c and mass dilating to zero during the uninterrupted travel thru empty space. Hence, URM bridges the gap between relativity and Maxwell's theories.
5. The most fundamental state of the photon or universe is the Zero Point State (ZPS) at $V = c$, wherein mass, space, and time are dilated to pure kinetic energy state—the all-inclusive, absolute (nonrelative), eternal state. There are infinite number of less fundamental relative states at $V < c$ representing varying mass, space, time realities that QM refers to as parallel universes (many worlds).
6. Each of the parallel relative less fundamental states ($V < c$) has its own space and clock-time with varying clock speed with no synchronicity among the infinite number of clocks and their time evolutions. Since there is no unique universal time, there is no unique beginning (big bang), evolution, or ending. URM supports Narlikar's conclusion[24] that—"… despite the popularity of the standard hot big bang cosmology (SBBC) it rests on rather shaky foundations."
7. Relativity, and not (quantum) uncertainty, governed by spontaneous mass-energy conversion or equivalence is fundamental to the universe wherein all things and phenomena are relativistically entwined in spite of their apparently different form, location and time. Uncertainty is not inherent in nature but in the measurement induced error when a quantum ($V \sim c$) phenomenon happening in relativistically dilated space-time is measured in fixed space-time ($V \ll c$).

VI. SUMMARY AND CONCLUSION

The widely accepted (Maxwell's theory) assumptions of a zero photon rest mass and fixed speed of light are inconsistent with relativity theory. Relativistic formulations of the fundamental physics of spontaneous mass-energy conversion or decay provide a new photon dynamics model that

eliminates these inconsistencies. The proposed model incorporates a postulated spontaneous mass creation/dilation process allowing a nonzero photon mass at rest (emission and absorption), which dilates to zero as it expands and accelerates thru uninterrupted space. This model removes the currently assumed restriction of a zero photon rest mass that is shown to be inconsistent with recent measurements. Integrating gravity into this model provides a universe model (URM) that is shown to predict the observed universe behavior without the need for superluminous inflation and resolves the current paradoxes (black hole singularity, dark energy, dark matter, inflation). The observed accelerated universe expansion or Dark Energy (Cosmological Constant) is described mathematically, rather than Einstein's fudge constant, as relativistic kinetic energy resulting from spontaneous mass-energy conversion or decay. It also explains the inner workings of quantum mechanics (quantum gravity, parallel universes, observer's paradox, and nonlocality) eliminating known inconsistencies between GR and QFT. URM also provides testable predictions for falsification via future observations as well as new fundamental universal understanding of the physics and cosmology theories. The commonly known speed of light, c, is described as a fundamental universal constant of conservation or equivalence of mass-energy rather than the fixed speed of light.

[1]L. J. Wang, Phys. Essays **30**, 75 (2017).
[2]S. Rainville, J. K. Thompson, E. G. Myers, J. M. Brown, M. S. Dewey, E. G. Kessler, Jr., R. D. Deslattes, H. G. Börner, M. Jentschel, P. Mutti, and D. E. Pritchard, Nature **438**, 1096 (2005).
[3]M. M. Nieto, e-print arXiv:hep-ph/9212283 v1 (1992).
[4]J. Q. Shen, e-print arXiv:physics/0311003 v1 (2003).
[5]J. Q. Shen, e-print arXiv:physics/0305090 v1 (2003).
[6]J. Luo, L. Tu, Z. Hu, and E. Luan, Phys. Rev. Lett. **90**, 081801 (2003).
[7]J. Heeck, Phys. Rev. Lett. **111**, 021801 (2013).
[8]D. Montanino, F. Vazza, A. Mirizzi, and M. Viel, Phys. Rev. Lett. **119**, 101101 (2017).
[9]Z. Vörös, R. Balili, D. W. Snoke, L. Pfeiffer, and K. West, e-print arXiv:cond-mat/0504151 v1 (2005).
[10]S. S. Gershtein, A. A. Logunov, and M. A. Mestvirishvili, e-print arXiv:gr-qc/0507084 v1 (2005).
[11]H. Minkowski, "Space and time," in *The Principle of Relativity*, (Atomizdat, Moscow, Russia, 1973), pp. 167–180 (in Russian).
[12]M. S. Turner, "Absurd universe," Astronomy **11**, 44 (2003).
[13]A. Singh, *The Hidden Factor: An Approach for Resolving Paradoxes of Science, Cosmology and Universal Reality* (AuthorHouse, Bloomington, IN, 2003).
[14]A. Singh, Phys. Essays **20**, 346 (2007).
[15]A. Singh, *The XXII Texas Symposium on Relativistic Astrophysics* (Stanford University, CA, 2004).
[16]A. Singh, Phys. Essays **19**, 19 (2006).
[17]A. Singh, Which of our basic physical assumptions are wrong?," FQXi Questioning the foundations essay contest, Foundations Questions Institute, http://fqxi.org/community/forum/topic/1317/ (2012).
[18]A. Singh, "How can mindless mathematical laws give rise to aims and intention?," FQXi Wandering towards a goal essay contest, Foundations Questions Institute, https://fqxi.org/community/forum/topic/2736 (2017).
[19]S. Perlmutter, Phys. Today **56**, 53 (2003).
[20]A. G. Riess, A. V. Filippenko, P. Challis, A. Clocchiattia, A. Diercks, P. M. Garnavich, R. L. Gilliland, C. J. Hogan, S. Jha, R. P. Kirshner, B. Leibundgut, M. M. Phillips, D. Reiss, B. P. Schmidt, R. A. Schommer, R. Chris Smith, J. Spyromilio, C. Stubbs, N. B. Suntzeff, and J. Tonry, Astron. J. **116**, 1009 (1998).
[21]CALAN/Tololo Survey Team, Astron. J. **106**, 2392 (1993).
[22]R. D. Blandford, e-print arXiv:astro-ph/0202264 v1 (2002).
[23]C. J. Conselice, A. Wilkinson, K. Duncan, and A. Mortlock, Astrophys. J. **830**, 1 (2016).
[24]J. V. Narlikar, EPJ H **43**, 43 (2018).