A Theory of Everything Physics Solution using a Two-Step Integrated Physics/Mathematics Methodology

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Abstract

Two astrophysics issue resolution methodologies are: the prevailing Hawking et. al. single primarily mathematics step and a two-step integrated physics/mathematics consisting of a conceptual physics step followed by an equally important mathematics step. The prevailing single step methodology provided most if not all of the spectacularly successful astrophysics achievements over the last century. However, it provided near zero results for multiple constituent theories such as a Theory of Everything (TOE) solution. In contrast, the two-step integrated physics/mathematics methodology provides a TOE solution. The prevailing single primarily mathematics step and the two-step integrated physics/mathematics methodologies are complementary and essential for future astrophysics achievements.

The conceptual physics step of a TOE Physics Solution using a Two-Step Integrated Physics/Mathematics Methodology, consisted of interrelated amplified requirements or "New Physics" requirements for 20 TOE constituent theories. The conceptual physics step had three goals. First, "Everything" was defined as 20 interrelated amplified constituent theories and their intimate physical relationships with each other. The 20 theories were; superstring, particle creation, inflation, Higgs forces, spontaneous symmetry breaking, superpartner and Standard Model (SM) decays, neutrino oscillations, dark matter, universe expansions, dark energy, messenger particles, relative strengths of forces/Hierarchy problem, Super Universe (multiverse), stellar black holes (stars and galaxies), black hole entropy, arrow of time, cosmological constant problem, black hole information paradox, baryogenesis, and quantum gravity. Second, all 19 key outstanding TOE physics questions were answered including what are: Higgs forces, the fundamental matter and force particles equivalent of Mendeleev's Periodic Table of elements, stellar black holes, inflation and spontaneous symmetry breaking potential field functions, quantum fluctuations of fundamental particles, physical and mathematical singularities, and the seven extra dimensions; what is: dark energy, dark matter, super supersymmetry (SSUSY) of Higgs particles, the border between quantum gravity and classical physics or Schrodinger wave function applicability, the boundary between quantum gravity and general relativity, our universe's implementation of the It from Qubit (IfQ) concept, and particle entanglement; and what caused: the start of our universe, hierarchy problem, black hole information paradox, baryogenesis, and the cosmological constant problem? Third, correct inputs were provided for the two part second mathematics step which followed, an amplification of the existing SM mathematics or Beyond the Standard Model (BSM) solution for particles and an N-body simulation for cosmology.

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I. INTRODUCTION – A TOE PHYSICS SOLUTION USING A TWO-STEP INTEGRATED PHYSICS/MATHEMATICS METHODOLOGY DEFINITION AND JUSTIFICATION

Two astrophysics issue resolution methodologies are: the prevailing Hawking et. al. single primarily mathematics step and this article's two-step integrated physics/mathematics consisting of a conceptual physics step followed by an equally important mathematics step. The prevailing single step is applicable to a single constituent theory (e.g., Higgs forces or spontaneous symmetry breaking or stellar black holes or inflation or etc.). The prevailing single step provided most if not all of the spectacularly successful astrophysics achievements over the last century (e.g., Higgs force prediction and detection; gravitational waves prediction and their detection via stellar black hole mergers; etc.). However, the prevailing single step provided near zero results after a century of attempts for a TOE solution, which had multiple constituent theories. A new astrophysics mindset is required to accept the two-step methodology.

This author's 42 years of systems engineering design, integration, and test experience was ideal for implementing the conceptual physics step. Each system designed (e.g., phased array radar, Manned Orbiting Laboratory, Global Positioning System, etc.) did not previously exist. Approximately 50% of the design requirements existed (e.g., phased array radar transmitter and receiver) whereas 50% were new (e.g., phased array radar stationary antenna with electronic beam steering replacement of a rotating antenna). Similarly, in astrophysics there are existing requirements (old physics like the law of conservation of energy/mass and Newton's gravitational force equation) and new requirements (New Physics like each matter particle has an associated Higgs force and the sum of eight permanent Higgs force energies associated with eight permanent matter particles is dark energy). New Physics requirements are essential for a TOE.

The conceptual physics step of the two-step integrated physics/mathematics methodology was defined over 15 years as follows. The TOE was initially defined as a single string theory as described by Brian Greene in his book, "The Elegant Universe." Other string theory literature was read, approximately 20 to 50 questions generated and answered, and a new TOE draft written. In the first year, this process was repeated approximately ten times. Within one year, the TOE was amplified from the inadequate single string theory to five constituent theories: Higgs forces, string, particle creation, inflation, and dark energy shown in Fig. 22 A Two-step integrated TOE jigsaw puzzle. The center and key constituent theory was Higgs forces. The five theories were independent of each other and shown as five independent jigsaw puzzle pieces of Fig. 22. Over the next fourteen years, the conceptual physics step was amplified via "New Physics" requirements from the inadequate five to twenty constituent theories and 19 key outstanding TOE physics questions were defined. During the 15 year period, approximately 250 TOE draft iterations were written. After each draft, approximately 20 to 50 questions were generated by reading contradictory astrophysics literature about the 20 constituent theories and 19 key outstanding TOE physics questions. All questions were answered, and a new amplified or "New Physics" TOE draft written. The final TOE draft iteration stabilized the number of TOE constituent theories at 20, integrated all 20 constituent theories with each other, and answered all 19 key outstanding TOE physics questions.

Two TOE deficiencies of the prevailing single primarily mathematics methodology were: the 20 existing TOE constituent theories' requirements were never completely defined, amplified by "New Physics," or integrated; and the 19 key outstanding TOE physics questions were not answered. In contrast, the conceptual physics step of the two-step integrated physics/mathematics methodology resolved both deficiencies. Examples of the first deficiency included Section V. An amplified Higgs forces (bosons) which contained an order magnitude more requirements than the existing Higgs forces theory. For example, requirement amplifications or "New Physics" included 32 associated super supersymmetric Higgs particles, one for each of 32 SM and supersymmetric matter and force particles. Similarly, in Section VI.A. Comparison between the current astrophysics spontaneous symmetry breaking and this article's description, the amplified spontaneous symmetry breaking contained an order magnitude more requirements than the existing ambiguously defined theory. For example, inflation and spontaneous symmetry breaking were separate, not combined functions.

The conceptual physics step resolved all 19 key outstanding TOE questions. Four examples of these questions and their answers follow.

1. What are fundamental matter and force particles? As described in Section VI.B. Fundamental SM/supersymmetry (SUSY)/super supersymmetry (SSUSY) matter and force particles, there are 64 fundamental matter and force particles, 22 permanent and 42 transient. The TOE is the intimate relationship between atomic/subatomic matter, dark matter, and dark energy as defined by the 22 permanent constituent fundamental matter and force particles. Atomic/subatomic matter consists of the: up quark, down quark, electron, electron-neutrino, muon-neutrino, and tau-neutrino or 5% of our universe's energy/mass. Dark matter consists of the: zino, photino, and three permanent Higgsinos associated with the zero energy graviton, gluon, and photon or approximately 26%. Dark energy consists of the sum of eight permanent Higgs force energies associated with eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino) or 69%.

   Furthermore, these 22 permanent fundamental matter and force particles are constituents of all objects in our universe including: all solar systems, galaxies, and permanent stellar black holes. All permanent stellar black holes consisting of 22 permanent fundamental matter and force particles (see Fig. 14a) is in sharp contrast to the unknown constituents of stellar black holes according to current astrophysics theory.

2. What are Higgs forces? Nobel Prize in Physics winners Higgs and Englert predicted the 125 GeV Higgs force using the prevailing single primarily mathematics step methodology. However, their Higgs force theory must be amplified by "New Physics" to define Higgs particles' supremacy as associate God particles as described in Section V. An amplified Higgs forces (bosons). Super force particles were God particles because they constituted 100% of our universe's total energy/mass between t = 0 s and the start of matter creation. During matter creation from t = 10^{-33} to 100 s in Fig 6, super force particles condensed and decayed to 22 permanent matter and force particles. Higgs particles were associate God particles because the sum of dark energy or eight permanent Higgs force energies and ½ of dark matter or three permanent Higgsino types constituted 69 + ½(26) = 82% of our universe's energy mass.

   Nobel Prize in Physics winner Weinberg predicted the electroweak unification theory and Higgs force existence using a spontaneous symmetry breaking explanation. However his prediction must be amplified as described in Section V. An amplified Higgs forces (bosons) for two reasons. First, the 125 GeV Higgs force was the product not the cause of spontaneous symmetry breaking. Spontaneous symmetry breaking was caused by temperature, not the Higgs force. At specific temperatures proportional to matter energy/mass according to the formula, eV ~ 10^4 K, each matter particle condensed with its associated Higgs force. For example, at 10^{-12} s, 10^{15} K, and 80 GeV, spontaneous symmetry breaking occurred for the transient W^- and its associated transient 125 GeV Higgs force. At approximately 100 s, 10^{10} K, and 0.51 MeV, spontaneous symmetry breaking occurred for the permanent electron and its associated permanent Higgs force. Second, the transient Higgs force associated with W^- has a lifetime of 10^{-25} s. This transient Higgs force gives mass to a transient W^- as Weinberg correctly predicted, but cannot give mass to a permanent fundamental particle such as an electron because the transient Higgs force exists for only 10^{-25} s. A permanent electron requires its permanent associated Higgs force to give it mass. This amplified requirement for permanent mass Higgs force association, is one justification for eight permanent Higgs forces associated with 8 permanent fundamental matter particles.

3. What is dark energy? As described in Section V. An amplified Higgs forces (bosons), the sum of eight permanent Higgs force fields associated with eight permanent matter particles is the permanent Higgs force field which permeates the vacuum of space. The permanent Higgs force field occupies space between the galaxies, stars, and filament matter particles. This is the second justification for eight permanent Higgs forces. The sum of eight permanent Higgs force energies is dark energy.

   Transient Higgs force searches and analyses using the Large Hadron Collider (LHC) dominate Higgs forces theory. Current Higgs forces theory excludes prediction and detection of permanent Higgs forces, even though the latter is essential for the permanent Higgs force field which permeates the vacuum of space. Therefore, equipment must be specified to detect permanent Higgs forces and their detection should be initiated.

4. Why is the conceptual step needed? Hawking initially believed in a TOE solution whereas he later stated there probably was no solution. We are in agreement that a TOE solution using the prevailing single primarily mathematics step is technically overwhelming. However, definition of the first conceptual physics step is the basis of this article. Also, preliminary definition of the two part second mathematics step exists. It consists of an amplified existing SM mathematical solution (BSM) for particles and an amplified N-body simulation for cosmology as described in Section XXIII. A TOE physics solution using a two-step integrated physics/mathematics methodology: Second mathematics step.

The conceptual physics step or "New Physics" consisted of interrelated amplified requirements for 20 TOE constituent theories. As described in the next Section IA. Introduction – Amplifications of 20 independent theories, each of the 20 theories' interrelated amplified requirements, or equivalently each of 20 jigsaw puzzle pieces was selectively amplified without sacrificing the theory's integrity to provide 20 snuggly fitting interrelated amplified constituent theories. These interrelated amplified requirements or "New Physics" requirements are future fundamental laws of physics. For example, current fundamental laws of physics include the Conservation of Energy/Mass and Newton's gravitational equation. Similarly, future fundamental laws of physics will include our universe's initial super force energy (10^{54} kg) equaled the energies of eight permanent matter particles/their associated eight permanent Higgs forces and three permanent Higgsinos/their three associated permanent forces (graviton, gluon, and photon). These 22 permanent matter and force particles were constituents of atomic/subatomic matter or 5% of our universe's energy/mass, dark matter 26%, and dark energy 69%. A second example is dark energy equaled the sum of eight permanent Higgs force energies associated with eight permanent matter particles. The conceptual step of the two-step integrated physics/mathematics methodology defined and integrated all 20 TOE interrelated amplified requirements and resolved all 19 key outstanding TOE questions, prior to initiation of the second mathematics step.

Although one of Einstein's primary goals was a TOE solution using the prevailing single primarily mathematics step, he was specifically excluded from the above Hawking et. al. designation because Einstein was 50 years ahead of his time. Most of the TOE's 20 interrelated amplified constituent theories (e.g., superstring, Higgs forces, spontaneous symmetry breaking, dark energy, stellar black holes, the Super Universe or multiverse, etc.) were unavailable to Einstein a century ago. If he had been born a half century later, his genius would definitely have defined the conceptual TOE physics step.

In summary, the prevailing single primarily mathematics step and the two-step integrated physics/mathematics methodologies are complementary and essential for future astrophysics achievements. The single step defines the leaves, trunk, branches, bark, and roots of a specific tree whereas the equally important two-step defines the forest. This article's superiority for a TOE solution can be demonstrated via a vigorous peer review including an unlimited number of astrophysicists' questions answered by this author.

A. Introduction – Amplifications of 20 independent theories

The 20 interrelated amplified constituent theories of a Two-Step Integrated TOE were modeled as jigsaw puzzle pieces. Initially, five independent existing theories (Higgs forces, string, particle creation, inflation, and dark energy) were modeled by five independent jigsaw puzzle pieces as shown in Fig. 22. The five theories were independent because physicists in each theory worked independently of each other. After approximately 250 TOE article iterations over 15 years, the number of independent existing jigsaw puzzle pieces expanded from five to 20 and all 19 key outstanding TOE physics questions were answered. Each of the 20 interrelated amplified constituent theories is described in a separate section of this article. The Two-Step Integrated TOE's basic premise was the 20 theories were physically interrelated to each other and their relationships were defined by additional interrelated amplified requirements or "New Physics." In Fig. 22, the shaded areas surrounding the 20 unshaded jigsaw puzzle pieces represented interrelated amplified requirements. For example, the unshaded area of the key Higgs forces jigsaw puzzle piece was amplified by its shaded area to provide interrelated amplified requirements. Each of the 20 theories or equivalently each of 20 jigsaw puzzle pieces was selectively amplified without sacrificing the theory's integrity to provide 20 snuggly fitting interrelated amplified constituent theories of Fig. 22 and Table VII.

Our universe's 128 matter and force particle types were created from the super force and manifested themselves during matter creation ($t = 10^{-33}$ s to $t = 100$ s) and at extremely high temperatures between 10^{25} and 10^{10} K as shown in Fig. 6. As shown in Table I, there were 13 SM matter particles and 3 SM force particles. There were 4 supersymmetric matter particles and 12 supersymmetric force particles. Each of these 32 matter and force particles had one of 32 super supersymmetric Higgs particles and each of those 64 had an anti-particle. The super force was the 129th particle. By $t = 100$ s and 10^{10} K, only 22 permanent fundamental matter and force particle types remained. Atomic/subatomic matter or six permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, and tau-neutrino) constituted 5% of our universe's energy/mass. Dark matter or the zino, photino, and three permanent Higgsino types constituted 26%. Dark energy or eight permanent Higgs force energies associated with eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino) constituted 69%. Three SM force particles (graviton, gluon, and photon) existed but accounted for 0%. These percentages remained constant for 13.8 billion years, that is, there was no quintessence. At temperatures less than 10^{10} K, only these 22 permanent matter and force particle types existed in our universe.

There were four star gravitational collapse stages. In a white dwarf star, molecules decomposed to atoms. In a neutron star, atoms decomposed to neutrons, protons, and electrons. In a super supermassive quark star (matter), protons and neutrons decomposed to up and down quarks. In a super supermassive black hole (energy), up and down quarks decomposed or evaporated to super force particles. New universes or super supermassive black holes (energy) were created in precursor universes of the Super Universe. The above matter decomposition to super force particles description was intimately related to and the reverse of our universe's matter creation.

II. AN AMPLIFIED SUPERSTRING

Via a single superstring theory solution, a TOE solution unifies all known physical phenomena from the near infinitely small Planck cube scale (quantum gravity theory) to the near infinitely large super supermassive quark star (matter) scale (Einstein's General Relativity). Each of 129 fundamental matter and force particle types is defined by its unique closed superstring in a Planck cube. Any object in the Super Universe is defined by a fixed background volume of contiguous Planck cubes containing the 129 fundamental matter or force particle closed superstring types. Super force superstring doughnut physical singularities existed at the center of Planck cubes at the start of the Super Universe, all precursor universes, and all universes including our universe.

The Planck cube quantum was selected for two reasons, Planck units and superstring theory. Planck units consist of five normalized, natural, universal, physical constants: gravitational constant, reduced Planck constant, speed of light in a vacuum, Coulomb constant, and Boltzmann constant. The Planck length which defines a Planck cube is a function of the first three constants. In superstring theory, the Planck cube is the size of matter and force particle superstrings.

Each of 129 fundamental matter and force particles is defined by its unique closed superstring in a Planck cube. Table I shows 129 fundamental SM/supersymmetric/super supersymmetric matter and force particles. There are 13 SM matter particles and 3 SM force particles including an added graviton force particle. There are 4 supersymmetric matter particles and 12 supersymmetric force particles. Each of these 32 SM/supersymmetric matter and force particles has one of 32 associated Higgs super supersymmetric (SSUSY) particles and each of those 64 has an associated anti-particle (see Section VI.B. Fundamental SM/supersymmetry (SUSY)/super supersymmetry (SSUSY) matter and force particles). Each of the 128 fundamental SM/supersymmetry/super supersymmetry particles and the 129^{th} super force particle are equivalently represented by: a dynamic point particle, its unique closed superstring (Fig. 1), or its associated Calabi-Yau membrane (cloud) as shown in Fig. 2 Electron Calabi-Yau membrane. In traditional string theory descriptions, a one brane vibrating string generates a two brane Calabi-Yau membrane over time. Superstring theory was amplified so that a zero brane dynamic point particle generates particle positions over time for both a one brane vibrating superstring and a two brane vibrating Calabi-Yau membrane. According to Greene, two basic Calabi-Yau membrane types are beach balls and doughnuts. Conifold transitions are the transformations of the two membrane types into each other. The Planck cube sized beach ball electron Calabi-Yau membrane of Fig. 2 contains periodic surface hills and valleys where particle energy/mass is proportional to amplitude displacement and frequency [1].

The energy/mass of a superstring is a function primarily of its diameter and secondarily the amplitude displacement and frequency of its hills and valleys. Differences between the 129 matter and force particles are the amplitude displacement and frequency of their hills and valleys, or their energy/masses. Figure 1a shows a simple representation of a graviton as a perfect circular superstring in a Planck cube. A superstring just touching the sides of a Planck cube with no amplitude displacement and frequency of its hills and valleys represents zero energy. In contrast, an electron superstring has amplitude displacement and frequency of its hills and valleys shown in the simple representation of Fig. 1b, and its energy/mass is 0.51 MeV. The photon and gluon are perfect circles similar to the graviton superstring and their energies are also zero. All other matter and force particles having energy/mass (e.g., up quark, down quark, zino, photino, W/Z's, Higgs, and super force particles) have superstrings similar to the electron but with different amplitude displacement and frequency of their hills and valleys. The electron Calabi-Yau membrane shown in Fig. 2 in the shape of a Planck cube sized beach ball with amplitude displacement and frequency of its hills and valleys, is the three-dimensional equivalent of the two-dimensional electron superstring of Fig. 1b. In Fig. 1b, the electron dynamic point particle positions are shown at sequential times t_1, t_2, t_3, t_4…..t_n and define an electron superstring in both Fig. 1b and Fig. 2. Since the electron has spin, the electron superstring will trace the three dimensional Calabi-Yau membrane or electron cloud of Fig. 2. The electron Calabi-Yau membrane or cloud is the sum of individual electron dynamic point particle positions from t_1, t_2, t_3, t_4…..t_m where m is much larger than the n points over a single electron superstring. An electron exists sequentially in time as n dynamic point particle positions in an electron superstring or m dynamic point particle positions in an electron Calabi-Yau membrane or cloud.

TABLE I. Fundamental SM/supersymmetric/super supersymmetric matter and force particles.

Symbol	SM	Matter	Force	Symbol	Supersymmetric	Matter	Force
p_1	graviton		x	p_{17}	gravitino	x	
p_2	gluon		x	p_{18}	gluino	x	
p_3	top quark	x		p_{19}	stop squark		x
p_4	bottom quark	x		p_{20}	sbottom squark		x
p_5	tau	x		p_{21}	stau		x
p_6	charm quark	x		p_{22}	scharm squark		x
p_7	strange quark	x		p_{23}	sstrange squark		x
p_8	muon	x		p_{24}	smuon		x
p_9	tau-neutrino	x		p_{25}	stau-sneutrino		x
p_{10}	down quark	x		p_{26}	sdown squark		x
p_{11}	up quark	x		p_{27}	sup squark		x
p_{12}	electron	x		p_{28}	selectron		x
p_{13}	muon-neutrino	x		p_{29}	smuon-sneutrino		x
p_{14}	electron-neutrino	x		p_{30}	selectron-sneutrino		x
p_{15}	W/Z's (hybrid)	x		p_{31}	wino/zinos	x	
p_{16}	photon		x	p_{32}	photino	x	

16	SM	$p_1 \ldots p_{16}$
16	Supersymmetric	$p_{17} \ldots p_{32}$
32	Higgs super supersymmetric particles	$h_{1 \ldots} h_{32}$
64	anti-particles	$p_{1bar} \ldots p_{32bar}$, $h_{1bar} \ldots h_{32bar}$
1	super force (mother)	p_{sf} (32 types)

129	total	

Any object in the Super Universe is defined by a fixed background volume of contiguous Planck cubes containing the 129 fundamental matter or force particle closed superstring types. Planck cubes are visualized as near infinitely small, cubic, Lego blocks. For example, a proton is represented by a 10^{-15} m radius spherical fixed background volume of contiguous Planck cubes containing up quark, down quark, and force particle closed superstrings. By extension, any object in the Super Universe [e.g., proton, atom, molecule, person, quark star, galaxy, our universe, or the entire Super Universe (see Fig. 4 and Fig. 14a)] is represented by a fixed background volume of contiguous Planck cubes containing the 129 fundamental matter or force particle closed superstring types. As described in Section VI. An amplified spontaneous symmetry breaking, following the end of matter creation at t = 100 s, only 22 permanent matter and force particle superstrings remained.

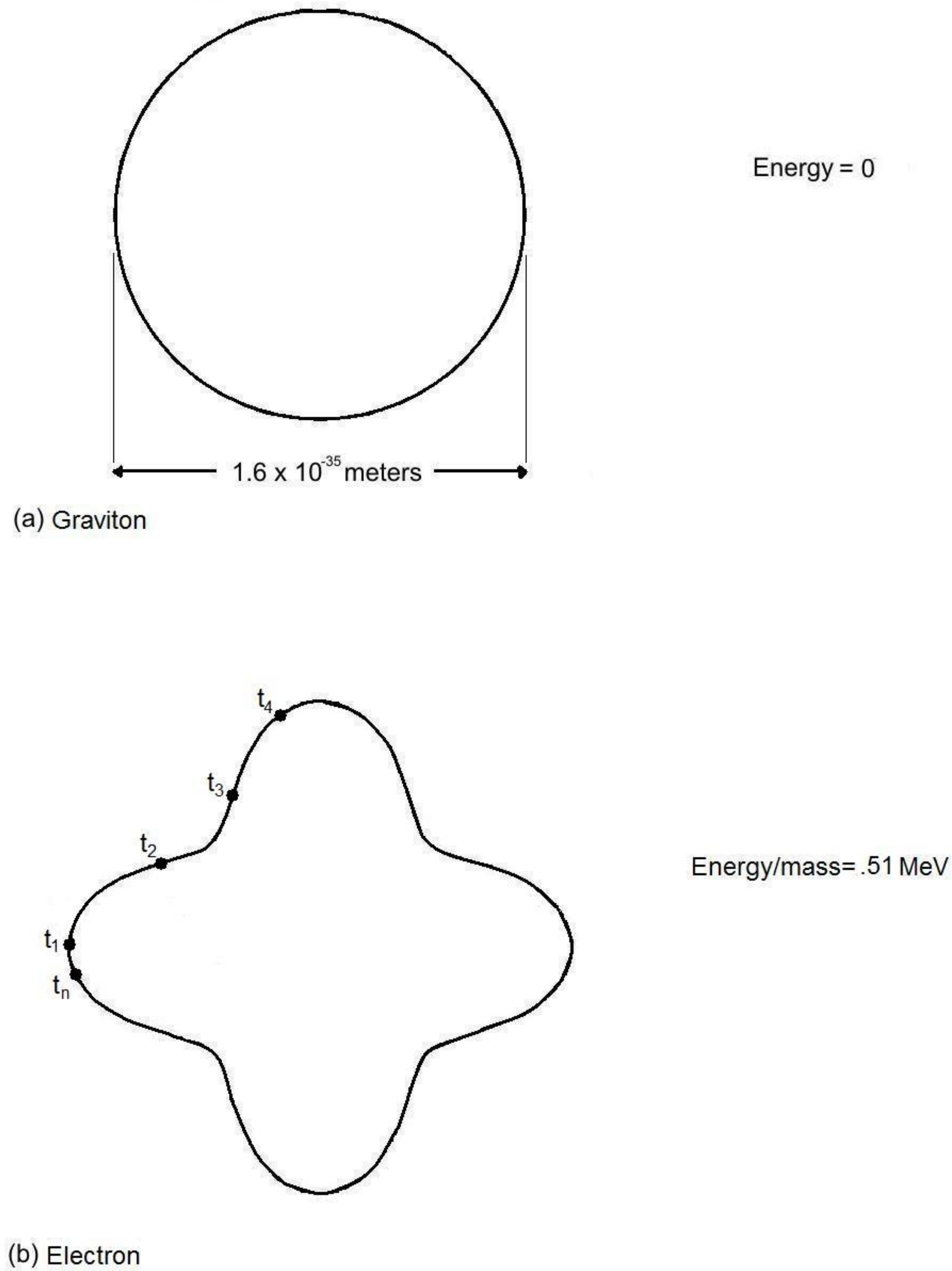


FIG. 1. Graviton and electron superstrings.

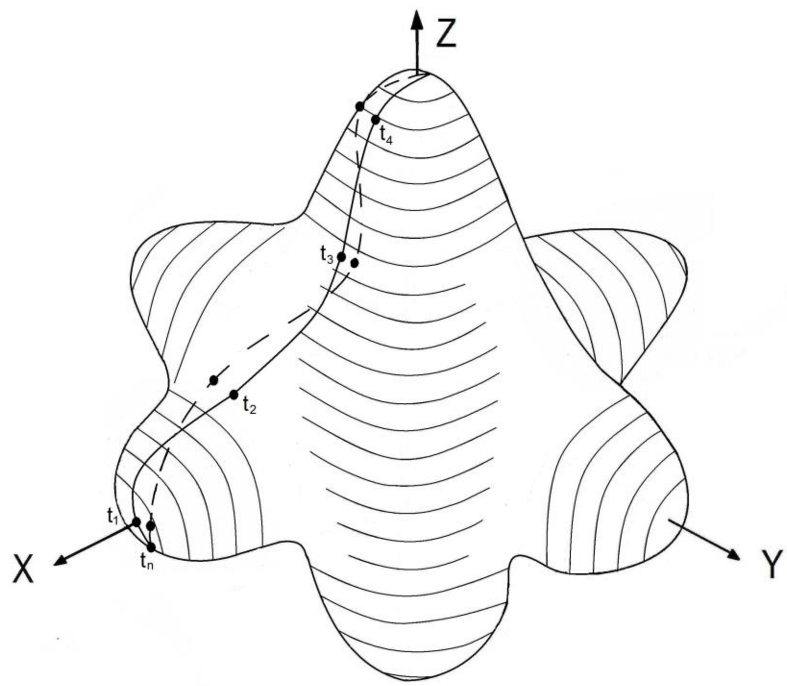


FIG. 2. Electron Calabi-Yau membrane.

A Calabi-Yau membrane's potential energy/mass was represented by three springs aligned along the Planck cube's X, Y, Z axes and connected together at the Planck cube's center (see Fig. 5). A Calabi-Yau membrane's energy/mass was primarily a function inversely proportional to its radius and secondarily directly proportional to the amplitude displacement and frequency of its hills and valleys. A particle's energy/mass was amplified from two superstring parameters according to Greene to three via addition of the radius parameter. Radius defined the particle's basic energy/mass whereas the amplitude displacement and frequency parameters modulated it. A Calabi-Yau membrane just touching a Planck cube's sides with zero amplitude displacement and frequency defined zero tension or zero energy/mass. A range of amplitude displacements and frequencies about this zero energy/mass defined the 32 SM/supersymmetric matter and force particles' energy/masses, from the lightest photon (zero) to the top quark (173 GeV) to supersymmetric particles (100 to 1500 GeV) [2].

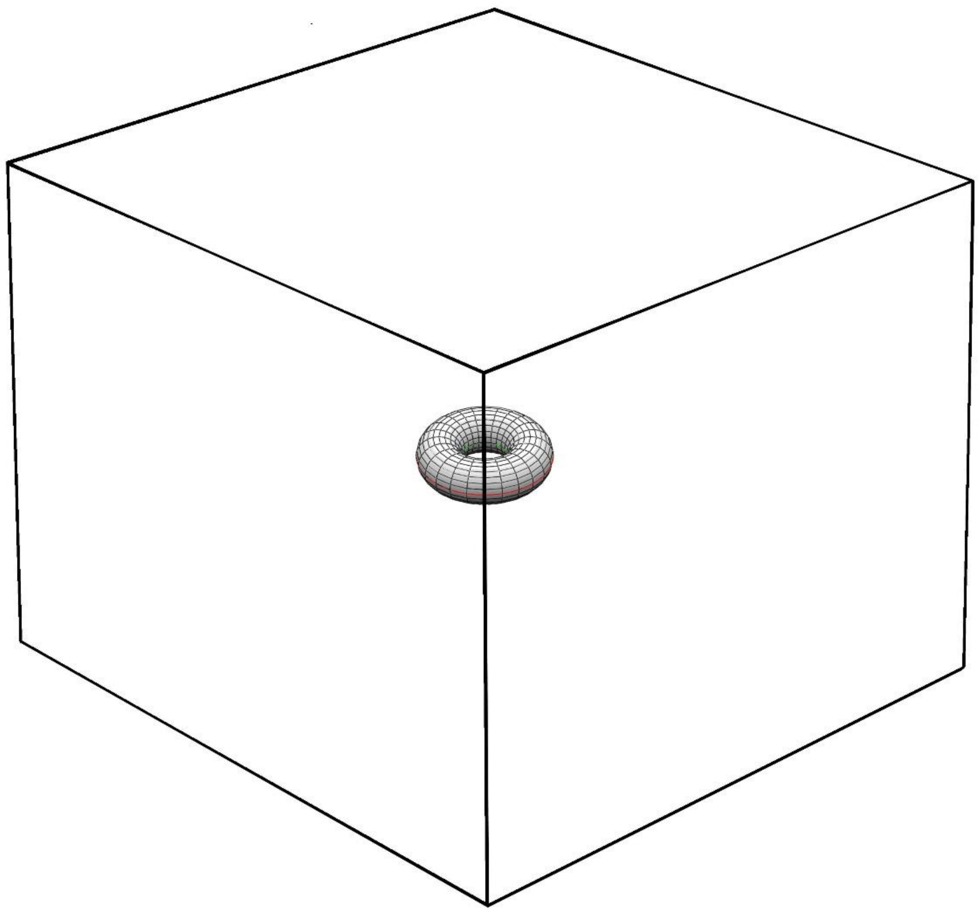


FIG. 3. Big bang doughnut singularity in a Planck cube.

Super force superstring doughnut physical singularities existed at the center of Planck cubes at the start of the Super Universe, all precursor universes, and all universes including our universe. The big bang's doughnut physical singularity consisted of superimposed super force superstrings containing our universe's near infinite energy of approximately 10^{54} kg (10^{24} $M_{\odot}$, 10^{90} eV, or 10^{94} K) as calculated from critical density using a measured Hubble constant [3]. A doughnut physical singularity's potential energy was also represented by three springs connected together at the Planck cube's center. Energy was assumed inversely proportional to the doughnut physical singularity's radius (precise function is undefined) so that the smaller the physical singularity, the greater was its energy. The size of the Super Universe's doughnut physical singularity was thus smaller than the size of our universe's doughnut physical singularity because the energy/mass of the Super Universe was 10^{120} times the energy/mass of our universe or (10^{120}) (10^{54} kg) = 10^{174} kg (see Section XIX. An amplified cosmological constant problem). The doughnut physical super force singularity at the center of a Planck cube is shown in Fig. 3. The physical singularity is a rotating, charged, doughnut-shaped, Kerr-Newman stellar black hole. As described in Section XVIII. An amplified arrow of time, this doughnut physical singularity was created by our precursor universe's maximum entropy super supermassive quark star's (matter) evaporation, deflation, and collapse to its associated minimum entropy super supermassive black hole (energy).

Pauli's exclusion principle states no two matter particles have identical quantum numbers, which was interpreted as two or more matter particles cannot occupy the same Planck cube. In contrast, multiple force particles can occupy the same Planck cube such as Higgs force superstrings in our universe's vacuum. The relationship between quantum numbers and particle spatial location must be amplified by quantum physicists. For example, the relationship between the four quantum numbers of an electron in an atom [e.g., orbit size (n), orbit shape (k), orbit pointing direction (m), and spin (s)] and the electron's location must be amplified to include "free" fundamental particles such as electrons and up quarks in our early universe's plasma of particles. Until that time, this author's definition that multiple matter particles cannot occupy whereas multiple force particles can occupy the same Planck cube, will be retained.

The Super Universe was defined by a fixed background volume of contiguous Planck cubes containing the 129 fundamental matter or force particle closed superstring types. At the present time t = 13.8 billion years, the Super Universe consists of 10^{305} contiguous Planck cubes. That is our universe's 10^{185} Planck cubes multiplied by the relative size of the Super Universe to our universe (10^{120}) or (10^{185}) (10^{120}) = 10^{305}. As described in Section XIX.B. Comparison of three multiverse theories, Guth's (Susskind) bubble nucleation and pocket universe theory is invalid. Therefore, there was only one Super Universe (consisting of 10^{120} parallel universes) superstring solution at time t, not 10^{500} environments described by Susskind [4].

This article never used the ambiguous word infinite because nothing in our universe is infinite. This also avoided the associated renormalization problem. For example, the Planck cube was described as near infinitely small and both the super supermassive quark star (matter) and our universe were described as near infinitely large, not infinitely large. Since both the Planck cube and the doughnut physical singularity in it at t = 0 were near infinitely small, our universe's energy density at that time was near infinitely large, not infinitely large.

Superstring and a TOE solution as described in this article are identical because both unify all known physical phenomena from the near infinitely small Planck cube scale (quantum gravity) to the near infinitely large super supermassive quark star (matter) scale (Einstein's General Relativity). This integrated superstring with all other nineteen theories in an Integrated TOE, (see Table VII).

A. Universal rectangular coordinate system

A Two-Step Integrated TOE required two complementary coordinate systems: a universal rectangular coordinate system described in this section and a highly curved spacetime described in Section XVI.A. Einstein's General Relativity. A universal rectangular coordinate system is required to describe: It from Qubit (IfQ), quantum fluctuations, and superstring's six extra dimensions.

As described in Section II. An amplified superstring, any object in the Super Universe (e.g., proton, atom, molecule, person, quark star, galaxy, our universe, or the entire Super Universe), is represented by a fixed background volume of contiguous Planck cubes containing the 129 fundamental matter or force particle closed superstring types. As described in Section VI. An amplified spontaneous symmetry breaking, following the end of matter creation, only 22 permanent matter and force particle superstrings existed.

A fixed background volume of contiguous Planck cubes implements the "It from Qubit" concept where "It" or spacetime is the volume of any object in the Super Universe. The volume is composed of the smallest chunks of information or contiguous Planck cubes containing 22 permanent fundamental matter or force particle closed superstring types [5]. For example, the chunk of information for an electron in a Planck cube consists of: energy/mass 0.51 MeV, spin ½, and charge -1. Three examples of the IfQ concept are shown in Fig. 4 Our universe's IfQ concept which shows: our universe, our Milky Way galaxy, and you or an "average human." The three figures are shown in two dimensions instead of three and are not to scale. The number of Higgs (h), matter (m), and force (f) particles are illustrative. For example, our universe is a three dimensional sphere with a radius of 46.5 billion light years and not a two dimensional circle. Furthermore, the Planck cubes are near infinitely small in comparison to our universe's size and our universe contains approximately 10^{185} Planck cubes shown as squares in Fig. 4. A subset of our universe or our Milky Way galaxy is shown in the middle figure. Our Milky Way galaxy is approximated as a sphere with a radius of 50,000 light years and contains approximately 10^{167} Planck cubes. A subset of our Milky Way galaxy is shown on the right as you or an "average human." An "average human" contains approximately 10^{103} Planck cubes. In Fig. 4, instead of our Milky Way galaxy any of the other over 100 billion galaxies (e.g., Andromeda) could have been selected as the middle figure. Any object in that galaxy could have been

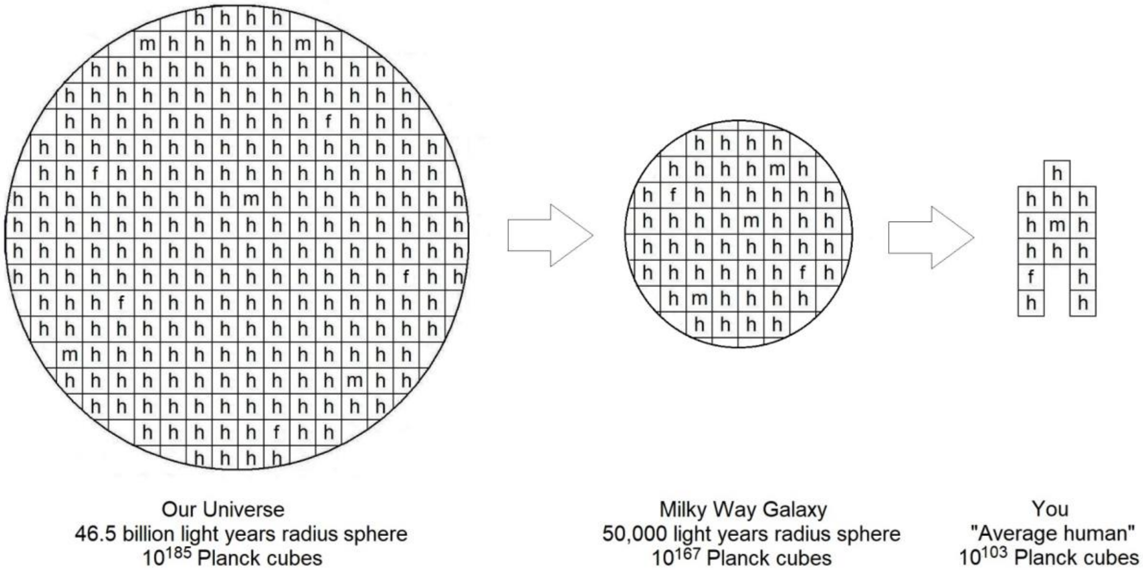


FIG. 4. Our universe's IfQ concept.

substituted for an "average human" in the right figure. The key conclusion of Fig. 4 is any object in our universe (e.g., proton, atom, molecule, person, quark star, galaxy, or our entire universe) can be described as a fixed background volume of contiguous Planck cubes each containing a chunk of information such as energy/mass, spin, and charge (e.g. an electron with 0.51MeV, spin ½, and charge -1). Furthermore, Fig. 4 can be amplified to include the Super Universe and can be shown for any time (e.g. 13.0 billion years) rather than current time of 13.8 billion years. A fourth example of the IfQ concept is the super supermassive quark star (matter) shown in Fig. 14a.

As described in Section II. An amplified superstring, each of the 128 fundamental SM/supersymmetric/super supersymmetric matter and force particles and the super force particle are equivalently represented by: a dynamic point particle, its unique closed superstring, or its associated Calabi-Yau membrane (cloud). As described in Section XXII.B. Quantum gravity interpretations, quantum fluctuations are jitter or a temporary change in energy caused by the uncertainty principle of a dynamic point particle's position and momentum in a Planck cube. Quantum fluctuations jitter the electron's dynamic point particle position by Δ y as shown in Fig. 2 by the displaced dots on the dashed closed superstring. The figure shows a closed electron superstring as a solid line with dots whereas the dots on the dashed closed superstring represent dynamic positions of the electron with quantum fluctuations. Although jitter is three dimensional in position and velocity (Δ x, Δ y, Δ z, Δ v_x, Δ v_y, Δ v_z), for simplicity jitter is shown in Fig. 2 in only one dimension Δ y. If the electron dynamic point particle position is defined over n points, the result is a vibrating closed superstring. If the electron dynamic point particle position is defined over a much larger m points, the result is a vibrating Calabi-Yau membrane or cloud. The dynamic point particle in the closed superstring jitters in position and momentum according to the uncertainty principle $\Delta y \Delta p_y \geq h/4\pi$. Equivalently $\Delta y \Delta v_y \geq h/4\pi m$, the uncertainty is inversely proportional to an object's mass "m," and the jitter is more significant for an electron (0.51 MeV) than for an up quark (2.2 MeV). Uncertainty and quantum fluctuations approach zero as object mass increases (e.g., for a proton, atom, and molecule), become unmeasurable, and the objects are treated classically.

There is a subtle difference between quantum and vacuum fluctuations. Quantum fluctuations or jitter are associated with each of the 129 fundamental SM/supersymmetric/super supersymmetric matter and force particles. Vacuum fluctuations or jitter are associated only with eight Higgs forces which are dark or vacuum energy. Furthermore as also described in Section XXII.B Quantum gravity interpretations, the Schrodinger electron cloud model for a hydrogen atom, is not suitable for all electrons, because the electron's position is distributed around an average electron distance from the proton. For example, Schrodinger's electron cloud model is not suitable for free electrons in our early universe's quark-gluon plasma, because neither a proton in a hydrogen atom nor an average distance of the electron from the proton exists.

The super force superstring spherical physical singularity smaller than a Planck cube at the start of inflation, consisted of the super force and its derivatives: gravitinos*, gravitons, 12 superpartner forces (inflatons), gluinos*, gluons, and 16 associated Higgs particles as shown in Fig. 6 Big Bang. Fluctuations existed for both individual force particle superstrings in individual Planck cubes (quantum fluctuations) during inflation and for superimposed super force superstrings in physical doughnut and spherical singularities smaller than Planck cubes prior to inflation.

The inertially stabilized X_u, Y_u, Z_u universal rectangular coordinate system of Fig. 5 originates at our universe's big bang at $x_u = 0$, $y_u = 0$, $z_u = 0$, $t = 0$. A Planck length ($l_p = 1.6 \times 10^{-35}$ m) cube is centered at x_u, y_u, z_u at time t with the Planck cube's X_p, Y_p, and Z_p axes aligned with the X_u, Y_u, Z_u axes. Any point within the Planck cube is identified by x_p, y_p, z_p coordinates measured from the cube's center with velocity components v_{xp}, v_{yp}, and v_{zp}. Superstring theory's six extra dimensions are these six dynamic point particle position and velocity coordinates in a Planck cube.

B. Proposed SM/supersymmetric/super supersymmetric matter and force particle symbols

Two reasons for replacing inadequate existing matter and force particle symbols with proposed symbols were explicit Higgs particle representation and elimination of existing symbol ambiguities via standardization of subscripts and capitals.

Table I Fundamental SM/supersymmetric/super supersymmetric matter and force particles shows proposed symbols with SM particles on the left and supersymmetric particles on the right. The subscript xx explicitly identifies a specific matter or force particle (e.g., the subscript 11 identifies the up quark p_{11}). Adding 16 to the SM particle subscript identifies its supersymmetric partner (e.g., sup squark p_{27}). Replacing p with h identifies the associated super supersymmetric Higgs particle (e.g., h_{11} is the Higgs force associated with the up quark p_{11}). An anti-particle is identified by the subscript bar (e.g., the anti-up quark is p_{11bar}). The proposed symbols are different than existing symbols. For example the up quark p_{11} replaces u, the down quark p_{10} replaces d, the sup squark p_{27} replaces a u with a tilde over it, the anti-up quark p_{11bar} replaces a u with a bar over it, and the photon p_{16} replaces γ.

The first reason for replacing existing symbols is explicit Higgs particle symbols are required. In the proposed symbols, there is a super supersymmetric Higgs particle for each of 32 SM/supersymmetric matter and force particles. Each SM/supersymmetric matter particle has an associated Higgs force and each SM/supersymmetric force particle has an associated Higgsino or Higgs matter particle. Explicit Higgs particles are essential because as subsequently described in Section VI. An amplified spontaneous symmetry breaking, baryogenesis and spontaneous symmetry breaking create eight permanent matter particles and their associated eight permanent Higgs forces. Also, baryogenesis creates three permanent Higgsino types and their three associated forces (graviton, gluon, and photon). There are 16 SM particles, their 16 supersymmetric particles, their 32 super supersymmetric Higgs particles, and their 64 anti-particles.

The second reason for the proposed symbols is elimination of existing symbol ambiguities via standardization of subscripts and capitals as described in the following six examples.

The first example is eight types of gluons p_2 are explicitly represented by: p_{2a}, p_{2b}, p_{2c}, p_{2d}, p_{2e}, p_{2f}, p_{2g}, and p_{2h}. Eight explicit gluon symbols are not available in existing symbols.

A second example is the photon p_{16} which is categorized into two types: p_{16a} for electromagnetic radiation and p_{16b} for force carrier. Electromagnetic radiation is further subdivided into gamma ray p_{16a1}, X rays p_{16a2}, etc. for each electromagnetic radiation type. The photon symbol γ illustrates ambiguities of existing symbols because all electromagnetic and the specific gamma ray radiation are defined by γ. In addition, a force carrier photon to transmit for example Coulomb's force, is not defined in existing symbols.

A third example is the W/Z's (p_{15}) which are hybrid matter/force particles. W/Z's are transient matter particles associated with transient Higgs forces (h_{15}) but with force particle spins of 1. The three W/Z's are explicitly represented as W^+ (p_{15a}), W^- (p_{15b}) and Z^0 (p_{15c}). Their three wino/zino superpartners are explicitly represented as wino^+ (p_{31a}), wino^- (p_{31b}) and zino^0 (p_{31c}).

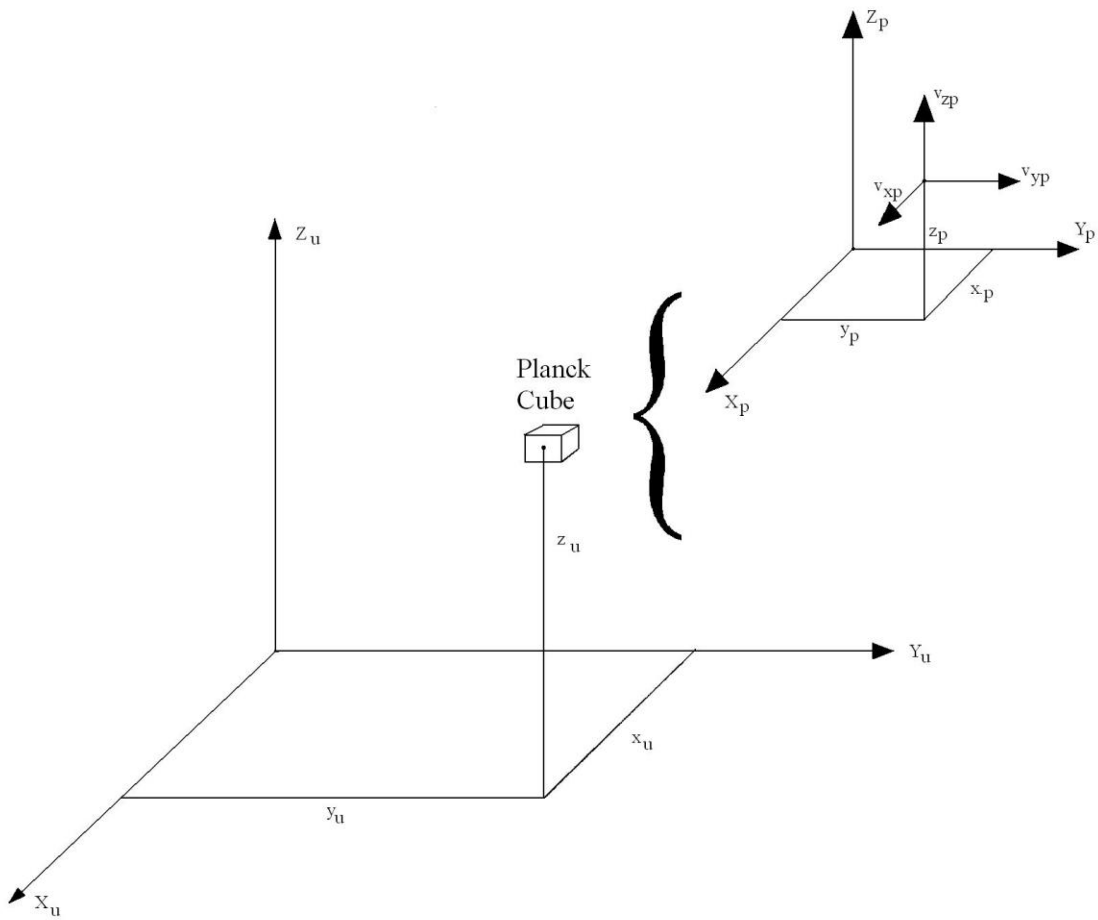


FIG. 5. Universal rectangular coordinate system.

A fourth example is there are 32 super force types identified for example by p_{sfp11} where the subscripts (sf) signify super force and the following subscripts (e.g., p11) signify one of 32 matter and force particles (e.g., up quark). The 32 super force types produce 32 SM/supersymmetric matter and force particles and their 32 associated super supersymmetric Higgs particles. Since the same 32 super force types produce both particles and anti-particles, a total of 128 particles are produced. There is only one super force type in existing symbols.

A fifth example is total particle energy/mass is represented by an upper case letter symbol. For example, total up quark (p_{11}) energy/mass for all up quarks in our universe is $P_{11.}$ The big bang time line of Fig. 6 exclusively uses total energy/mass for 64 matter and force particle types. Total particle energy/mass symbols are not available in existing symbols.

A sixth example is there are 32 super force energy densities which are identified for example by P_{sfdp11} where the subscripts (sfd) signify super force energy density and the following subscripts (e.g., p11) signify one of 32 matter and force particles (e.g., up quark) (see Section VI. An amplified spontaneous symmetry breaking). Only one super force energy density is available in existing symbols.

III. AN AMPLIFIED PARTICLE CREATION

Our universe's 128 matter and force particle types were created from the super force during particle creation between t = 5.4 x 10^{-44} and 100 s as shown in Fig. 6 Big Bang time line of Rees [6]. Although graviton and gluon

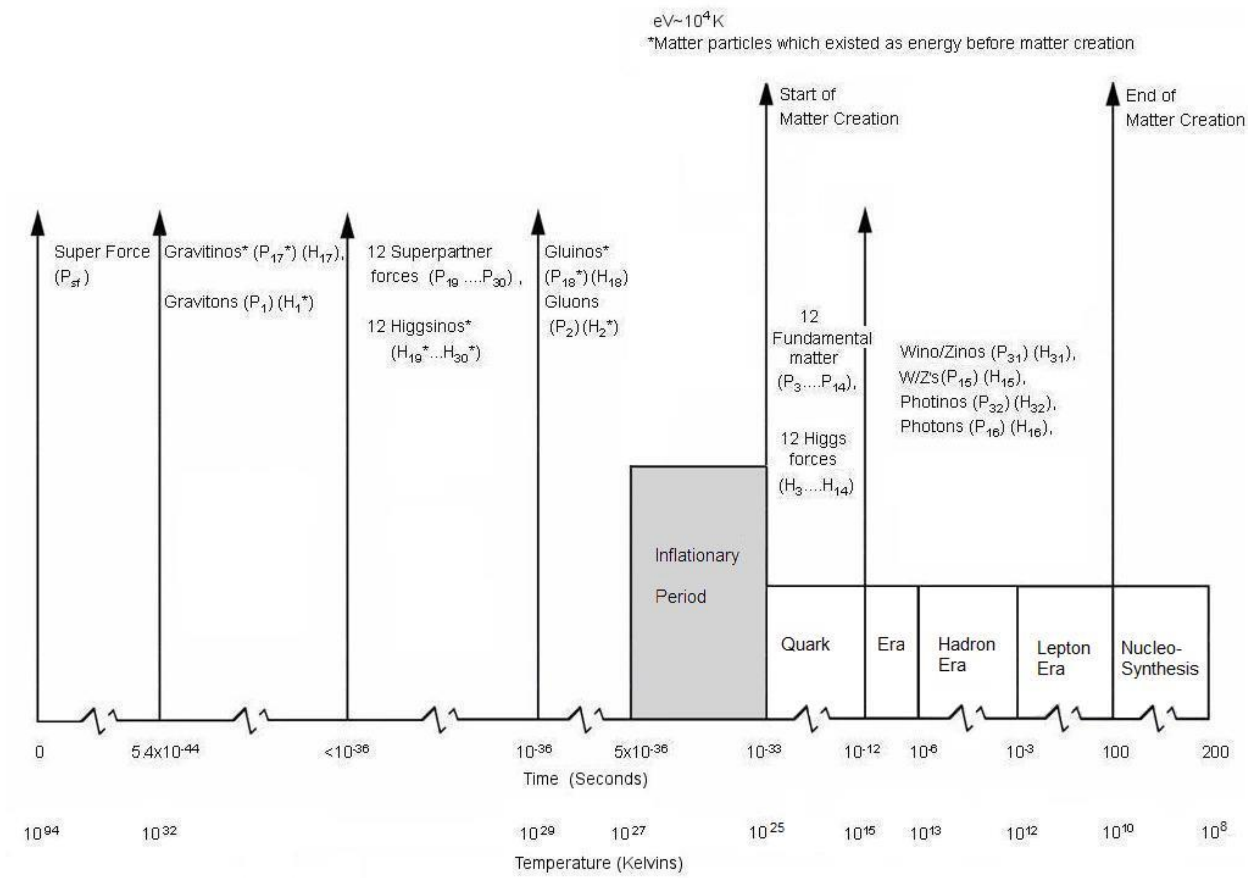


FIG. 6**.** Big bang.

force energies were created at 5.4 x 10^{-44} and 10^{-36} s respectively, they manifested themselves as force particles during inflation (5 x 10^{-36} to 10^{-33} s) when the size of our universe was larger than a Planck cube, required to accommodate force particle superstrings. All matter particles and the photon force particle manifested themselves during matter creation between t = 10^{-33} s and t = 100 s and at extremely high temperatures between 10^{25} and 10^{10} K. Condensation of matter particles required both Planck cube size to accommodate matter particle superstrings and condensation temperatures related to their energy/masses. The X axis was shown both as time in seconds and temperature in Kelvins because of the intimate relationship between particle creation time and temperature or energy/mass (e.g., W^- at 10^{-12} s, 10^{15} K, and 80 GeV). Energy/mass in electron volts was related to temperature via eV ~ 10^4 K. For simplicity, Fig. 6 excluded 64 anti-particles.

Figure 6 shows creation of our universe's 40 matter and force particle types from individual super force superstring particles. Upper case letters are exclusively used because particle creation involves total particle energy/mass. For example, total up quark energy/mass or the energy/mass of all up quarks in our universe is P_{11}. Total energy/mass (e.g., P_{11}) consists of three types of energies: rest mass, kinetic (translational and rotational), and potential (gravitational, electromagnetic, nuclear binding for protons and neutrons) energies.

At t = 0 our universe was a doughnut physical singularity at a Planck cube center which immediately transformed to a spherical physical singularity via Greene's conifold transition. Following this conifold transition, our universe was spherical in shape and remained spherical for the next 13.8 billion years. Our universe expanded from a spherical physical singularity at t > 0 s, to a larger spherical physical singularity but smaller than a Planck cube at the start of inflation (t = 5 x 10^{-36} s), to an 8 m radius sphere of individual super, graviton, or gluon force particle

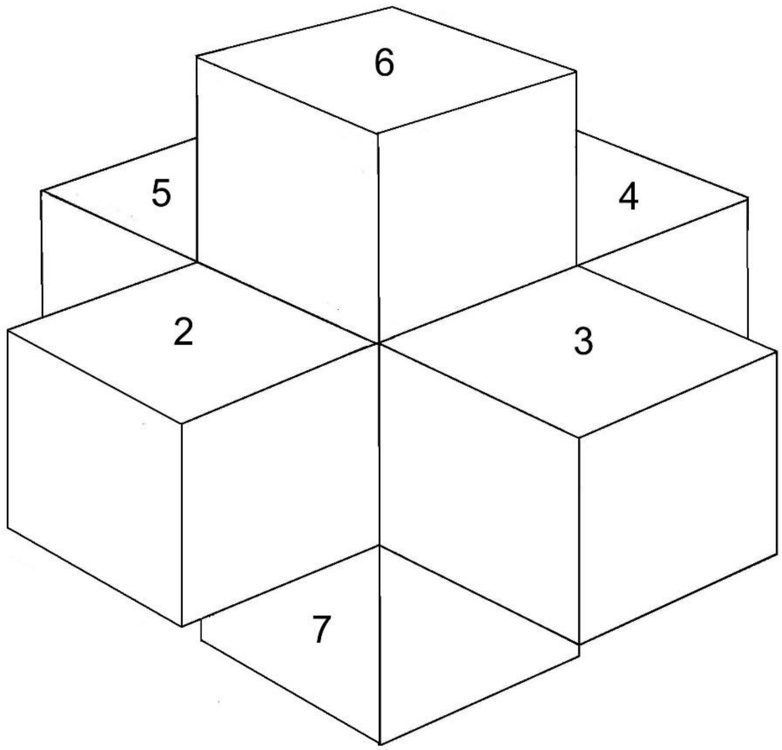


Fig. 7. One to seven Planck cubes expansion.

closed superstrings at the end of inflation or 10^{-33} s. Currently, our spherical universe has a radius of 46.5 billion light years.

Inflation start time (5×10^{-36} s) was amplified to be time synchronous with the one to seven Planck cubes spherical physical singularity to individual super, graviton, or gluon force particle closed superstrings expansion. Since individual super force, matter, and force particles existed as closed superstrings in Planck cubes, they could not exist before the start of inflation at $t = 5 \times 10^{-36}$ s when our universe was smaller than a Planck cube. The one to seven Planck cubes spherical physical singularity to individual super, graviton, or gluon force particle closed superstrings expansion consisted of six contiguous Planck cubes attached to the six faces of our universe's original Planck cube as shown in Fig. 7. The center cube numbered 1 but hidden from view, contained our universe's spherical physical singularity (10^{54} kilograms) of superimposed super force closed superstrings. Part of the super force's energy condensed into six individual super, graviton, or gluon force particle closed superstrings in the six contiguous Planck cubes. In Fig. 7, the six force particle cubes are explicitly shown and numbered as 2, 3, 4, 5, 6, and 7, whereas the center super force singularity cube numbered 1, is hidden from view. The first force particle Planck cube shell consisting of six force particles was then pushed out, and a second force particle Planck cube shell between the center Planck cube and the first force particle shell was created. This process continued until enough shells with enough Planck cubes existed to accommodate all our universe's super, graviton, and gluon force particles. By the end of inflation, our spherical universe had expanded from a super force spherical physical singularity inside a Planck cube to a sphere with a radius of 8 meters. The exponential inflation factor was approximately 8 meters/.8 x 10^{-35} meters or 10^{36}.

Figure 6 describes the creation of the 64 SM/supersymmetric/super supersymmetric matter and force particles as follows. At $t = 5.4 \times 10^{-44}$ s or the Planck time, four fundamental forces were unified. Gravitons (P_1), their gravitino* superpartners (P_{17}*), and their two associated super supersymmetric Higgs particles (H_1*, H_{17}) condensed from the super force. At $t = 10^{-36}$ s or the Grand Unified Theory (GUT) time, three forces were unified. Gluons (P_2), their gluino superpartners (P_{18}*), and their two associated super supersymmetric Higgs particles (H_2*, H_{18}) condensed from the super force. At t = 10^{-12} s, two forces were unified. Photons (P_{16}), their photino superpartners (P_{32}), and their two associated super supersymmetric Higgs particles (H_{16}, H_{32}) condensed from the super force. Also, W/Z's (P_{15}), their Wino/Zino superpartners (P_{31}), and their two associated super supersymmetric Higgs particles (H_{15}, H_{31}) condensed from the super force. At t < 10^{-36} s, 12 superpartner forces (P_{19}….P_{30}) and their 12 associated Higgsinos (H_{19}*….H_{30}*) condensed from the super force. Twelve fundamental matter (P_3….P_{14}) and their associated super supersymmetric Higgs forces (H_3….H_{14}) condensed during matter creation. The asterisk (*) signifies matter particles which existed as energy before condensation to matter particle closed superstrings in Planck cubes during matter creation. Twelve superpartner forces and their 12 associated Higgsinos* were X bosons or the latent energy which expanded our universe during the inflationary period [7]. X bosons were to the inflation period as eight permanent Higgs forces (dark energy) were to our universe's expansion from the start of matter creation to the present time.

The quantum gravity (mechanics)/general relativity boundary was the start of inflation at t = 5 x 10^{-36} s when our universe was a spherical physical singularity inside a Planck cube. General relativity was applicable for all times in our universe between t = 0 and t = 13.8 billion years, whereas quantum gravity theory was applicable for all those times except between 0 and 5 x 10^{-36} s. Between 0 and 5 x 10^{-36} s, quantum gravity theory was not applicable because our universe was a singularity smaller than the Planck cube quantum. The latter was required for matter (e.g. electron, up quark) and force (e.g. graviton) closed superstring particles. According to Donoghue, gravity is a good quantum theory at ordinary energies but at high energies it remains a formidable challenge [8]. That high energy challenge may be the quantum gravity/general relativity boundary which occurs at the beginning of inflation (5 x 10^{-33} s).

This integrated particle creation with superstring, inflation, Higgs forces, spontaneous symmetry breaking, superpartner and SM decays, neutrino oscillations, dark matter, universe expansions, dark energy, relative strengths of forces, stellar black holes, black hole entropy, black hole information paradox, baryogenesis, and quantum gravity theories, (see Table VII).

IV. AN AMPLIFIED INFLATION

Inflation start time (5 x 10^{-36} s) was amplified to be time synchronous with the one to seven Planck cubes spherical physical singularity to individual super, graviton, or gluon force particle closed superstrings expansion as shown in Fig. 7. Since individual super force and matter particles existed as closed superstrings in Planck cubes, they could not exist when our universe was smaller than a Planck cube or when our universe's radius was smaller than .8 x 10^{-35} m, see Fig. 8. As described in Section III. An amplified particle creation, the one to seven Planck cubes spherical physical singularity to individual super, graviton, or gluon force particle closed superstrings expansion consisted of six contiguous Planck cubes attached to the six faces of our universe's original Planck cube. The original Planck cube contained a spherical physical singularity of superimposed super force closed superstrings, part of which condensed into individual super, graviton, or gluon force particle closed superstrings in the six contiguous Planck cubes. The first Planck cube shell was then pushed out and a second Planck cube shell of individual super, graviton, or gluon force particle closed superstrings condensed between the center Planck cube and the first shell. This process continued until enough shells with enough Planck cubes existed to accommodate all our universe's individual super, graviton, or gluon force particle closed superstrings. Fig. 8 had an amplified "New Physics" inflationary period start radius of approximately .8 x 10^{-35} m with an exponential inflation factor of 10^{36} (8/.8 x 10^{-35}). Guth's comparable values were 10^{-52} m and 10^{53} (8/.8 x 10^{-52}) [9]. Liddle and Lyth specified an exponential inflation factor of 10^{26} [10]. Thus this article's estimated exponential inflation factor of 10^{36} was between Guth's 10^{53} and Liddle and Lyth's 10^{26}. Future B-mode polarization measurements and analyses should define inflation and the correct exponential inflation factor from the above three estimates.

The above predicted exponential inflation factor of 10^{36}, is compatible with the hierarchy problem resolution described in Section XIII. An amplified relative strengths of forces/Hierarchy problem. In summary, the computed relative strengths of gravitational and electromagnetic force between an electron and quark was 10^{-39}, or equivalently a range dilution of approximately 10^{-19}. From Fig. 8, the electromagnetic/weak force creation/activation time ($t_{w/z}$) was 10^{-12} s which corresponded via the right and top dashed lines to our universe's radius ($r_{w/z}$) of 10^{11} m. The gravitational force activation time (t_g) was the time required to produce a 10^{-19} range reduction factor ($r_g/r_{w/z}$). From Fig. 8, the bottom and left dashed lines related our universe's radius (r_g) or 10^{-8} m to the gravitational force activation time (t_g) of 10^{-33} s or the start of matter creation. From Fig. 6, t_g corresponded to a gravitino energy/mass

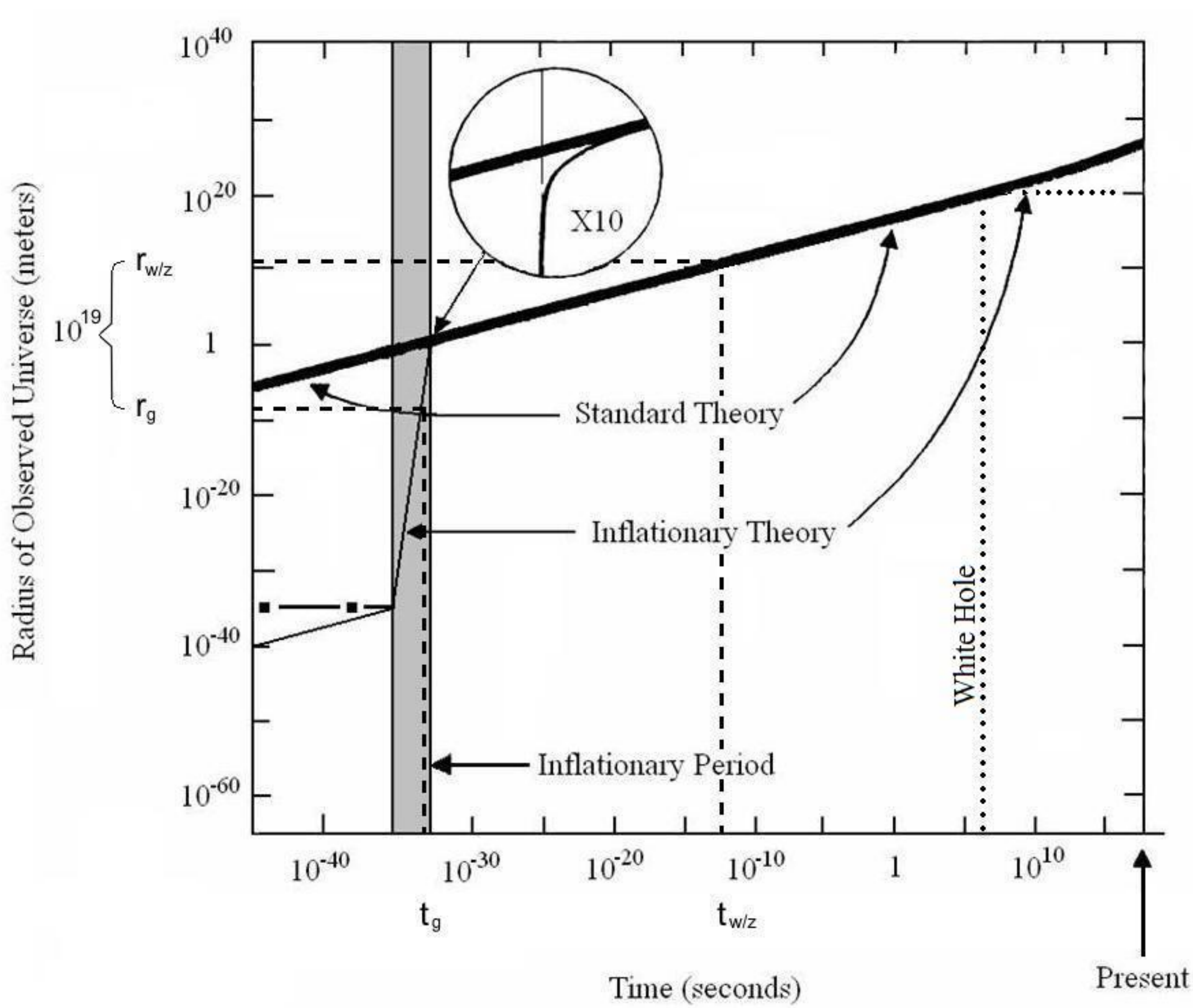


FIG. 8. Size of universe in the standard and inflationary theories.

of approximately 10^{25} K or 10^{21} eV. This also agrees with the conclusion of Section IV.A. Spontaneous symmetry breaking and inflation functions that no matter particles were created before or during inflation.

During matter creation between t = 10^{-33} and 100 s shown in Fig. 6, eight of the created matter particles were permanent and included six atomic/subatomic matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, and tau-neutrino) and two dark matter particles (zino and photino). Nine of the created matter particles were transient and included the top quark, bottom quark, charm quark, strange quark, tau, muon, gravitino, gluino, and W/Z's. By the end of matter creation at t = 100 s, all nine transient matter particles had decayed to eight permanent matter particles.

During matter creation, gravitinos* (P_{17}*), gluinos* (P_{18}*), and 12 fundamental matter (6 quarks and 6 leptons) particles (P_3….P_{14}) energy/masses condensed to matter particles. At t = 10^{-12} s, W/Z's (P_{15}), winos/zinos (P_{31}) and photino (P_{32}) energy/masses condensed to matter particles.

Particle/anti-particle pairs condensed from super force particles and evaporated back to them. As our universe expanded and cooled this baryogenesis process was predominantly from energy to matter rather than to anti-matter (see Section VI. An amplified spontaneous symmetry breaking and Section XXI. An amplified baryogenesis). Particles/anti-particles were the intermediate or false vacuum state prior to the permanent matter plus true vacuum state. During matter creation (10^{-33} to 100 s), our universe consisted of a time varying particle soup. The end of matter creation was defined as 100 s because only electrons remained following electron anti-electron annihilations during the lepton era. The end of matter creation was actually the end of the lightest anti-matter particle or the anti-electron-neutrino. Anti-electron-neutrinos existed after 100 s. However, since the end time of anti-electron-neutrinos was unknown, the end of matter creation was approximated as 100 s or the end of anti-electrons. Also at t = 100 s, nucleosynthesis began.

This integrated inflation with superstring, particle creation, universe expansions, and quantum gravity theories, (see Table VII).

A. Spontaneous symmetry breaking and inflation functions

There were two similar but different potential field functions causing universe expansions during matter creation (spontaneous symmetry breaking) and inflation. Dark energy or the sum of eight permanent Higgs force energies, caused universe expansion during matter creation. Matter creation consisted of spontaneous symmetry breaking and baryogenesis. Spontaneous symmetry breaking was the condensation of super force particles to matter particles and their associated Higgs forces. Baryogenesis was the asymmetric production of particles and anti-particles. In contrast, inflation was the exponential expansion of our universe caused by inflatons or X bosons.

Up quark baryogenesis and spontaneous symmetry breaking is shown in Fig. 10. The true or permanent vacuum state (dark energy density) consisted of space between matter particles, or the sum of eight permanent Higgs force energy densities. The false vacuum state was the intermediate or transient state between the super force state and the permanent matter/Higgs force or true vacuum state. During matter creation (10^{-33} to 100 s), there were two false vacuum states. First during baryogenesis for each of 17 matter particles, particle/anti-particle pairs condensed from and evaporated to the super force. The second false vacuum state occurred during the decay of nine transient matter particles to eight permanent matter particles and intermediate force particles. These are described in detail in Section VI. An amplified spontaneous symmetry breaking and shown in Fig. 10 Up quark baryogenesis and spontaneous symmetry breaking function.

In contrast, inflation was a single field inflation function shown in Fig. 9 and validated by Planck satellite measurements [11]. The vertical Z axis of Fig. 9 represents inflaton energy density $V(\phi)$ while the X axis represents inflaton (ϕ) time during the inflationary period, t = 5 x 10^{-36} to 10^{-33} s. The instantaneous value of inflaton energy density versus inflaton time is shown by the ball position as it rolls down the Fig. 9 function. When all the inflaton energy density has been expended, inflation is "gracefully exited" as the ball stops rolling at time t = 10^{-33} s. Since inflation expanded space faster than the speed of light and matter particles could not travel faster than the speed of light, if matter particles were created before or during inflation they would not be uniformly distributed in space. This is contrary to the measured homogeneous and isotropic nature of our universe on a large scale (490 million ly cube) [12]. Thus, no matter particles were created before or during inflation.

V. AN AMPLIFIED HIGGS FORCES (BOSONS)

Super force particles were God particles because they constituted 100% of our universe's total energy/mass between t = 0 s and the start of matter creation at t = 10^{-33} s. Higgs particles were associate God particles because they constituted approximately 82% of our universe's total energy/mass between the start of recombination at approximately 380,000 years and 13.8 billion years (see Section XVI.A Einstein's General Relativity). The sum of eight Higgs force energies associated with eight permanent matter particles was dark energy and 69% of our universe's energy/mass. Dark matter consisted of zinos, photinos, and three permanent Higgsino types (see Section IX. An amplified dark matter). Assuming three permanent Higgsino types were half of dark matter's energy/mass (26%), they were 13% of our universe's energy/mass. Eight Higgs forces plus three permanent Higgsino types constituted approximately 69% + 13% = 82% of our universe's energy/mass.

Amplifications to Higgs force theory ("New Physics") were key to this article's Two-Step Integrated TOE and are described as follows. First, amplifications included 32 associated super supersymmetric Higgs particles, one for each of 32 SM and supersymmetric matter and force particle types. These 32 Higgs particles defined a "Super supersymmetry (SSUSY)." If a SM/supersymmetric particle was a matter particle (e.g., up quark, gravitino), its associated Higgs particle was a Higgs force. If a SM/supersymmetric particle was a force particle (e.g., graviton, sup squark), its associated Higgs particle was a Higgsino. As described in Section VI. An amplified spontaneous symmetry breaking, the super force condensed into eight permanent matter particles/Higgs forces. During

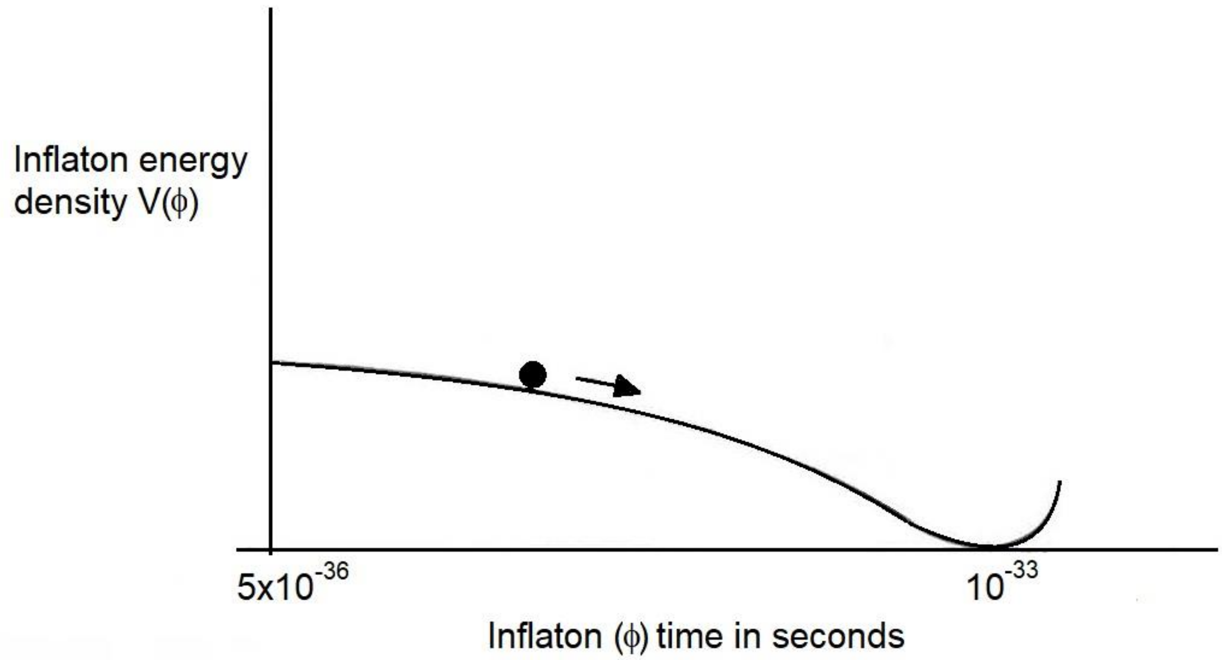


FIG. 9. Single field inflation.

baryogenesis, the super force condensed into three permanent Higgsinos/associated forces (graviton, gluon, and photon).

In reference to quantum fluctuations and according to Carroll [13], contributions from fermions (e.g., up quark) were exactly cancelled by equal and opposite contributions from their supersymmetric force particles (e.g., sup squark) before supersymmetry was broken. In the Minimal Supersymmetric Standard Model according to Randall [14], the strength of three forces (strong, weak, and electromagnetic) precisely met at the Grand Unification time t = 10^{-36} s with an energy of 10^{16} GeV. Similarly, perhaps contributions of a SM or supersymmetric matter particle (e.g. up quark, gravitino) were exactly cancelled by equal and opposite contributions from their super supersymmetric Higgs force particles (e.g., Higgs force associated with up quark and Higgs force associated with the gravitino) before super supersymmetry was broken. Under that assumption, the strength of four forces (strong, weak, electromagnetic, and gravitational) may have precisely met at the Planck time t = 5.4 x 10^{-44} s or 10^{19} GeV.

Matter creation included a super force particle's condensation to a matter particle/Higgs force. Just as a permanent electron or up quark have permanent electric fields because of their electric charges, an electron or up quark also have permanent Higgs force fields because of their masses. Figure 13 shows an up quark with quantized Higgs force particles. The 17 matter particles/Higgs forces (eight permanent and nine transient) were one and inseparable, created simultaneously, and modeled as an undersized porcupine (e.g., up quark Planck cube closed superstring or p_{11}) with overgrown spines (e.g., a three dimensional radial Higgs force field quantized into Higgs force Planck cube closed superstrings or h_{11}). The Higgs force was a residual super force which contained the mass, charges, and spin of its associated matter particle. When a matter particle (e.g., up quark) condensed from the super force, the residual super force was the Higgs force associated with the matter particle.

Extremely high temperatures between 10^{25} and 10^{10} K in our early universe caused matter creation via spontaneous symmetry breaking and baryogenesis. The Higgs force was a product not the cause of spontaneous symmetry breaking. The super force condensed into 17 matter particles/Higgs forces at 17 different temperatures. There were nine transient matter particles (top quark, bottom quark, charm quark, strange quark, tau, muon, gravitino, gluino, and W/Z's) and eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino). The zino and photino were dark matter particles.

Spontaneous symmetry breaking was similar to the three condensation phases of H_2O from steam, to water, to ice as temperature decreased from 212° to 32° F. Similarly the super force, three W/Z's/three Higgs forces, down quark/Higgs force, up quark/Higgs force, etc., were the same but manifested themselves differently as temperature decreased from 10^{25} to 10^{10} K. There was an intimate relationship between matter creation time and the matter particle's energy/mass or temperature. That is, 17 SM/supersymmetric matter particles had specific matter creation times and related temperatures or energy/masses (e.g., W^- at 10^{-12} s, 10^{15} K, or 80 GeV). The earlier the matter creation time, the greater was the matter particle's temperature or energy/mass.

Ice also evaporated or melted to water which then evaporated to steam as temperature increased from 32° to 212° F. Similarly, particle creation and spontaneous symmetry breaking were bidirectional. For example, as temperature increased, the down quark/Higgs force evaporated back to the super force (see stellar black hole evaporation in Section XVIII. An amplified arrow of time).

Therefore, the super force condensed into a matter particle/Higgs force or a matter particle/Higgs force evaporated to the super force. In Beta minus decay, the down quark decayed to an up quark and a W^-. The W^- then decayed to an electron and an anti-electron-neutrino. The Beta minus decay equation produced correct results with a misunderstood process because indivisible fundamental particles such as the down quark or W^- cannot be split into two other fundamental particles.

Particle decay was the evaporation of a heavy matter particle/Higgs force to the super force and the condensation of the super force to lighter and permanent matter particles/Higgs forces. In the Beta minus decay with Higgs force amplification or "New Physics," the down quark/Higgs force evaporated to a super force particle. Division of energy not matter occurred as one portion of the super force condensed to the up quark/Higgs force, and a second portion to the W^- particle/Higgs force. The three W/Z's (W^+, W^-, and Z^0) were transient matter particles because, for example, within 10^{-25} s of its creation, the W^- transient matter particle/Higgs force evaporated back to a super force particle. The super force then condensed into an electron/Higgs force and an anti-electron-neutrino/Higgs force. Since the W/Z's were reclassified as transient matter (hybrid) particles, this produced the asymmetrical number 17 instead of 16 matter particles, that is, 9 transient and 8 permanent matter particles. By 100 seconds after the big bang, the nine transient matter particles/Higgs forces decayed via evaporation/condensation cycles to and from the super force to eight permanent matter particles/Higgs forces. The latter included the: up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, photino and their eight Higgs force energies or dark energy.

Mass was given to a matter particle by its Higgs force and gravitons or gravitational force messenger particles (see Section XII.A Gravitational/electromagnetic). Graviton requirements were amplified to include embedded clocks/computers. The embedded graviton clock/computer calculated Newton's gravitational force by extracting masses of the transmitting and receiving matter particles from their Higgs forces, calculating the range factor $1/r^2$ as $1/ [(t_r - t_t) (c)]^2$ from the graviton transmission (t_t) and reception (t_r) times, and providing gravitational force to the receiving particle. Permanent Higgs forces give mass to their permanent associated matter particles. Transient Higgs forces (e.g., the 125 GeV Higgs associated with W^-) cannot give mass to permanent matter particles (e.g. up quark) because the former exist for only 10^{-25} s.

As stated in Section II. An amplified superstring, there were 129 fundamental matter and force particles in our universe consisting of 16 SM, 16 supersymmetric, 32 super symmetric Higgs, and 64 anti-particles plus the super force or mother particle. Super supersymmetric Higgs meant if a SM/supersymmetric particle was a matter particle (e.g., up quark, gravitino), its associated Higgs particle was a Higgs force. Thus, each SM/supersymmetric matter particle had an associated Higgs force. If a SM/supersymmetric particle was a force particle (e.g., graviton, sup squark), its associated Higgs particle was a Higgsino. By the end of matter creation or t = 100 s, only 22 permanent fundamental matter and force particle types remained of the 129. Atomic/subatomic matter or six permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, and tau-neutrino) constituted 5% of our universe's energy/mass. Dark matter consisted of the zino and photino (13%) each associated with a Higgs force and three permanent Higgsinos (13%). Dark energy or eight Higgs force energies associated with eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino) constituted 69%. Three SM force particles (graviton, gluon, and photon) accounted for 0%.

The following is according to Kane [15]. Masses of SM matter particles: six quarks, six leptons, and W/Z's are provided by Higgs forces. The number of Higgs forces is unknown. Particle masses that interact with Higgs forces are proportional to their Higgs forces. Kane's 13 SM matter particles consisted of six permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, and tau-neutrino) and seven transient matter particles (top quark, bottom quark, strange quark, charm quark, muon, tau, and W/Z's).

The relationship of a permanent matter particle's (e.g., up quark p_{11}) energy/mass to its associated permanent Higgs force (h_{11}) energy was p_{11} = (c) (h_{11}). This fundamental particle relationship was the counterpart of atomic/subatomic matter energy/mass plus dark matter energy/mass associated with Higgs forces divided by dark energy in any large scale 490 million light year cube in our universe, or c = (5 + 13)/69 = .26. Thus, a permanent up quark's energy/mass of 2.2 MeV was approximately .26 of its associated permanent Higgs force energy or 8.5 MeV. The permanent Higgs force energy (18.1 MeV) associated with the permanent down quark, permanent Higgs force energy (8.5 MeV) associated with the permanent up quark, and permanent Higgs force energy (2.0 MeV) associated with the permanent electron were added to Table II [16]. Permanent Higgs force energies associated with the permanent electron-neutrino, muon-neutrino, and tau-neutrino were left blank in Table II because the energy/masses of three permanent neutrinos were small, non-zero, and unknown. Permanent Higgs force energies associated with the permanent zino and photino were left blank in Table II because the energy/masses of those two permanent particles were unknown.

Eight permanent Higgs force fields associated with eight permanent matter particles, multiplied by the number of each particle type (e.g., approximately10^{80} electrons) in our universe, produced the permanent Higgs force field or the vacuum (dark energy) density of space between galaxies, stars, and filament matter particles. A single transient Higgs force of 125 GeV or 10^{11} eV cannot produce permanent dark energy of .69 x 10^{90} eV. Furthermore, the vacuum expectation value (VEV) or $2M_w/g \sim 246$ GeV is invalid for the permanent vacuum in space because the W boson mass (M_w) and its associated Higgs force are transient (10^{-25} s). In contrast, eight permanent Higgs force energies associated with eight permanent matter particles produced permanent dark energy and the permanent vacuum or dark energy density of space.

In summary, there were six Higgs force theory amplifications or "New Physics" requirements. First, Higgs particles were associate God particles because they constituted approximately 82% of our universe's total energy/mass. The sum of eight permanent Higgs force energies associated with eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino) was dark energy. Dark matter consisted of zinos, photinos, and three permanent Higgsinos associated with the graviton, gluon, and photon. Second, matter creation via spontaneous symmetry breaking and baryogenesis created: eight permanent matter particles and their eight associated permanent Higgs forces; and three permanent Higgsinos and their three permanent associated forces. Third, perhaps unification of four forces (strong, weak, electromagnetic, and gravitational) required quantum fluctuation contributions of 32 SM/supersymmetric matter/force particles to be exactly cancelled by equal and opposite contributions from their 32 super supersymmetric Higgs particles. The latter consisted of 17 Higgs forces (eight permanent and nine transient) and 15 Higgsinos (three permanent and twelve transient). Fourth, each of eight permanent matter particles and their eight permanent associated Higgs forces were one and inseparable. For example, the permanent electron had three permanent fields: a gravitational field; an electric field; and a Higgs force field. Fifth, mass was given to each of eight permanent matter particles by their eight permanent associated Higgs forces. Transient Higgs forces (e.g., the 125 GeV Higgs associated with W^-) could not give mass to permanent matter particles (e.g. electron) because the former existed for only 10^{-25} s. Sixth, eight permanent Higgs force fields associated with eight permanent matter particles produced the permanent Higgs force field or the vacuum (dark energy) density of space. A single transient Higgs force of 125 GeV or 10^{11} eV cannot produce permanent dark energy of .69 x 10^{90} eV. In contrast, eight permanent Higgs force fields associated with eight permanent matter particles multiplied by the number of each particle type (e.g., approximately10^{80} electrons) in our universe, produced the vacuum (dark energy) density of space.

This integrated Higgs forces with superstring, particle creation, spontaneous symmetry breaking, superpartner and SM decays, dark matter, universe expansions, dark energy, messenger particles, arrow of time, baryogenesis, and quantum gravity theories, (see Table VII).

VI. AN AMPLIFIED SPONTANEOUS SYMMETRY BREAKING

Baryogenesis, matter decays, and spontaneous symmetry breaking occurred at extremely high temperatures in our early universe and created 22 permanent fundamental matter and force particles: eight permanent matter particles and their eight associated Higgs forces and three permanent Higgsinos and their three associated forces (graviton, gluon, and photon).

Baryogenesis occurred for: 17 transient and permanent SM/supersymmetric matter particles and three permanent Higgsinos; decay for nine transient SM/supersymmetric matter particles; and spontaneous symmetry breaking for eight permanent SM/supersymmetric matter particles. All three occurred during matter creation between 10^{-33} and 100 s and at temperatures between 10^{25} and 10^{10} K. Since baryogenesis was similar for 17 matter particles and three permanent Higgsinos, and spontaneous symmetry breaking was similar for eight permanent matter particles, only up quark baryogenesis and spontaneous symmetry breaking is described. Decay is described for both SM and supersymmetric matter particles.

Baryogenesis, matter decays, and spontaneous symmetry breaking had the following approximate time sequential phases.

1. Baryogenesis of nine transient matter particles
2. Baryogenesis of three permanent Higgsinos
3. Decay of nine transient matter particles to eight permanent matter particles
4. Baryogenesis and spontaneous symmetry breaking of eight permanent matter particles.

Because of the intimate relationship between matter creation time and temperature or energy/mass, the four phases occurred for the heaviest matter particle (e.g., assumed to be the gravitino) at the earliest matter creation time and highest energy/mass and for the lightest matter particle (e.g., electron-neutrino) at the latest matter creation time and lowest energy/mass.

Baryogenesis of nine transient matter particles was similar to the permanent up quark's baryogenesis shown in Fig. 10 from Guth's amplified energy density of Higgs fields [17]. The Z axis represented super force energy density allocated to up quarks/Higgs forces, the X axis a Higgs force (h_{11}) associated with an up quark, and the Y axis a Higgs force (h_{11bar}) associated with an anti-up quark. During up quark baryogenesis, the ball initially at its peak position (x = 0, y = 0, z = 2), moved down the baryogenesis and spontaneous symmetry breaking function equidistant between the X and Y axes. Super force particles condensed in equal amounts to: up quarks and up quark Higgs forces; and anti-up quarks and anti-up quark Higgs forces. A portion of these four particles then annihilated by evaporating back to super force particles as the ball returned to its peak position. Another portion remained as up quarks/Higgs forces. During the second condensation/evaporation cycle, the ball moved down the baryogenesis and spontaneous symmetry breaking function closer to the X axis than the Y axis and then back to its peak position. After n of these condensation/evaporation cycles in the false vacuum state, the ball eventually moved to the Fig. 10 ball position (x = -2, y = 0, z = 1.5) or the true vacuum state. In the true vacuum state the super force condensed totally to the permanent up quark/Higgs force and none to the anti-up quark/Higgs force (see Section XXI. An amplified baryogenesis).

Annihilation of an up quark/Higgs force and an anti-up quark/Higgs force during the baryogenesis evaporation cycle to the super force, is significantly different than the prevailing two particle annihilation description (e.g., up quark/anti-up quark) to gamma ray photons. First, since all matter particles have associated super supersymmetric Higgs forces, the latter must be included in annihilation descriptions. Second, annihilations produce super force energy not photon energy although the two may be identical except in name.

Following baryogenesis of each of nine transient matter particles, each decayed as follows. Decays were gauge mediated where heavier matter particles/Higgs forces decayed in a cascading process to lighter energy/mass matter particles/Higgs forces and intermediate force particles. Intermediate force particles were W/Z's for SM particles and winos for supersymmetric particles. For example, a transient SM bottom quark/Higgs force decayed to an up quark/Higgs force and a W^-/Higgs force. A transient superpartner (e.g., gravitino or gluino) decayed into a lower energy/mass superpartner and its intermediate force particle or wino. The latter decayed to SM particles/Higgs forces. The decay chain ended with zinos/Higgs forces and photinos/Higgs forces or the stable Lightest Supersymmetric Particles (LSP) and SM particles/Higgs forces. Stable LSPs or lightest neutralinos also included three permanent Higgsino types associated with gravitons, gluinos, and photons. Dark matter consisted of zinos, photinos, and three permanent Higgsino types [18] [19].

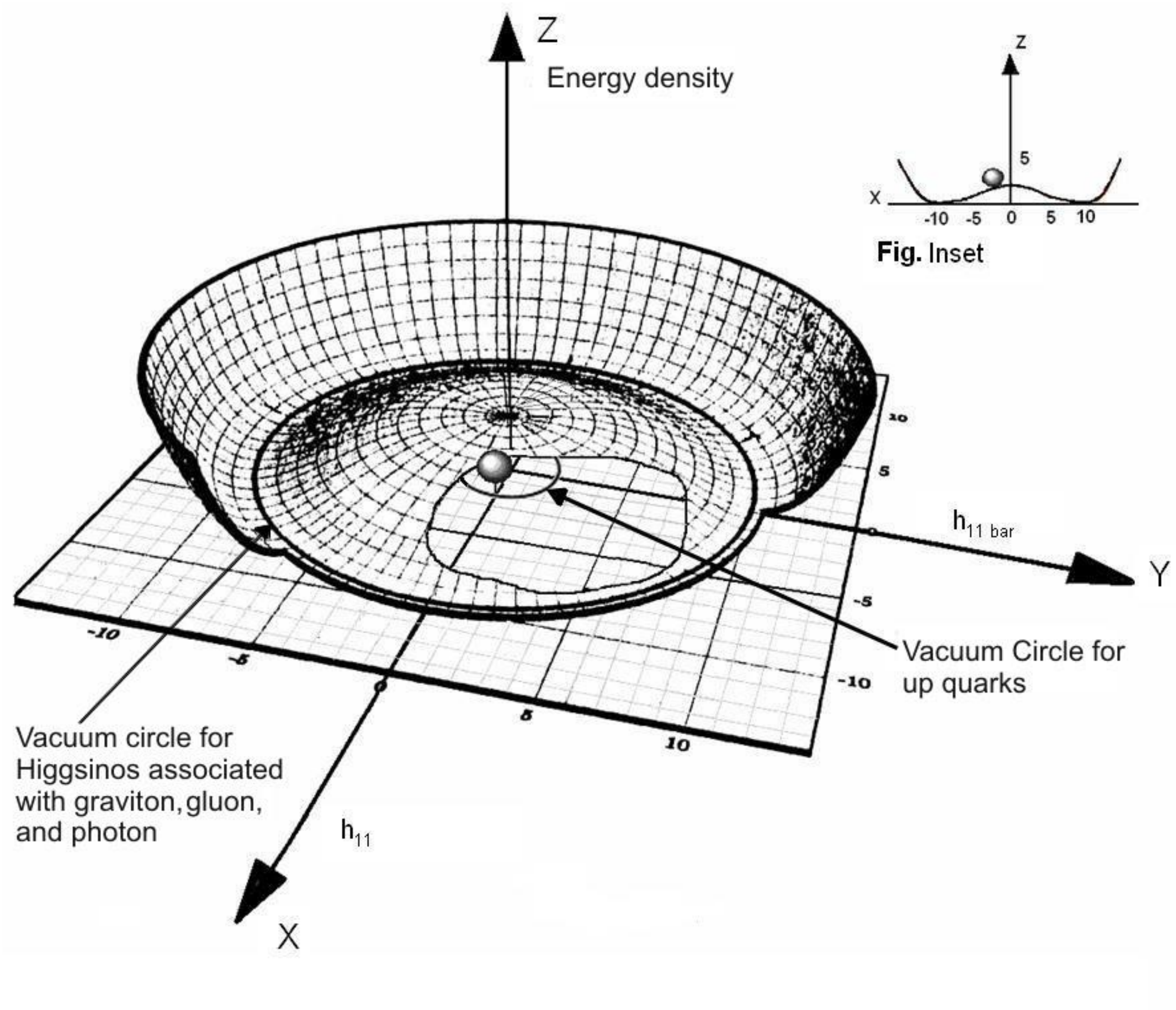


FIG. 10. Up quark baryogenesis and spontaneous symmetry breaking function.

Following baryogenesis and decay of nine transient matter particles to eight permanent matter particles, baryogenesis and spontaneous symmetry breaking occurred for eight permanent matter particles. For the up quark, there were two key ball positions in Fig. 10. When the ball was in its peak position, up quark baryogenesis had not occurred. When the ball was in the Fig. 10 position, up quark baryogenesis had occurred and super force energy density had totally condensed to up quarks/Higgs forces. The z coordinate of the Fig. 10 ball position was the super force energy density condensed to all up quark Higgs forces in our universe. The z coordinate of the peak ball position minus the z coordinate of the Fig. 10 ball position was the super force energy density condensed to all up quarks in our universe. During the hadron era, the ball moved from its peak position to the Fig. 10 position. It took another 13.8 billion years for the ball to move vertically down to its current position just above the vacuum circle for up quarks. As the ball moved vertically down, the up quark's Higgs force (ball's x coordinate) remained constant whereas the up quark Higgs forces' energy density (ball's z coordinate) slowly decreased as our universe expanded.

There were eight baryogenesis and spontaneous symmetry breaking functions associated with eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino). Each occurred at a temperature related to its energy/mass. Each had the same generic up quark Mexican hat shape of Fig. 10, but each had a different peak super force energy density (peak z coordinate) and Higgs force (ball x coordinate). By 100 s, only eight permanent matter particles/Higgs forces remained.

There was no spontaneous symmetry breaking for three permanent Higgsinos. However, three permanent Higgsinos associated with three SM force particles (graviton, gluon, and photon) experienced baryogenesis at creation times dependent on the permanent Higgsinos' energy/masses as follows. Higgsino baryogenesis was similar to up quark baryogenesis. Super force particles condensed into four particles (e.g., Higgsino and associated SM force, anti-Higgsino and associated SM force). During baryogenesis, the super force condensed totally to the Higgsino/SM force and none to the anti-Higgsino/SM force. By the end of Higgsino baryogenesis, the ball position in the Higgsino version of Fig. 10 was at x = -10, y = 0, z = 0 and on the vacuum circle for Higgsinos associated with the graviton, gluon, and photon. All a super force particle's energy condensed to a Higgsino and none to its associated zero energy force particle (graviton, gluon, or photon). In contrast to inseparable matter particles and their Higgs forces during our universe's lifetime, the three permanent Higgsinos and their associated graviton, gluon, and photon forces became independent of each other following their associated creation. Thus by 100 s, eight permanent matter particles/Higgs forces and three permanent Higgsinos/associated forces (graviton, gluon, and photon) for a total of 22 permanent fundamental matter and force particles remained.

During matter creation (10^{-33} to 100 s), there were two time sequential false vacuum phases. First during baryogenesis for each of 17 matter particles, particle/anti-particle pairs condensed from and evaporated to the super force. As our universe expanded and cooled and after n of the condensation/evaporation cycles, this baryogenesis process was predominantly from energy to matter rather than to anti-matter. Particles/anti-particles were the intermediate, transient, or the false vacuum state prior to the permanent matter/Higgs force or true vacuum state.

The second time sequential false vacuum phase occurred during the decay of nine transient matter particles to eight permanent matter particles and intermediate force particles. The super force condensed to a transient matter particle/Higgs force and bidirectionally evaporated back to the super force in the false vacuum state. Then, the super force condensed to lighter and stable matter particles/Higgs forces and intermediate force particles. This occurred for all nine transient matter particles. By 100 s, all nine transient matter particles/Higgs forces had condensed to eight permanent matter particles/Higgs forces. The true or permanent vacuum state consisted of space between matter particles, or the sum of eight permanent Higgs force energy densities.

Figure 6 shows total particle energy/masses of 64 matter and force particles designated as $P_1....P_{32}$ and $H_1....H_{32}$ where the symbols are described in Table I. These included gravitons (P_1), gluons (P_2), twelve fundamental matter particles ($P_3….P_{14}$), W/Z's (P_{15}), photons (P_{16}), 4 supersymmetric matter particles: gravitinos (P_{17}*), gluinos (P_{18}*), wino/zinos (P_{31}), photinos (P_{32}); and 12 supersymmetric force particles ($P_{19}….P_{30}$) energy/masses. The 32 super supersymmetric Higgs particles included 17 Higgs force energies ($H_3….H_{14}$, H_{17}, H_{18}, H_{31}, H_{32}, H_{15}) which were super force energy residuals following condensations of 12 fundamental matter, four supersymmetric matter, and W/Z's. There were also 15 Higgs matter particles (14 Higgsinos* and 1 Higgsino) energy/masses (H_1*, H_2*, H_{19}*….H_{30}*, H_{16}) for a total of 32 super supersymmetric Higgs particles. Sixty four anti-particles condensed at the same temperature and time as their identical energy/mass particles but were not explicitly shown in Fig. 6 because baryogenesis and inflation eliminated them.

Two conditions are required for matter condensation, our universe must be larger than a Planck cube and the specific matter condensation temperature must exist. The one to seven Planck cube spherical physical singularity to individual super, graviton, or gluon force particle closed superstrings expansion began at the start of inflation when the size of our universe became larger than a Planck cube. During inflation the gravitino, assumed to be the heaviest supersymmetric matter particle and its Higgs force existed as a super force particle (p_{sfp17}) or ($p_{17} + h_{17}$). At the gravitino condensation temperature at the start of matter creation, p_{sfp17} condensed to the gravitino p_{17} and its associated super supersymmetric Higgs force h_{17} (see Section XIII. An amplified relative strengths of forces/Hierarchy problem).

Each of the 129 particles was assumed to exist within a Planck cube although each may exist in a different size (ds) cube defined by (l_{ds}). Scattering experiments revealed quarks and leptons to be smaller than 10^{-18} meters [20]. If higher resolution scattering reveals matter particles are a different size than a Planck cube, the Planck cube used in this article must be replaced by a different size quantum cube defined by l_{ds}.

Spontaneous symmetry breaking was described as the condensation of super forces into eight permanent matter particles and their eight associated Higgs forces. Figure 13 shows an up quark particle p_{11} surrounded by quantized Higgs force particles h_{11} in two instead of three dimensions. The up quark/Higgs force are one and inseparable and modeled as an undersized porcupine with overgrown spines.

This integrated spontaneous symmetry breaking with superstring, particle creation, Higgs forces, superpartner and SM decays, neutrino oscillations, dark matter, universe expansions, dark energy, baryogenesis, and quantum gravity theories, (see Table VII).

A. Comparison between the current astrophysics spontaneous symmetry breaking and this article's description

Spontaneous symmetry breaking in our early universe was defined by Goldstone's "Mexican hat" potential with Z axis V(ϕ), X axis Re(ϕ), and Y axis Im(ϕ). The three axes were ambiguous because they were not related to our early universe's high energy particles such as the super force, up quark, and Higgs force. In his book "The Inflationary Universe," Guth amplified the Goldstone Mexican hat potential to his Fig. 8.3 Energy density of Higgs fields by defining the Z axis as Energy density, the X axis as Higgs field B, and the Y axis as Higgs field A. Guth evolved his Fig. 8.3 to his Fig. 12.1 Energy density of Higgs fields for the new inflationary theory. This Fig. 12.1 flattened the Mexican hat and combined spontaneous symmetry breaking and inflation functions [21].

Subsequently, Guth's flattened Mexican hat (Fig. 12.1) was amplified to this article's Fig. 10 Up quark baryogenesis and spontaneous symmetry breaking function and its narrative description. Guth's definitions of the three X, Y, and Z axes were amplified. Baryogenesis was added to spontaneous symmetry breaking of Fig. 10 and spontaneous symmetry breaking was separated from inflation shown in Fig. 9. The Fig. 10 ball's position before super force condensation described super force energy density allocated to up quarks/Higgs forces and after condensation described separate up quarks and Higgs forces energy densities. Also, the ball did not roll down the spontaneous symmetry breaking function into the trough as traditionally described, but rolled down the spontaneous symmetry breaking function until the Fig. 10 ball position, where it moved vertically down to its present position just over the vacuum circle for up quarks. Therefore, Guth's Fig. 12.1 (spontaneous symmetry breaking and inflation) description will be compared to this article's Fig. 10 (baryogenesis and spontaneous symmetry breaking) description, to identify their differences.

There are three related astrophysics functions: inflation, baryogenesis, and spontaneous symmetry breaking listed in their correct time sequence. In the current astrophysics literature, baryogenesis is incompletely defined. Furthermore, inflation and spontaneous symmetry breaking are frequently incorrectly combined.

Section VI. An amplified spontaneous symmetry breaking, described both baryogenesis and spontaneous symmetry breaking using Fig. 10 Up quark baryogenesis and spontaneous symmetry breaking function. Baryogenesis occurred first in time followed by spontaneous symmetry breaking. In contrast to the current astrophysics spontaneous symmetry breaking defined by Guth's last "Mexican hat" potential (Fig. 12.1), this article's Fig. 10 defined the three axes as follows. The Z axis was the super force energy density allocated to one of eight permanent matter particles and its associated Higgs force (e.g., up quark/Higgs force), the X axis was the Higgs force (h_{11}) associated with an up quark, and the Y axis was an anti-up quark Higgs force (h_{11bar}). Spontaneous symmetry breaking shown for the up quark in Fig. 10, occurred for eight permanent matter particles in sequence, at their matter creation time related to the particle's energy/mass. That is, the heaviest energy/mass permanent matter particle (assumed to be a zino or photino) occurred first in time and the lightest energy/mass particle (electron-neutrino) occurred last. The eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino) were associated with eight permanent Higgs force energies or dark energy.

Following baryogenesis but before spontaneous symmetry breaking, anti-up quarks and anti-up quark Higgs forces no longer existed. Therefore, the Y axis of Fig. 10 which represented an anti-up quark Higgs force (h_{11bar}) was no longer required to describe spontaneous symmetry breaking. If the Y axis were compressed to zero, the result was the Fig. 10 inset. Fig. 9 Single field inflation was similar to the right hand portion of the Fig. 10 inset which described spontaneous symmetry breaking. This may explain the incorrect combination of inflation and spontaneous symmetry breaking in Guth's last Fig. 12.1.

Section IV.A. Spontaneous symmetry breaking and the inflation functions, described spontaneous symmetry breaking and inflation as similar but two separate functions. During matter creation, spontaneous symmetry breaking was the condensation of super force or mother particles to eight permanent matter particles and their eight associated permanent Higgs forces. Baryogenesis was the condensation of three permanent Higgsinos and their three associated

	Matter			Force
Quarks	u up	c charm	t top	γ photon
	d down	s strange	b bottom	Z Z particle
Leptons	ν_e electon-neutrino	ν_μ muon-neutrino	ν_τ tau-neutrino	W W particle
	e electron	μ muon	τ tau	g gluon
				H Higgs force

FIG. 11. SM matter and force particles.

permanent forces (graviton, gluon, and photon). Since inflation expanded space faster than the speed of light and matter particles could not travel faster than the speed of light, if matter particles were created before or during inflation they would not be uniformly distributed in space. This is contrary to the measured homogeneous and isotropic nature of matter in our universe on a large scale (490 million light year cube). The conclusion was no matter particles were created before or during inflation. In addition, if inflation and spontaneous symmetry breaking were combined in current astrophysics descriptions, this was incorrect.

B. Fundamental SM/supersymmetry (SUSY)/super supersymmetry (SSUSY) matter and force particles

The fundamental particles counterpart of Mendeleev's Periodic Table of elements is Fig. 12 Beyond the SM physics solution.

Figure 11 shows the SM matter and force particles. There are twelve matter particles: six quarks (up, down, strange, charm, bottom, and top); and six leptons (electron, muon, tau, electron-neutrino, muon-neutrino, and tau-neutrino). The SM assumed neutrinos were massless. There are four force particles (photon, W/Z's, gluon, and Higgs if the W and Z particles are combined into W/Z's). Although the SM is the gold standard of particle physics, this figure inadequately represents our universe's matter and force particles because it: does not emphasize Higgs particles' supremacy; does not differentiate between important permanent and less important transient particles; defines only a single Higgs force; does not include the graviton; and does not include: dark matter, dark energy, supersymmetry (SUSY), and super supersymmetry (SSUSY) or 32 associated Higgs particles consisting of 17 Higgs forces and 15 Higgsinos. Furthermore, the SM inadequately described our universe during its life time because 129 matter/force particles not 16 existed during matter creation and no transient matter particles existed following the end of matter creation at t = 100 s and a temperature of 10^{10} K (See three exceptions in Section XVIII. An amplified arrow of time).

Figure 12 Beyond the SM physics solution defined 64 fundamental SM/SUSY/SSUSY matter and force particles. It amplified Fig. 11 and resolved all SM inadequacies. Figure 12 consists of a circular area surrounded by an annular area. The circular area defines 22 permanent matter and force particles. Matter and force particles are related to their associated Higgs particles via common subscripts (e.g., up quark p_{11} and associated Higgs force h_{11}, and photon p_{16} and associated Higgsino h_{16}). The outer circular area clockwise from the top consists of: atomic/subatomic matter particles (up quark p_{11}, down quark p_{10}, electron p_{12}, electron-neutrino p_{14}, muon-neutrino p_{13}, and tau-neutrino p_9) which constitute 5% of our universe's energy/mass between t = 380,000 years and 13.8 billion years; 2 of 5 dark matter particles (zino p_{31} and photino p_{32}) or approximately 13%; and the graviton p_1, gluon p_2, and photon p_{16} forces or 0%. The inner circular area clockwise from the top consists of: dark energy or the sum of eight Higgs force energies (h_{11}, h_{10}, h_{12}, h_{14}, h_{13}, h_9, h_{31}, h_{32}) associated with eight permanent matter particles (up quark p_{11}, down quark p_{10}, electron p_{12}, electron-neutrino p_{14}, muon-neutrino p_{13}, tau-neutrino p_9, zino p_{31}, and photino p_{32}) or (69%); and 3 of 5 dark matter particles or three permanent Higgsinos (h_1, h_2, h_{16}) associated with the graviton p_1, gluon p_2, and photon p_{16} or approximately 13%. The large inner circular area consists of eleven Higgs particles (eight permanent Higgs forces and three permanent Higgsinos) and emphasizes Higgs particles' supremacy because they constitute approximately 82% of our universe's energy mass.

The annular area defines 44 transient matter and force particles, all of which were eliminated by 100 s after the big bang via inflation or particle decay. The outer portion of the annular area clockwise from the top consists of: nine transient matter particles (top p_3, bottom p_4, charm p_6, strange p_7, tau p_5, muon p_8, gravitino p_{17}, gluino p_{18}, and W/Z's p_{15}) and twelve transient force particles (stop p_{19}, sbottom p_{20}, stau p_{21}, scharm p_{22}, sstrange p_{23}, smuon p_{24}, stau-sneutrino p_{25}, sdown p_{26}, sup p_{27}, selectron p_{28}, smuon-sneutrino p_{29}, and selectron-sneutrino p_{30}). The inner portion of the annular area clockwise from the top consists of: nine transient Higgs forces (h_3, h_4, h_6, h_7, h_5, h_8, h_{17}, h_{18}, and h_{15}) associated with nine transient matter particles and twelve transient Higgsinos (h_{19}, h_{20}, h_{21}, h_{22}, h_{23}, h_{24}, h_{25}, h_{26}, h_{27}, h_{28}, h_{29}, and h_{30}) associated with twelve transient force particles.

Mendeleev left gaps in his table for undetected elements, predicted properties for these elements, and provided incentives for their detection. In Fig. 12, all 64 proposed matter and force particles are identified. However only 17 have been detected, whereas the 47 which remain undetected are identified by a star following their names.

Table II Fundamental SM/supersymmetry (SUSY)/super supersymmetry (SSUSY) matter and force particles energy/mass, spin, and charge is an extension of Fig. 12 because it identifies the energy/mass, spin, and charge for each of the 64 fundamental matter and force particles shown in the figure. The first column of Table II defines particle symbol, where p_{xx} identifies one of 32 particles and h_{xx} identifies one of 32 super supersymmetric Higgs particles (force or matter particles). The second column defines particle name. The third column defines whether the particle is a matter (M) or force (F) particle. The fourth column defines whether the matter/force particle is transient (Trans) or permanent (Perm). Matter particle p_{31} wino/zinos is defined in Table II as permanent. The zinos are permanent, however, as described in Section VII. An amplified superpartner and SM decays, winos are transient supersymmetric intermediate force particles. Similarly, h_{31} Higgs force (wino/zinos) is defined in Table II as permanent. Zinos are permanent and have permanent associated Higgs forces whereas winos are transient and have transient associated Higgs forces. The fifth column defines SM, SUSY, or SSUSY matter and force particles. The first 16 rows are SM, the next 16 rows are SUSY, and the last 32 rows are SSUSY. The sixth column defines energy/mass which is described for all 16 SM particles. The only other energy/masses defined are the Higgs force h_{15} (125 GeV) associated with W/Z's and the three estimated Higgs force energies associated with the down quark, up quark, and electron as described in Section V. An amplified Higgs forces (bosons). The observation of a 125 GeV boson by the Atlas and CMS collaborations is consistent with a SM Higgs boson [22]. The seventh column defines particle spin, described for all 64 particles. The eighth column defines electric charge, described only for the 16 SM particles.

Table II can be merged into Fig. 12 if the latter is larger than the current page size figure. Each item in Fig. 12, for example the electron, would include its energy/mass, spin, and electric charge. The electron in Fig. 12 could appear as p_{12} electron followed by (0.51 MeV, ½, -1).

Table III summarizes the number of SM, SUSY, and SSUSY particles in Table II. The SM consists of 13 matter and 3 force particles. The reason for the asymmetry is W/Z's are reclassified as hybrid matter/force particles because they are primarily transient matter particles associated with transient Higgs forces but have force particle spins of 1. SUSY consists of 4 matter and 12 force particles. SSUSY consists of 15 matter and 17 force particles. The reason for the asymmetry is W/Z's are reclassified as primarily transient matter particles associated with super

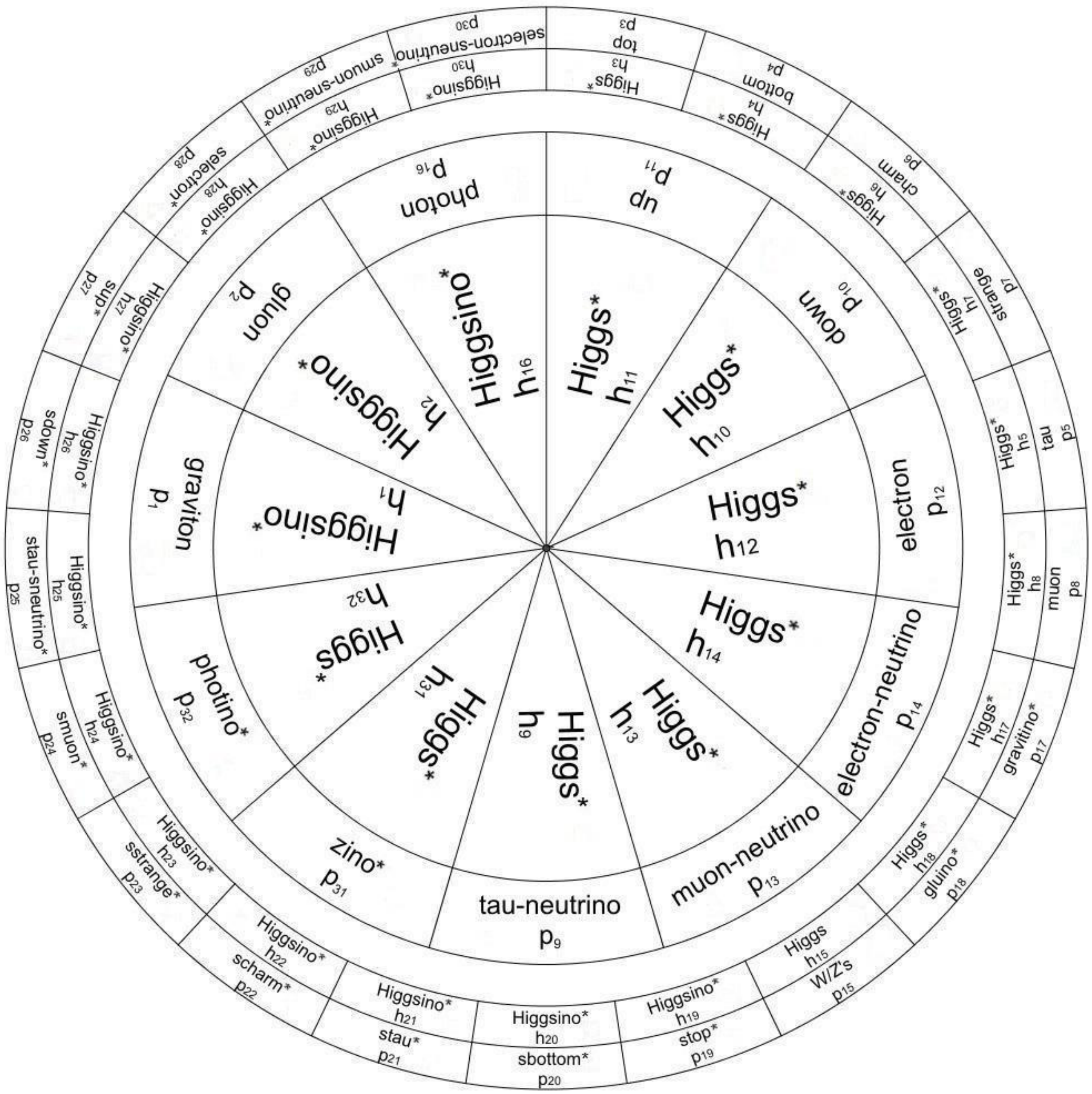


FIG. 12. Beyond the SM physics solution.

TABLE II. Fundamental SM/supersymmetry (SUSY)/super supersymmetry (SSUSY) matter and force particles energy/mass, spin, and charge.

Particle Symbol	Particle Name	Matter/ Force	Trans/ Perm	SM/SUSY/ SSUSY	Energy/mass	Spin	Electric Charge
p_1	graviton	F	P	SM	0	2	0
p_2	gluon	F	P	SM	0	1	0
p_3	top quark	M	T	SM	173 GeV	1/2	+ 2/3
p_4	bottom quark	M	T	SM	4.2 GeV	1/2	-1/3
p_5	tau	M	T	SM	1.78 GeV	1/2	-1
p_6	charm quark	M	T	SM	1.28 GeV	1/2	+ 2/3
p_7	strange quark	M	T	SM	95 MeV	1/2	-1/3
p_8	muon	M	T	SM	105.7 MeV	1/2	-1
p_9	tau-neutrino	M	P	SM	Small, non-zero	1/2	0
p_{10}	down quark	M	P	SM	4.7 MeV	1/2	-1/3
p_{11}	up quark	M	P	SM	2.2 MeV	1/2	+ 2/3
p_{12}	electron	M	P	SM	0.51 MeV	1/2	-1
p_{13}	muon-neutrino	M	P	SM	Small, non-zero	1/2	0
p_{14}	electron-neutrino	M	P	SM	Small, non-zero	1/2	0
p_{15}	W/Z's (hybrid)	M	T	SM	W 80, Z 91 GeV	1	W±1, Z 0
p_{16}	photon	F	P	SM	0	1	0
p_{17}	gravitino	M	T	SUSY		3/2	
p_{18}	gluino	M	T	SUSY		1/2	
p_{19}	stop squark	F	T	SUSY		0	
p_{20}	sbottom squark	F	T	SUSY		0	
p_{21}	stau	F	T	SUSY		0	
p_{22}	scharm squark	F	T	SUSY		0	
p_{23}	sstrange squark	F	T	SUSY		0	
p_{24}	smuon	F	T	SUSY		0	
p_{25}	stau-sneutrino	F	T	SUSY		0	
p_{26}	sdown squark	F	T	SUSY		0	
p_{27}	sup squark	F	T	SUSY		0	
p_{28}	selectron	F	T	SUSY		0	
p_{29}	smuon-sneutrino	F	T	SUSY		0	
p_{30}	selectron-sneutrino	F	T	SUSY		0	
p_{31}	wino/zinos	M	P	SUSY		1/2	
p_{32}	photino	M	P	SUSY		1/2	
h_1	Higgsino (graviton)	M	P	SSUSY		1/2	
h_2	Higgsino (gluon)	M	P	SSUSY		1/2	
h_3	Higgs force (top quark)	F	T	SSUSY		0	
h_4	Higgs force (bottom quark)	F	T	SSUSY		0	
h_5	Higgs force (tau)	F	T	SSUSY		0	
h_6	Higgs force (charm quark)	F	T	SSUSY		0	
h_7	Higgs force (strange quark)	F	T	SSUSY		0	
h_8	Higgs force (muon)	F	T	SSUSY		0	
h_9	Higgs force (tau-neutrino)	F	P	SSUSY		0	
h_{10}	Higgs force (down quark)	F	P	SSUSY	18.1 MeV	0	
h_{11}	Higgs force (up quark)	F	P	SSUSY	8.5 MeV	0	
h_{12}	Higgs force (electron)	F	P	SSUSY	2.0 MeV	0	
h_{13}	Higgs force (muon-neutrino)	F	P	SSUSY		0	
h_{14}	Higgs force (electron-	F	P	SSUSY		0	

	neutrino)						
h_{15}	Higgs force (W/Z's) (hybrid)	F	T	SSUSY	125 GeV	0	
h_{16}	Higgsino (photon)	M	P	SSUSY		1/2	
h_{17}	Higgs force (gravitino)	F	T	SSUSY		0	
h_{18}	Higgs force (gluino)	F	T	SSUSY		0	
h_{19}	Higgsino (stop squark)	M	T	SSUSY		1/2	
h_{20}	Higgsino (sbottom squark)	M	T	SSUSY		1/2	
h_{21}	Higgsino (stau)	M	T	SSUSY		1/2	
h_{22}	Higgsino (scharm squark)	M	T	SSUSY		1/2	
h_{23}	Higgsino (sstrange squark)	M	T	SSUSY		1/2	
h_{24}	Higgsino (smuon)	M	T	SSUSY		1/2	
h_{25}	Higgsino (stau-sneutrino)	M	T	SSUSY		1/2	
h_{26}	Higgsino (sdown squark)	M	T	SSUSY		1/2	
h_{27}	Higgsino (sup squark)	M	T	SSUSY		1/2	
h_{28}	Higgsino (selectron)	M	T	SSUSY		1/2	
h_{29}	Higgsino (smuon-sneutrino)	M	T	SSUSY		1/2	
h_{30}	Higgsino (selectron-sneutrino)	M	T	SSUSY		1/2	
h_{31}	Higgs force (wino/zinos)	F	P	SSUSY		0	
h_{32}	Higgs force (photino)	F	P	SSUSY		0	

TABLE III. Number of SM, SUSY, and SSUSY particles.

	Matter (M)	Force (F)	Total
SM	13	3	16
SUSY	4	12	16
SSUSY	15	17	32
Total	32	32	64

supersymmetric Higgs forces. SM/SUSY/SSUSY consists of 32 matter and 32 force particles for a total of 64 matter and force particles.

VII. AN AMPLIFIED SUPERPARTNER AND SM DECAYS

Decays are series of evaporations/condensations of matter particles/Higgs forces to and from the super force. The theory of superpartner and SM decays is amplified to include supersymmetric intermediate force particles or winos and simultaneous decay of matter particles/Higgs forces.

The heaviest matter particles condensed directly from the super force. Lighter matter particles were created primarily via a heavier particle's decay. Decays were gauge mediated where heavier matter particles/Higgs forces decayed in a cascading process to lighter energy/mass matter particles/Higgs forces and intermediate force particles. Intermediate force particles were W/Z's for SM particles and winos for supersymmetric particles. For example, in a Beta minus decay, the transient intermediate force particle W^- decayed to an electron and an anti-electron-neutrino. Similarly, the transient wino intermediate force particle decayed to SM quarks and leptons. Heavier matter particles/Higgs forces could have multiple ways of decaying, each with its own branching ratio. However, total energy/mass during the decay was conserved.

A superpartner decayed into a lower energy/mass superpartner and its intermediate force particle. The latter decayed to SM particles/Higgs forces. The decay chain ended with zinos/Higgs forces and photinos/Higgs forces of the stable Lightest Supersymmetric Particles (LSP) and SM particles/Higgs forces. Stable LSPs or lightest neutralinos also included three permanent Higgsino types. Dark matter consisted of zinos, photinos, and three permanent Higgsino types.

This integrated superpartner and SM decays with superstring, particle creation, Higgs forces, spontaneous symmetry breaking, and quantum gravity theories, (see Table VII)

VIII. AN AMPLIFIED NEUTRINO OSCILLATIONS

Neutrinos oscillated between three flavors via the seesaw model using a neutral heavy lepton (NHL). The three neutrino flavors were: electron-neutrino, muon-neutrino, and tau-neutrino. According to the seesaw model, neutrino mass was $(m_D)^2/M_{NHL}$, where m_D was the SM Dirac mass (i.e. p_{14}, p_{13}, p_9) and M_{NHL} was the neutral heavy lepton mass also referred to as a large right-handed Majorana [23]. The neutral heavy lepton appeared in some SM extensions and was assumed to be either a zino p_{31} or photino p_{32}, and a constituent of dark matter.

The future Deep Underground Neutrino Experiment (DUNE), where neutrinos shot from the Fermi National Accelerator Laboratory in Illinois to the Sanford Underground Research Facility in South Dakota, will provide information on mysterious neutrino oscillations [24]. Once neutrino mass oscillations are understood, origin of neutrino mass insight will be available to select either the Higgs mechanism as proposed in this article, or a new undiscovered mechanism.

This integrated neutrino oscillations with superstring, particle creation, spontaneous symmetry breaking, dark matter, and quantum gravity theories, (see Table VII).

IX. AN AMPLIFIED DARK MATTER

Dark matter consisted of zinos, photinos, and three Higgsino types. Dark matter agglomeration formed the framework of galaxies.

Superpartners decay into the zino and photino of the LSP and SM quarks and leptons. A prime candidate for dark matter is the LSP or neutralino which is an amalgam of the zino p_{31}, photino p_{32}, and three Higgsino types h_1, h_2, and h_{16}.

Dark matter agglomeration formed the framework of galaxies and its start time was approximately 30,000 years [25]. Following this transition, galactic regions were static whereas intergalactic regions were dynamic or expanding. Between 30,000 and 380,000 years dark matter clumped together, whereas electrically charged matter particles did not. At 380,000 years, electrically neutral atoms formed and began clumping around the dark matter framework [26].

This integrated dark matter with superstring, particle creation, Higgs forces, spontaneous symmetry breaking, neutrino oscillations, universe expansions, dark energy, cosmological constant problem, baryogenesis, and quantum gravity theories (see Table VII).

X. AN AMPLIFIED UNIVERSE EXPANSIONS

There were three sequential universe expansion periods. Entropy increase of the super force and its derivatives drove the first expansion within our universe's first Planck cube between t = 0 and $t = 5 \times 10^{-36}$ s. X bosons or inflatons' latent heat drove the second inflationary period's exponential expansion between $t = 5 \times 10^{-36}$ and $t = 10^{-33}$ s. Dark energy drove the third, our universe's expansion following the start of matter creation or after $t = 10^{-33}$ s. The product of our universe's expansion rate and the graviton's intergalactic propagation time was superstring theory's seventh extra dimension. Universe expansions theory was amplified to include expansion within our universe's first Planck cube and identification of X bosons as the latent heat source during inflation.

During the first expansion period, our universe's doughnut physical singularity at a Planck cube center at t = 0 was immediately transformed to a spherical physical singularity via Greene's conifold transition. Our universe expanded from a spherical physical singularity at t > 0 s, to a larger spherical physical singularity but smaller than a Planck cube at the start of inflation ($t = 5 \times 10^{-36}$ s). Entropy increase of the super force, gravitinos*, gravitons, 12 superpartner forces, gluinos*, gluons, and 16 associated Higgs particles drove this expansion similar to the loosening of a smaller than a Planck cube sized knot of vibrating superstrings.

During inflation, our universe expanded from a spherical physical singularity smaller than a Planck cube to an 8 m radius sphere of individual super, graviton, or gluon force particle closed superstrings by the end of inflation or 10^{-33}

s (see Fig. 6), with a temperature of approximately 10^{25} K. The second inflationary expansion period was similar to a water container freezing and bursting. More energy exists in liquid than frozen water. When water freezes, its temperature remains constant and latent heat is released. X bosons (12 superpartner forces, their 12 associated Higgsinos, and their 24 anti-particles) were the latent heat energy source during inflation.

Our universe's third expansion period occurred from 10^{-33} s to the present time. Galaxy seeds or dark matter particles were created following the start of matter creation (10^{-33} s) and actual galaxies were formed at approximately 200 million years. Dark energy (i.e., eight Higgs force energies) drove our universe's third expansion period.

Our universe's third expansion period can be represented by a marbles/dough/balloon model consisting of marbles mixed in transparent rising dough in a balloon. Space between galaxies expands whereas space within galaxies does not. The rigid marbles (galaxies) do not expand, whereas the dough (intergalactic space) and the balloon (our universe) expand.

A. Superstring theory's seventh extra dimension

Einstein's general relativity representation of static galactic squares (cubes) on a rubber fabric must transition into dynamic or expanding intergalactic squares (cubes). Newton's gravitational force equation ($F = Gm_1m_2/r^2$) is valid for galactic regions. For intergalactic regions the radius (r) must be amplified as follows. The radius (r) consists of two components $r_1 + e_rt_i$. The first constant component (r_1) is the initial radius between two masses in two galaxies at a graviton's emission time. The second variable component (e_rt_i) is our universe's expansion rate (e_r) multiplied by the graviton's intergalactic propagation time (t_i). Our universe's expansion rate (e_r) is itself a function of time because our universe decelerated during its first 8 billion years and accelerated during the last 6 billion years. The product (e_rt_i) is superstring theory's seventh extra dimension which dilutes the intergalactic gravitational force because of our universe's expansion.

This integrated universe expansions with superstring, particle creation, inflation, Higgs forces, spontaneous symmetry breaking, dark matter, dark energy, relative strengths of forces, and quantum gravity theories, (see Table VII).

XI. AN AMPLIFIED DARK ENERGY

After recombination or approximately t = 380,000 years, our universe consisted of atomic/subatomic matter (5%), cold dark matter (26%), and dark energy (69%), and those percentages remained constant for 13.8 billion years. Dark energy was the sum of eight Higgs force energies associated with eight permanent matter particles. The cosmological constant was proportional to vacuum or dark energy density. Dark energy density was the sum of eight permanent Higgs force energy densities.

By t = 100 s only 22 permanent matter and force particles remained, consisting of eight permanent matter particles/Higgs forces and three permanent Higgsinos/three SM forces. Following t = 100 s, baryonic matter was changed only by big bang, stellar, or supernova nucleosynthesis which transformed neutrons into protons and vice versa. Nucleosynthesis changed total up and down quark rest mass without changing total baryonic energy/mass. This was because only 1% of a proton/neutron's energy/mass was rest mass and 99% was nuclear binding energy. Also, nuclear binding energy was a fraction of a proton/neutron's total kinetic and potential energies. Furthermore, when a particle's rest mass was converted to energy and radiation, they were absorbed by other baryonic particles in the first particle's vicinity. By the end of recombination at approximately 380,000 years, our universe consisted of atomic/subatomic matter (5%), cold dark matter (26%), and dark energy (69%), and these percentages remained constant for 13.8 billion years (see Section XVI.A. Einstein's General Relativity). There was no quintessence or dynamic dark energy in our universe (see Section XXIV. Validation of a TOE physics solution using a two-step integrated physics/mathematics methodology, Morandi and Sun).

At t = 200 s or the start of the opaque era, our universe consisted of: eight uniformly distributed permanent matter particles or electrons, up quarks and down quarks in protons and helium nuclei, electron-neutrinos, muon-neutrinos, tau-neutrinos, zinos, and photinos; three permanent Higgsino types and their three forces (graviton, gluon, and photon); and eight permanent Higgs forces in the space between matter particles (true vacuum). Our universe's uniform 10^8 K temperature caused radiation emission/absorption between electrons, protons, and helium nuclei. At approximately 380,000 years, radiation ended and neutral atoms clumped around the dark matter framework. Galaxies formed after 200 million years and the temperature of intergalactic space decreased relative to galaxies. Dark energy was a constant for 13.8 billion years, however, as our universe expanded dark energy density decreased.

Dark energy was the sum of eight permanent Higgs force energies associated with eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino). Since the zino and photino were two dark matter particles, there was an intimate relationship between Higgs forces, dark energy, and dark matter [27]. Since the cosmological constant lambda was proportional to dark energy density, there was an intimate relationship between the cosmological constant and dark matter (see Section XXIV. Validation of a TOE physics solution using a two-step integrated physics/mathematics methodology, Edmonds et. al.).

The cosmological constant lambda (Λ) was proportional to the vacuum or dark energy density (ρ_Λ), or $\Lambda = 8\pi G\rho_\Lambda$, where G is the gravitational constant [28]. Dark energy density: was uniformly distributed in our universe; was the sum of eight permanent Higgs force energy densities, or $\rho_{\Lambda} = H_{11d}$, H_{10d}, H_{12d}, H_{31d}, H_{32d}, H_{9d}, H_{13d}, H_{14d}; and decreased with time along with the cosmological constant as our universe expanded.

This integrated dark energy with superstring, particle creation, Higgs forces, spontaneous symmetry breaking, dark matter, universe expansions, Super Universe, stellar black holes, arrow of time, cosmological constant problem, baryogenesis, and quantum gravity theories, (see Table VII).

XII. AN AMPLIFIED MESSENGER PARTICLES

Messenger particles were amplified to contain embedded clocks/computers as their operational mechanisms.

Particles are insufficient to constitute matter, glues are also required. Strong force glue (gluon) is required for nuclei. Electromagnetic force glue (photon) is required for atoms/molecules. Gravitational force glue (graviton) is required for multi-mass systems [29].

A. Gravitational/electromagnetic

The graviton/photon clock/computer calculates Newton's gravitational or Coulomb's force and provides it to the receiving particle.

Figure 13 in two instead of three dimensions, shows an up quark particle p_{11} surrounded by quantized Higgs force particles h_{11}. The up quark/Higgs force are one and inseparable and modeled as an undersized porcupine with overgrown spines. Both the undersized porcupine (up quark) and its associated Higgs force (overgrown spines) have been quantized into Planck cube closed superstrings. Radial Higgs force strength is diminished by the propagation factor $1/R^2$ where R is the distance between the up quark p_{11} in the center Planck cube and a quantized Higgs force h_{11} in another Planck cube.

Newton's gravitational force ($F = Gm_1m_2/r^2$) and Coulomb's force ($F = Cq_1q_2/r^2$) equations have the same form, where m_1 and m_2 are two masses, q_1 and q_2 are two charges, r is the distance between masses/charges, G is the gravitational constant, and C is Coulomb's constant. For Newton's gravitational force, the graviton extracts mass m_1 from the attached Higgs force particle (see h_{11} contents of Fig. 13) associated with the transmitting particle (e.g., up quark p_{11}). The Higgs force particle contents includes mass, charges, and spin of both the particle p_{11} and its associated Higgs force h_{11} (Higgs force spin = 0), and messenger particle p_1, p_2, p_{15}, p_{16} templates. For example, the p_1 template contains Newton's gravitational force equation parameters: G, m_1, m_2, t_r, t_t, and c. The graviton extracts G from the graviton p_1 template. The clock initiates at transmission time t_t and stops at reception time t_r. The computer calculates the range factor ($1/r^2$) as $1/ [(t_r – t_t) (c)]^2$. Upon graviton reception the receiving mass m_2 is extracted from the Higgs force particle associated with the receiving particle (e.g., down quark p_{10}). The graviton clock/computer calculates Newton's gravitational force and provides it to the receiving particle. The gravitational force between transmitting and receiving particles consist of a continuous series of graviton messenger particles. For Coulomb's force, the two masses m_1 and m_2 are replaced by two charges q_1 and q_2 and the Gravitational constant G is replaced by Coulomb's constant C. The above concepts for two interacting fundamental particles must be

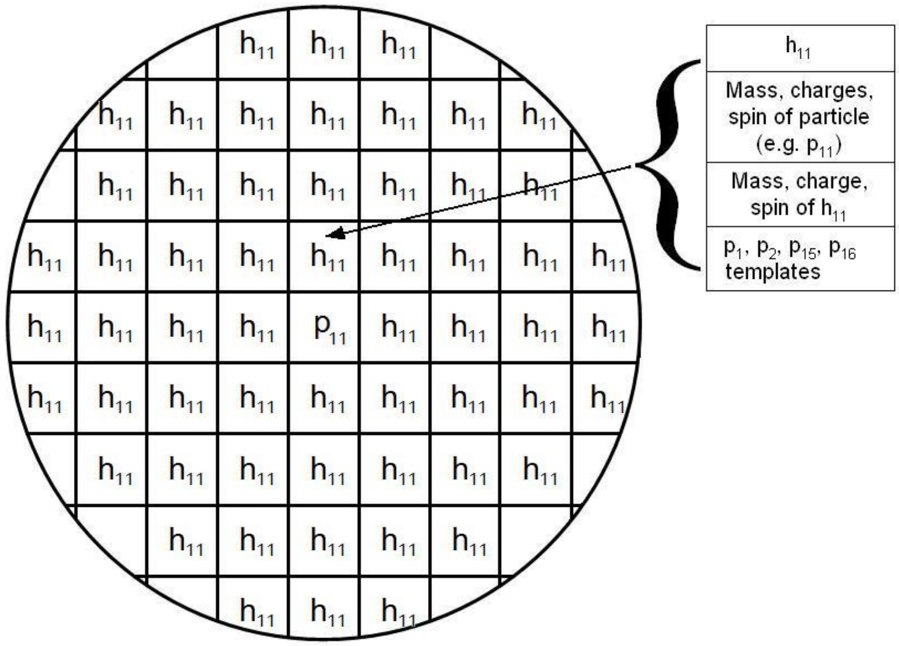


FIG. 13. Up quark with quantized Higgs force particles.

amplified to include: multiple (three or more) fundamental particles. Multiple fundamental receiving particles are differentiated from each other by the receiving fundamental particle's position (range, azimuth, elevation, and time) relative to the transmitting fundamental particle's position.

As described in Section XXII.B. Quantum gravity interpretations, the border between quantum gravity (i.e., fundamental particle superstrings in Planck cubes) and classical physics is the "independent Planck cube." Each permanent macroscopic object in our universe consists of a fixed background volume of contiguous Planck cubes containing a maximum of 22 permanent matter and force particle types. A proton is the smallest macroscopic object that behaves as a unified object of contiguous Planck cube particles instead of "independent Planck cubes" (e.g., the latter exist during the hot quark-gluon plasma or matter creation shown in Fig. 6). Therefore, protons, neutrons, atoms, molecules, stars, and galaxies are processed using the classical Newton's gravitational force equation ($F = Gm_1m_2/r^2$) where the two masses m_1 and m_2 are, for example, two proton masses and r is the distance between the two protons, Similar to multiple fundamental receiving particles, multiple receiving protons are differentiated from each other by the receiving proton's position (range, azimuth, elevation, and time) relative to the transmitting proton's position. Multiple neutrons, molecules, stars, and galaxies are processed similarly to multiple protons.

Newton's gravitational force is calculated for Higgsinos in a similar manner except the Higgsino mass and p_1 template are embedded in the Higgsinos.

B. Strong

The gluon clock/computer calculates the strong force and provides it to the receiving quark.

Quantum Chromodynamics (QCD) is strong force theory and has two major properties, confinement where the force between quarks does not diminish with separation and asymptotic freedom where the force approaches zero at short separations and quarks are free particles. Potential energy between two quarks is $V = -\alpha_s/r + kr$ and force is $F = -dV/dr = \alpha_s/r^2 - k$ where r is the range between quark masses, k is a constant, and α_s is the running or nonlinear coupling constant which decreases with separation. The force equation has two components, a Coulomb like force (α_s/r^2) and a constant force (-k). As two confined quarks separate, the gluon fields form narrow tubes of color charge, which attract the quarks as if confined by an elastic bag. For quark separations comparable to the proton's radius (10^{-15} m), the gluon clock/computer provides the constant –k force to the receiving quark. For quark separations less than a proton radius, the gluon clock/computer calculates the strong force using either the Coulomb term or a force versus range table lookup and provides it to the receiving quark [30].

C. W/Z's

The W/Z's are hybrid matter/force particles. W/Z's are transient matter particles associated with their transient Higgs forces, but with force particle spins of 1. The three W/Z's have half-lives of approximately 10^{-25} s.

D. Summary of fields

As described in Section VI.B Fundamental SM/supersymmetry (SUSY)/super supersymmetry (SSUSY) matter and force particles, there are 64 fundamental matter and force particles excluding their 64 anti-particles and the super force or mother particle. There are 22 permanent and 42 transient SM/SUSY/SSUSY matter and force particles in the Beyond the SM physics solution of Fig. 12. For simplicity, summary of fields analyzes just the permanent electron and up quark matter particles.

The electron has three permanent fields: a gravitational field (attracts other matter particles); an electric field (attracts/repels other charged particles); and a Higgs force field (provides electron's mass). Gravitational, electric, or Higgs force field strength is diminished by the propagation factor $1/R^2$ where R is the distance between the electron (p_{12}) in the center Planck cube and a quantized gravitational, electric, or Higgs force field in another Planck cube. For example, a figure called Electron with quantized photon particles or the electric field equivalent to Fig. 13 Up quark with quantized Higgs force particles can be derived as follows. In Fig. 13, the center up quark (p_{11}) is replaced with an electron (p_{12}) and all quantized Higgs force particles (h_{11}) are replaced by photons (p_{16}).

Similarly, the up quark has four permanent fields: a gravitational field; an electric field; a Higgs force field; and a strong force field.

This integrated messenger particles with superstring, Higgs forces and quantum gravity theories, (see Table VII).

TABLE IV. Relative strengths of forces.

Force	Relative Strengths
Strong	1
Electromagnetic/weak	10^{-3}
Gravitational	10^{-42}

XIII. AN AMPLIFIED RELATIVE STRENGTHS OF FORCES/HIERARCHY PROBLEM

The relative strengths of gravitational and electromagnetic/weak forces are due to propagation factor dilution ($1/r^2$) between gravitational force activation and electromagnetic/weak force creation/activation times.

There were two interpretations of the Hierarchy Problem. In the first interpretation, the Hierarchy Problem was the relative strength of the gravitation force to the electromagnetic/weak force [31]. In the second interpretation, the Hierarchy Problem was related to the ratio of W/Z mass to Planck mass [32]. Both interpretations were related but different. In the first interpretation, the relative strength of the gravitational force to the electromagnetic/weak force was 10^{-39} as shown in Table IV. This corresponded to a propagation dilution factor ($1/r^2$) of approximately half of 10^{-39} or 10^{-19}. In the second interpretation as shown in Fig. 6, the mass of the W/Z particles (approximately 10^{15} K or 10^{11} eV) relative to the Planck mass of 10^{28} eV at the Planck time was 10^{-17}. In the second interpretation although the graviton was created at the Planck time, it was not activated until condensation of its supersymmetric gravitino, assumed to be the heaviest matter particle. As described below, this occurred at the start of matter creation or $t = 10^{-33}$ s. Thus, the first interpretation was correct and the second incorrect.

The first interpretation is described as follows. Column two of Table IV shows computed relative strengths of gravitational and electromagnetic force between an electron and quark as 10^{-39}. From Fig. 8, the electromagnetic/weak force creation/activation time ($t_{w/z}$) was 10^{-12} s when our universe's radius was ($r_{w/z}$) via the right and top dashed lines. All force strengths were equal at the Planck time 5.4 x 10^{-44} s. From Fig. 6, the gravitational force or graviton was created at 5.4 x 10^{-44} s but activated at t_g in Fig. 8 when our universe's radius was (r_g). This activation occurred during condensation of the heaviest supersymmetric matter particle assumed to be the gravitino. At electromagnetic/weak force creation/activation time ($t_{w/z}$) or 10^{-12} s, the gravitational force had already been diluted by 10^{-39} or equivalently a range dilution of approximately 10^{-19}. Since energy/masses of supersymmetric particles were estimated between 100 to 1500 GeV by Snowmass [2] and W/Z's were 80 to 90 GeV, their relative energy/masses and activation times were incompatible with the required range reduction factor. Thus, the Snowmass estimates of supersymmetric particle energy/masses were too low.

From Fig. 8, the electromagnetic/weak force creation/activation time ($t_{w/z}$) was 10^{-12} s which corresponded via the right and top dashed lines to our universe's radius ($r_{w/z}$) of 10^{11} m. The gravitational force activation time (t_g) was the time required to produce a 10^{-19} range reduction factor ($r_g/r_{w/z}$). From Fig. 8, the bottom and left dashed lines related our universe's radius (r_g) or 10^{-8} m to the gravitational force activation time (t_g) of 10^{-33} s or the start of matter creation (dashed and solid lines at 10^{-33} s of Fig. 8 are actually superimposed). From Fig. 6, t_g corresponded to a gravitino energy/mass of approximately 10^{25} K or 10^{21} eV.

This integrated relative strengths of forces with superstring, particle creation, universe expansions, and quantum gravity theories, (see Table VII).

XIV. CONSERVATION OF ENERGY/MASS ACCOUNTABILITY

All 128 fundamental matter and force particle types complied with conservation of energy/mass accountability. Accountability of our universe's total 10^{54} kg of energy by the end of matter creation at t = 100 s follows.

Nine transient matter particles (top quark, bottom quark, charm quark, strange quark, tau, muon, gravitino, gluino, and W/Z's) and their nine associated transient Higgs forces for a total of 18 particles accounted for 0%. By 100 s, nine transient matter particles/Higgs forces evaporated and condensed or decayed to eight permanent matter particles/Higgs forces.

X bosons or inflatons consisted of 12 transient superpartner forces and their 12 associated transient Higgsinos for a total of 24 particles. X bosons or inflatons accounted for 0% because all their energy expanded our universe during inflation.

By the end of matter creation at t = 100 s and at a temperature of 10^{10} K, all 64 anti-particles had been eliminated either by baryogenesis or inflation (12 anti-Higgsinos and their 12 associated superpartner forces).

Subtracting the above 106 fundamental transient matter and force particles from the 128 total leaves 22 permanent matter and force particles. Three SM force particles (graviton, gluon, and photon) existed but accounted for 0% energy. That is, in transit photons contained radiation energies at t = 100 s, but these photons were assumed to contain zero energy. Transmitted radiation energies were allocated to transmitting particles until the radiation was received and then allocated to receiving particles.

Three types of matter and force particles with energy/masses remained at t = 100 s: atomic/subatomic matter, dark matter, and dark energy. However, because of significant photon radiation energy during the opaque era as described in Section XVI.A. Einstein's General Relativity, constant energy/mass percentages of atomic/subatomic, dark matter, and dark energy was defined not at t = 100 s but at approximately 380,000 years. Atomic/subatomic matter or six permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, and tau-neutrino) constituted 5% of our universe's energy/mass at approximately 380,000 years. Dark matter or the zino, photino, and three permanent Higgsino types constituted 26% of our universe's energy/mass. Dark energy or eight permanent Higgs force energies associated with eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino) constituted 69% of our universe's energy/mass [33]. These percentages remained constant for 13.8 billion years.

XV. AN AMPLIFIED SUPER UNIVERSE (MULTIVERSE)

The Super Universe of parallel universes (multiverse) consisted of nested parallel precursor universes. Precursor universes consisted of nested parallel universes. Our universe was nested in our older and larger precursor universe which was nested in the still older and larger Super Universe as shown in Fig. 16. The Super Universe was modelled as a near infinitely large gumball machine. Our universe with a radius of 46.5 billion ly was one of the gumballs and parallel universes were other gumballs with different radii. A subset of the gumballs which included our universe was our precursor universe. The entire gumball machine was the Super Universe of parallel universes.

Universal laws of physics and structure were assumed across the Super Universe. The Super Universe: had a single vacuum or dark energy density; was homogeneous and isotropic on a large scale; contained 129 fundamental matter and force superstring particle types; had eight permanent matter particles/Higgs forces; obeyed conservation of energy/mass; and had a constant dark energy to total energy/mass percentage (69%) just like our universe.

This integrated the Super Universe with superstring, dark energy, and quantum gravity theories, (see Table VII).

XVI. AN AMPLIFIED STELLAR BLACK HOLES (STARS AND GALAXIES)

Stellar black hole theory was amplified to include quark stars (matter) and black holes (energy).

Currently a stellar black hole is defined as a spacetime region where gravity is so strong not even light can escape and having no support level below neutron degeneracy pressure. The black hole spacetime region is a three dimensional sphere which appears as a two dimensional hole just as our three dimensional sun appears as a two dimensional disk. An inconsistency in black hole definitions exists. A stellar black hole contains a physical singularity having minimum area and volume whereas the same stellar black hole has maximum entropy with maximum event horizon area as defined by Bekenstein or maximum volume as defined in Section XVII. An amplified black hole entropy.

Stellar black hole theory was thus amplified to include a quark star (matter) and black hole (energy), both of which were "black." Their differences were a quark star (matter) had mass, volume, near zero temperature in accordance with the black hole temperature equation, permanence, and maximum entropy. In contrast, its associated black hole (energy) had super force energy, a minimum volume doughnut physical singularity at a Planck cube center, near infinite temperature, transientness, and minimal entropy.

Twenty two permanent fundamental matter and force particles are constituents of all objects in our universe including: all solar systems, galaxies, and permanent stellar black holes as described in Section VI.B. Fundamental SM/supersymmetry (SUSY)/super supersymmetry (SSUSY) matter and force particles. All permanent stellar black holes or quark stars (matter) consist of 22 permanent fundamental matter and force particles (see Fig. 14a), which is in sharp contrast to the unknown constituents of stellar black holes according to current astrophysics theory.

Stars are formed via molecular cloud gravitational collapse, star accretion, and star merger. Following star formation, stellar gravitational collapse occurs when internal energy is insufficient to resist the star's own gravity and is stopped by Pauli's exclusion principle degeneracy pressure. If the star's mass is less than 8 solar masses, it gravitationally collapses to a white dwarf star supported by electron degeneracy pressure. The discrepancy between the initial 8 solar masses and approximately 1.39 solar masses or Chandrasekhar limit is due to solar winds. If the star is between 8 and 20 solar masses, it gravitationally collapses to a neutron star supported by neutron degeneracy pressure with a supernova explosion. If the star is between 20 and 100 solar masses, it gravitationally collapses to a quark star (matter) supported by Planck cube matter degeneracy pressure (e.g., up quark) with a quark-nova explosion. According to Leahy and Ouyed, the quark star (matter) forms with a quark-nova's nuclear binding energy release. The delayed (10 - 40 days) secondary quark-nova explosion follows a neutron star's primary supernova explosion (see Section XXIV. Validation of a TOE physics solution using a two-step integrated physics/mathematics methodology, Leahy and Ouyed).

Six types of Super Universe stellar black holes were: supermassive quark star (matter), quark star (matter), super supermassive quark star (matter), its associated super supermassive black hole (energy), super super supermassive quark star (matter), and its associated super super supermassive black hole (energy). The first two types, supermassive quark stars (matter) and quark stars (matter) existed in universes. The second two types, super supermassive quark stars (matter) and their associated super supermassive black holes (energy) existed in precursor universes and created universes. The third two types, super super supermassive quark stars (matter) and their associated super super supermassive black holes (energy) existed in the Super Universe and created precursor universes.

TABLE V. Relationships between stellar black hole types and precursor universes, universes, and galaxies.

Stellar black hole types	Stellar black hole sizes (solar energy/mass)	Creation of precursor universes, universes, galaxies
Super super supermassive quark stars (matter)/black holes (energy)	>> 10^{24}	Precursor universes
Super supermassive quark stars (matter)/black holes (energy)	~ 10^{24}	Universes
Supermassive quark stars (matter)	10^6 – 10^{10}	Galaxies
Quark stars (matter)	Several - 10^6	Small galaxies

The first type or a supermassive quark star (matter) contains 10^6 to 10^{10} solar masses [34]. They may be "fossil quasars" with masses proportional to their host galaxies' masses. According to Carilli, galaxy to central black hole mass ratio was 30:1 in our early universe and 700:1 now [35]. Population III stars containing hydrogen, helium, and lithium first formed approximately 200 million years after the start of our universe. These first generation stars contained up to 100 times more gas than the sun, had short lives, and created over 100 billion neutron stars or quark stars (matter) with their supernova or quark-nova remnants [36]. Over the next 13.6 billion years, by accretion of stars/matter and merger with galaxies, approximately 100 billion supermassive quark stars (matter) and their 100 billion galaxies formed in our universe. That is, over the last 13.6 billion years, approximately 10^6 to 10^{10} solar masses were swallowed by these supermassive quark stars (matter). Another method, direct-collapse black holes (DCBHs) with 10^4 to 10^5 solar masses, may have formed a portion of the approximately 100 billion supermassive quark stars (matter) and their 100 billion galaxies in our universe. That is, over the last 13.6 billion years, approximately 10^2 to 10^5 solar masses were swallowed by these DCBHs. The latter were born a few hundred million years after the big bang and bypassed the optimum Eddington feeding rate for black hole growth [37].

The second type or quark star (matter) contains between several and 10^6 solar masses. Quark stars (matter) having several solar masses were initially created by first generation star collapses. Their sizes were augmented by accretion of stars/matter and merger with neutron stars or quark star (matter) galaxies during the next 13.6 billion years.

The third type or a super supermassive quark star (matter) contains approximately 10^{24} solar masses. In our precursor universe, a super supermassive quark star (matter) which consisted of a cold quark-gluon plasma [38], increased in size via accretion of stars/matter and merger with galaxies. At the 10^{24} solar mass threshold or our universe's energy/mass, Planck cube matter degeneracy pressure was insufficient to stop further gravitational collapse. The super supermassive quark star (matter) instantaneously evaporated, deflated, and gravitationally collapsed to the fourth type or its associated super supermassive black hole (energy) which created our universe's "big bang" (white hole) and a bubble of zero-point energy. A zero-point energy bubble is completely empty (i.e., a perfect vacuum) whereas a true vacuum contains dark energy or Higgs forces.

In the Super Universe, the fifth type or a super super supermassive quark star (matter) contained >> 10^{24} solar masses and instantaneously evaporated, deflated, and gravitationally collapsed to the sixth type or its associated super super supermassive black hole (energy) and created a precursor universe. Table V shows the relationships between stellar black hole types, precursor universes, universes, and galaxies.

This integrated stellar black holes with superstring, particle creation, dark energy, black hole entropy, arrow of time, cosmological constant problem, black hole information paradox, baryogenesis, and quantum gravity theories, (see Table VII).

A. Einstein's General Relativity

The Friedmann, Lemaitre, Robertson, and Walker (FLRW) metric is the accepted solution to Einstein's General Relativity equations. The three terms in Friedmann's equation are [39]:

$$\ddot{a}/a = - 4\pi G\rho/3 - 4\pi Gp + \Lambda/3 \qquad (1)$$

where a is the scale factor, G is the gravitational constant, ρ is mass density, p is pressure, and Λ is the cosmological constant. Since the radiation pressure force ended at approximately 380,000 years, the second term ($- 4\pi Gp$) is ignored after that time and the remaining terms describe two opposing forces which shape universes. The first term ($- 4\pi G\rho/3$) is the gravity/matter force and the third term ($+ \Lambda/3$) is the anti-gravity/dark energy force.

In reference to the radiation pressure force and as shown in Fig. 6, the end of nucleosynthesis at t = 200 s was followed by the opaque era (t = 200 s to approximately 380,000 years). Our universe's uniform 10^8 K temperature at t = 200 s caused radiation emission/absorption between electrons, protons, and helium nuclei. During the opaque era, our universe consisted of 22 permanent matter and force particles: eight permanent matter particles or electrons, up quarks and down quarks in protons and helium nuclei, electron-neutrinos, muon-neutrinos, tau-neutrinos, zinos, and photinos; three permanent Higgsino types and three associated forces (graviton, gluon, and photon); and eight Higgs forces in the space between matter particles (true vacuum). These 22 permanent matter and force particles consisted of atomic/subatomic matter, dark matter, and dark energy. During the opaque era and prior to 380,000 years, photon radiation having zero net energy, made our universe foggy or opaque. Recombination started at approximately t = 380,000 years when electrons, protons, and helium nuclei combined to form electrically neutral hydrogen and helium atoms. After 380,000 years, radiation ended, neutral atoms formed, and the Cosmic Microwave Background (CMB) was created and estimated to be .005% of total universe energy/mass. After 380,000 years, atomic/subatomic matter was 5%, cold dark matter was 26%, and dark energy was 69% of total universe energy/mass and those percentages remained constant for the next 13.8 billion years because there was no quintessence in our universe.

The FLRW metric had three scenarios [40]. In the first scenario, matter and dark energy forces were in close balance. From a doughnut physical singularity, a universe expanded at a decelerating rate until it reached an inflection point and then expanded at an accelerating rate. This was our universe's scenario where the inflection point was eight billion years after our universe's start. At t = 0, our universe was a doughnut physical singularity at a Planck cube center which immediately transformed to a spherical physical singularity via Greene's conifold transition. Our universe expanded from a spherical physical singularity at t > 0, to a larger spherical physical singularity but smaller than a Planck cube at the start of inflation (t = 5 x 10^{-36} s), to an 8 m radius sphere of individual super, graviton, or gluon force particle closed superstrings at the end of inflation or 10^{-33} s. This was the start of a hot quark-gluon plasma with a temperature of approximately 10^{25} K. Because of its higher energy density, the doughnut physical singularity at t = 0 s had a steeper curved spacetime than the spherical physical singularity at 5 x 10^{-36} seconds. Currently, our spherical universe has a radius of 46.5 billion light years. At t = 0, our universe was "almost flat" because it was a doughnut physical singularity but not a "flat" universe as described in the following second scenario. This first scenario (big freeze) applied to most Super Universe parallel universes because it was balanced and stable.

In the second scenario, the matter force was greater than the dark energy force. From a doughnut physical singularity, a universe expanded at a decelerating rate until it reached a maximum radius and then contracted to another doughnut physical singularity (big crunch). At its $t = 0$, that universe was a doughnut physical singularity at a Planck cube center which immediately transformed to a spherical physical singularity via Greene's conifold transition. That universe expanded from a spherical physical singularity at $t > 0$, to a larger spherical physical singularity but smaller than a Planck cube at the start of its inflation, to a sphere and the start of a hot quark-gluon plasma at the end of its inflation. At its maximum radius that universe was "flat," as it transitioned from an expanding spherical universe to a contracting spherical universe. This second scenario includes our precursor universe's final stage, where the super supermassive quark star (matter) evaporated, deflated, and gravitationally collapsed to a super supermassive black hole (energy). This created our universe's "big bang" (white hole), see Section XVIII. An amplified arrow of time. There was a difference between our "almost flat" universe in the first scenario at $t = 1$ s and the second scenario's "flat" universe as it transitioned from an expanding spherical universe to a contracting spherical universe.

In the third scenario, the dark energy force was greater than the matter force. From a nonzero radius, a universe expands at an ever increasing acceleration rate. This is the least understood of the three scenarios.

Universes were always spherical in shape in the first two scenarios except at the start or end of a universe which consisted of a super force superstring doughnut physical singularity. In the above first scenario and at $t = 0$, our universe was a doughnut physical singularity in a Planck cube. The doughnut physical singularity immediately transformed to a spherical physical singularity via Greene's conifold transition. Following this conifold transition, our expanding universe remained spherical for the next 13.8 billion years. In the above second scenario and at its $t = 0$, that universe was a doughnut physical singularity in a Planck cube. That doughnut physical singularity immediately transformed to a spherical physical singularity via Greene's conifold transition. Following this conifold transition, that universe remained spherical during its expansion and contracting phases, until it collapsed to another doughnut spherical singularity. At its maximum radius that universe was "flat," as it transitioned from an expanding spherical universe to a contracting spherical universe.

There is an intimate relationship between galaxy distance from the big bang location and the time required for the galaxy to reach that distance (see Amplified Hubble's law in Section XIX. An amplified cosmological constant problem). Because of the time varying acceleration of our universe, the relationship between distance or scale factor (a) and time (t) is a polynomial power series in time defined as the dark energy expansion equations with currently undefined coefficients b, c, d, e and f or,

Distance $\quad a = b + ct + dt^2 + et^3 + ft^4 \ldots..$ (2)

Velocity $\quad \dot{a} = c + 2dt + 3et^2 + 4ft^3 \ldots..$

Acceleration $\quad \ddot{a} = 2d + 6et + 12ft^2 \ldots..$

Two techniques for defining the dark energy expansion equations' coefficients are summarized as follows and are suggested rather than definitive techniques. The first technique uses measured galaxy positions and the Illustris N-body simulator to compute fitted galaxy distances (a) and times t (or equivalently v) to best fit the above dark energy expansion equations (2). Then the coefficients b, c, d, e and f are calculated (see Section XXIII. A TOE physics solution using a two-step integrated physics/mathematics methodology: Second mathematics step). However, this first technique is a dark energy fitting technique, rather than a dark energy predicting technique.

The second technique is a "strawman" rather than the final dark energy prediction solution. Dark energy prediction is viable but extremely difficult. Difficulties include: Number of Planck cubes in the test volume is near infinite; number of each type of 11 permanent matter particles and their spatial distributions are imprecisely known; energy/masses of five dark matter particles are unknown; and Higgs force energies associated with the zino and photino are unknown.

A test volume includes two test galaxies. There are three types of Planck cubes in the test volume. Planck cube type 1 contains one of eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino), each of which has an associated three dimensional Higgs force. The zino and photino are 2 of 5 dark matter particles. Planck cube type 2 contains one of three Higgsinos associated with the graviton, gluon, and photon. These are 3 of 5 dark matter particles which have no associated three dimensional Higgs forces. Planck cube type 3 contains superimposed Higgs force energies associated with matter particles in Planck cube type 1. Planck cube type 1 exists in stars, galaxies, filaments, and dark matter halos. Planck cube type 2 exists primarily in dark matter halos. Planck cube type 3 exists in the vacuum of space between matter particles. The two test galaxies were assumed to have three dimensional dark matter weak lensing mass maps and three dimensional galaxy mass maps. The former was created using B-mode polarization gravitational lensing by matter distribution in our universe [41]. Two types of B-mode polarization measure our universe's matter distribution and the primordial gravitational waves stretched by inflation [42].

Each Planck cube type 1 containing one of eight permanent matter particles contributes a three dimensional Higgs force energy to each Planck cube type 3. The first six permanent matter particles in Planck cube type 1 are in stars, galaxies, and filaments whereas the last two (zino and photino) are primarily in dark matter halos. First, the sum of all Higgs force energies in each Planck cube type 3 is calculated for the test volume. Then, the following are calculated for the test volume: average dark energy density (ρ_Λ); its associated cosmological constant where Λ equals $8\pi G\rho_\Lambda$; average matter density (ρ); the first gravity/matter ($- 4\pi G\rho/3$) and third anti-gravity/dark energy ($+ \Lambda/3$) terms of equation (1). Then the computed $\ddot{a}/a$ is equated to the dark energy polynomial power series equations (2) or $a = b + ct + dt^2 + et^3 + ft^4$…. and $\ddot{a} = 2d + 6et + 12ft^2$…... These calculations are repeated for different galaxy combinations in different test volumes to best fit the dark energy expansion equations (2) and define the coefficients b, c, d, e, and f.

Because this "strawman" dark energy prediction technique is viable but extremely difficult, the following should be considered.

1. Update the three dimensional dark matter weak lensing mass maps and three dimensional galaxy mass maps as resolution measurements improve
2. Eliminate contributions of distant matter particles to superimposed Higgs force energies because Higgs force strength diminishes by $1/R^2$ where R is the distance between a specific Planck cube type 1 and a specific associated Planck cube type 3
3. Disregard electron-neutrinos, muon-neutrinos, tau-neutrinos and their associated Higgs force energies in the test volume because their energy/masses and associated Higgs force energies are small. (See section V. An amplified Higgs forces (bosons) and Table II).

B. Star factor products

Because of three star factor products, only a small portion of our universe's volume (10^{-51}) contained stellar black holes. The three factor products were: stars were concentrated matter surrounded by large volumes of space (10^{-32}); only a small fraction of stars were stellar black holes (10^{-3}); and stellar black holes were compressed stars (10^{-16}). Newton's equations of motion and Cartesian Coordinates were applicable for most of our universe's volume provided the dark energy expansion equations (2) were obeyed. In those sub-volumes containing stellar black holes and only on an exception basis, Einstein's equations of General Relativity must be substituted for Newton's equations and spacetime coordinates substituted for Cartesian Coordinates.

XVII. AN AMPLIFIED BLACK HOLE ENTROPY

The proposed entropy formula for a quark star (matter) was proportional to the quark star's volume (r^3) and inversely proportional to a Planck cube's volume $(l_p)^3$.

Entropy of a black hole is currently defined as $S_{BH} = \eta A/(l_p)^2$ where η is a constant, A is the event horizon area, and l_p is the Planck length [43]. BH stands for either "black hole" or "Bekenstein-Hawking." Entropy may be intuitively proportional to the black hole's volume or r^3, even though the Bekenstein-Hawking formula which is proportional to the event horizon area or r^2, has been accepted.

A second proposed entropy formula uses Boltzmann's equation $S = k \log \Omega$, where k is Boltzmann's constant, and Ω is the total number of different ways matter particle closed superstrings can arrange themselves. A quark star (matter) contains N matter particle closed superstrings each in a Planck cube and a total of M Planck cubes containing matter or force particle closed superstrings. N ($N \sim 10^{80}$) and M ($M \sim 10^{167}$) are large and $N << M$. According to Dabholkar, the total number of ways of distributing N matter particle closed superstrings each with a volume $(l_p)^3$ within a quark star (matter) of volume $V = (4\pi r^3/3)$ is [44]:

$S = k \log \Omega$ or (3)

$\Omega = (1/N!)(V/(l_p)^3)^N$ where l_p equals Planck length or

$\Omega = (1/N!)(4\pi r^3/3(l_p)^3)^N$ where r is the quark star (matter) radius or

$S = k \log (1/N!)(4\pi r^3/3(l_p)^3)^N$ (4)

This integrated black hole entropy with superstring, particle creation, stellar black holes, arrow of time, cosmological constant problem, black hole information paradox, baryogenesis, and quantum gravity theories, (see Table VII).

XVIII. AN AMPLIFIED ARROW OF TIME

In our precursor universe and at the 10^{24} solar mass threshold, a maximum entropy super supermassive quark star (matter) instantaneously evaporated, deflated, and gravitationally collapsed to its associated minimum entropy super supermassive black hole's (energy) doughnut physical singularity, which created our universe.

In an isolated system such as our universe, the Second Law of Thermodynamics states entropy increases irreversibly with time and provides a thermodynamic arrow of time. In contrast, Einstein's Theory of General Relativity is time symmetric and apparently contradicts the Second Law of Thermodynamics. Schwarzschild's solution of Einstein's equations consists of a black hole, a white hole, and an Einstein-Rosen bridge (i.e. wormhole or doughnut physical singularity) connecting the two universes. Schwarzschild's solution is Friedmann's second scenario end state described in Section

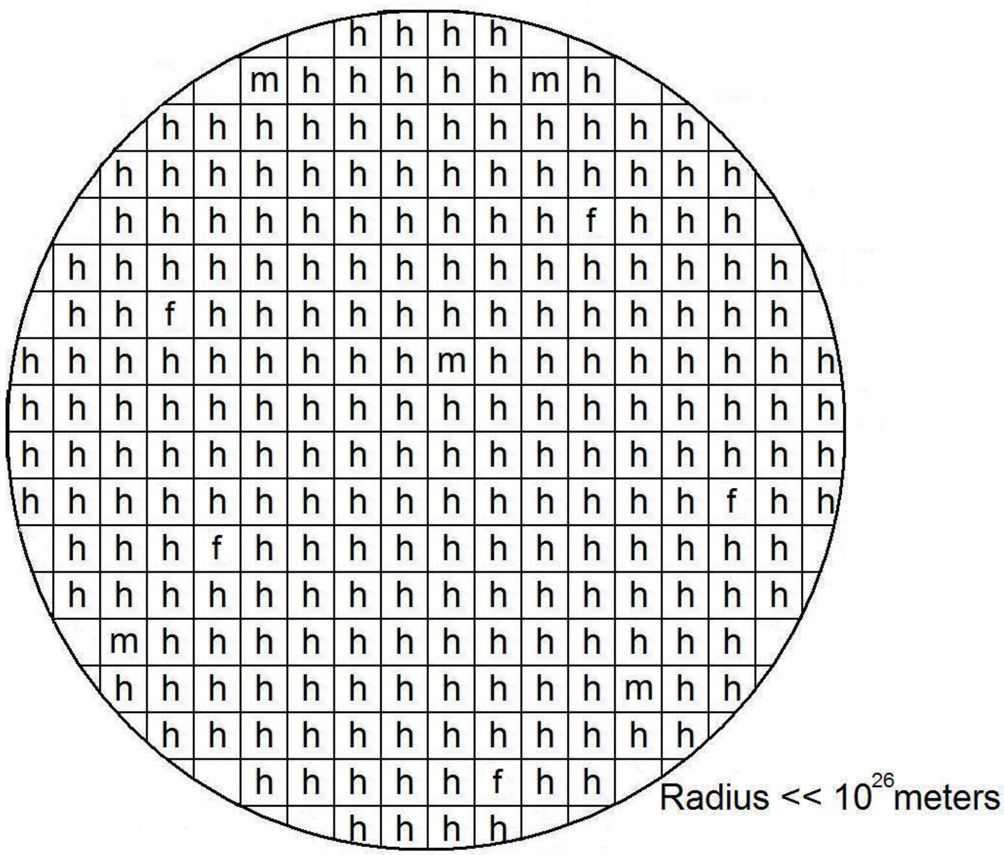
XVI.A. Einstein's General Relativity, where a super supermassive quark star (matter) gravitationally collapsed to a super supermassive black hole (energy).

During a specific time interval within a subset volume of our universe, entropy decreased without negating our universe's Second Law of Thermodynamics. A nebula's hydrogen/helium gas, dust, and plasma began ordering itself at our solar system's creation 4.6 billion years ago. Entropy decreased because life was created. Life is synonymous with low entropy or available energy and death with high entropy or unavailable energy. Since our solar system was one of approximately 100 billion Milky Way stars and our galaxy was one of approximately 100 billion galaxies in our universe, our solar system's entropy decrease did not negate our universe's entropy increase via the remaining 10^{22} stars. Similarly, entropy increased in our precursor universe whereas entropy decreased in a subset volume where a super supermassive quark star (matter) evaporated, deflated, and gravitationally collapsed to a super supermassive black hole (energy).

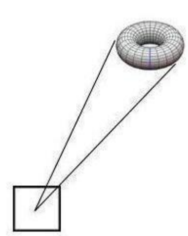
At the 10^{24} solar mass threshold, a maximum entropy super supermassive quark star (matter) instantaneously evaporated, deflated, and gravitationally collapsed to its associated minimum entropy super supermassive black hole's (energy) doughnut physical singularity shown in Fig. 14. In Fig. 14a, a matter particle is shown as an m, a Higgs force as an h, and a force particle as an f in their Planck cubes. The m represents one of eight types of permanent matter particles or one of three permanent Higgsino types and h represents superimposed Higgs forces of each permanent matter particle (eight types). The f represents one of three permanent force particles; graviton, gluon, or photon. Following the end of matter creation in our universe (approximately 100 s and 10^{10} K see Fig. 6) or in any other universe, only twenty two permanent matter and force particles remained. That is following matter creation in all universes, precursor universes, and the Super Universe, only twenty two permanent matter and force particles remained. Three exception examples were: a universe with intelligent life developing a Large Hadron Collider type device which produced extremely high temperatures required for transient matter particles like a top quark; radioactive decay where for example, beta decay transformed carbon-14 into nitrogen-14 via creation of the high temperature W^- transient matter particle; and collapse of a super supermassive quark star (matter) to a super supermassive black hole (energy) in our precursor universe.

Fig. 14a shows only the super supermassive quark star (matter) core. Outside the core, are superimposed Higgs forces of each permanent matter particle (eight types) from inside the core. These Higgs forces existed from the super supermassive quark star (matter) core's boundary to near infinity. Fig. 14a is shown in two instead of three dimensions and not to scale since Planck cubes are near infinitely small in comparison to the super supermassive quark star's (matter) radius. At approximately one second before t = 0, the super supermassive quark star (matter) swallowed an additional matter particle and the Planck cube matter degeneracy pressure threshold was exceeded. At the super supermassive quark star's (matter) center, a single electron-neutrino/Higgs force was subjected to extremely high pressure and temperature caused by matter particles above it. The electron-neutrino/Higgs force evaporated at 10^{10} K to the super force, incrementally increasing the super supermassive quark star (matter) center's temperature. A chain reaction began which instantaneously evaporated, deflated, and gravitationally collapsed the super supermassive quark star (matter) to a super supermassive black hole (energy) shown in Fig. 14b. The super supermassive black hole (energy) or super force doughnut physical singularity was a Kerr-Newman black hole.

In Fig. 14a, the super supermassive quark star (matter) existed until approximately one second before our universe's start. The Hawking temperature of the super supermassive quark star (matter) having our universe's mass $M = 10^{23}\ M_\odot$ was $T=10^{-7}\ (M_\odot /M)$ K or 10^{-30} K and its life time t was approximately $10^{66}(M/M_\odot)^3$ years, where $M_\odot$ was solar mass, and K was degrees Kelvin [45]. Since the super supermassive quark star's (matter) equation of state and cold quark-gluon plasma density were unknown, its radius was estimated as follows. Its largest radius was approximated by its Schwarzschild radius or $r_s = 2Gm/c^2 = (1.48 \times 10^{-27}$ m/kg$)\ (.31 \times 10^{54}$ kg$) \sim 5 \times 10^{26}$ m, where r_s is the Schwarzschild radius, G is the gravitational constant, c is the velocity of light, and m is our universe's mass [46]. The smallest radius



(a) Super supermassive quark star (matter) at t=-1 second



(b) Super supermassive black hole (energy) at t=0

FIG. 14. Super supermassive quark star (matter) collapse to a super supermassive black hole (energy).

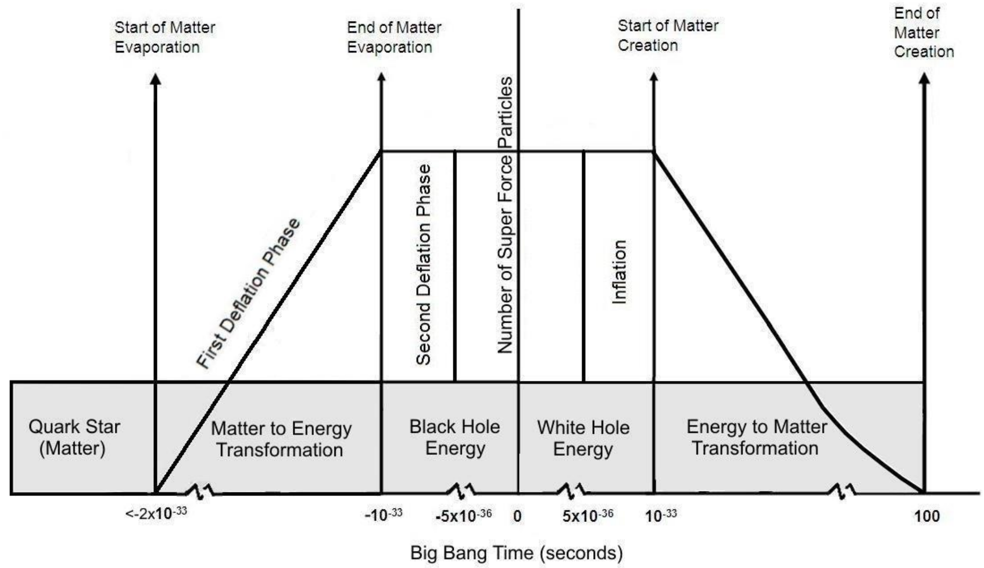


FIG. 15. Quark star/black hole to big bang (white hole) transition.

was approximated by assuming all matter particles were in contiguous Planck cubes. Since there were approximately 10^{81} matter particles in our universe, the minimum quark star volume was V = (1.6 x 10^{-35} m)^3/ (matter particle) (10^{81} matter particles) = 4 x 10^{-24} m^3, and its radius was approximately 10^{-8} m. The approximate estimated radius was between the largest (5 x 10^{26} m) and smallest (10^{-8} m) radius and shown in Fig. 14a as << 10^{26} m. This << 10^{26} m radius was approximated and visualized as a radius of 50,000 ly or the radius of our Milky Way galaxy.

Figure 15 shows our precursor universe's super supermassive quark star (matter)/black hole (energy) to our universe's big bang (white hole) transition. The right side of Fig. 15 from t = 0 to t =100 s was derived from Fig. 6 Big bang. The X axis of Fig. 15 represents big bang time in seconds plus or minus from t = 0 and the Y axis represents number of super force particles. Fig. 15 shows time symmetry between -10^{-33} and 10^{-33} s in accordance with Einstein's theory of General Relativity. At t = 0, all our universe's energy consisted of superimposed super force superstring particles in a doughnut physical singularity at the center of a Planck cube. The number of super force particles was a maximum between t = 0 and the end of inflation at t = 10^{-33} s. The start of inflation was time synchronous with the one to seven Planck cubes spherical physical singularity to individual super, graviton, or gluon force particle closed superstrings expansion described in Section III. An amplified particle creation. During inflation, the size of our universe expanded from a spherical singularity smaller than a Planck cube consisting of superimposed super force superstrings, to a sphere with a radius of 8 m consisting of individual super, graviton, or gluon force superstrings. The end of inflation was the start of matter creation and a hot quark-gluon plasma with a temperature of approximately 10^{25} K. During matter creation between 10^{-33} and 100 s and at extremely high temperatures between 10^{25} and 10^{10} K, the super force condensed to matter particles/Higgs forces. By t = 100 s: only eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino); their eight associated super supersymmetric Higgs forces; three permanent super supersymmetric Higgsino types; and their three associated SM forces (graviton, gluon, and photon) remained.

On the left side of Fig. 15, matter evaporation occurred between < -2×10^{-33} and -10^{-33} s and was the counterpart of matter creation or condensation between 10^{-33} and 100 s. Deflation differed from inflation because it consisted of two phases. During the two deflation phases, the deflation rate was assumed to be the reverse of the exponential inflation rate of 10^{36}. During the first deflation phase between < -2×10^{-33} and -10^{-33} s, the super supermassive quark star (matter) or cold quark-gluon plasma at 10^{-30} K, gravitationally collapsed to a hot quark-gluon plasma with a radius of 8 m and a temperature of approximately 10^{25} K. During the second deflation phase between -10^{-33} and -5×10^{-36} s, the super supermassive black hole (energy) deflated from an 8 m sphere of individual super, graviton, or gluon force particle closed superstrings to a spherical physical singularity. The second deflation phase was the time reverse of inflation. At -5×10^{-36} s, the super supermassive black hole (energy) or spherical physical singularity consisting of superimposed super force superstrings was identical to our universe's white hole (energy) spherical physical singularity consisting of superimposed super force superstrings at 5×10^{-36} s.

The start of matter evaporation coincided with the start of the first deflation phase at $t < -2 \times 10^{-33}$ s. Deflation of the 10^{-30} K super supermassive quark star (matter) began when its energy/mass reached the threshold of 10^{24} solar masses (10^{54} kg). A single electron-neutrino at the center of the super supermassive quark star (matter) was subjected to extremely high pressure and temperature (10^{10} K), even though the super supermassive quark star's (matter) average temperature was 10^{-30} K. This electron-neutrino/Higgs force evaporated to the super force, incrementally raising the temperature of the super supermassive quark star's (matter) center. A chain reaction began which instantaneously evaporated, deflated, and gravitationally collapsed the maximum entropy super supermassive quark star (matter) to: a hot quark-gluon plasma prior to -10^{-33} s; an 8 m sphere of individual super, graviton, or gluon force superstring particles at -10^{-33} s, or a super supermassive black hole (energy); a super supermassive black hole (energy) spherical physical singularity of superimposed super force superstrings smaller than a Planck cube at -5×10^{-36} s; and to a super supermassive black hole (energy) doughnut physical singularity at 0 s. The super supermassive black hole (energy) "resurrected" life via creation of super force particles in a subset volume of our precursor universe.

The Planck cubes in the super supermassive quark star (matter) containing the 22 permanent matter and force particles were incompressible until the super supermassive quark star's (matter) energy/mass reached the energy/mass of our universe or 10^{54} kg. At this 10^{54} kg threshold, the lightest Planck cube matter particle or electron-neutrino degeneracy pressure was exceeded and the electron-neutrino and its associated Higgs force evaporated to the super force. As the temperature of the center of the super supermassive quark star (matter) rose, each permanent matter particle (eight matter particles/eight associated Higgs forces and three Higgsinos/three associated graviton, gluon, photon forces), evaporated at 11 different temperatures.

Jeans instability formula for interstellar gas cloud collapse and star formation was directly proportional to two parameters: the gas cloud's enclosed mass and gas density. This produced a variety of star sizes. Similarly, quark star (matter) collapse size was assumed to be a function of two parameters, energy/mass and energy/mass density. For our universe's creation, the energy/mass parameter was 10^{24} solar masses and the undefined energy/mass density was $\rho_{qs,}$ If only one collapse parameter existed (e.g., energy/mass), each super supermassive quark star (matter) would collapse at 10^{24} solar masses to its associated super supermassive black hole (energy) and all created universes would be identically sized. There were combinations of energy/mass and energy/mass density parameters of super supermassive quark star (matter) collapses to associated super supermassive black holes (energy) for a variety of created universe sizes. There were also combinations of energy/mass and energy/mass density parameters of super super supermassive quark star (matter) collapses to associated super super supermassive black holes (energy) for a variety of created precursor universe sizes.

Following is a thought experiment on the creation of a variety of quark star (matter) sizes. A neutron star consisted of eight permanent matter particles: up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino and three permanent Higgsino types. For analysis simplicity, the relatively low energy/mass electron and three neutrino matter particles were ignored. The seven remaining fundamental matter particles (up quark, down quark, zino, photino, and three permanent Higgsino types) were modeled as indivisible ball bearings in Planck cubes. Protons/neutrons were modeled as basketballs. Proton basketballs contained two up quarks and one down quark whereas neutron basketballs contained one up quark and two down quarks. In the first example, the neutron star consisted entirely of proton/neutron basketballs. As the number of basketballs in the neutron star increased, the basketballs compressed until neutron degeneracy pressure was inadequate to prevent further collapse to a quark star (matter) and its quark-nova explosion. In the second example, the neutron star consisted of proton/neutron basketballs with a percentage of zinos, photinos, and three permanent Higgsino types. The presence of zinos, photinos, and three permanent Higgsino types mitigated neutron star collapse until its mass was larger than the first example. The larger the percentage of zinos, photinos, and three permanent Higgsino types relative to proton/neutron basketballs in a neutron star, the larger was the neutron star, its resultant quark star (matter), and its quark-nova explosion. In the super supermassive quark star (matter) which created our universe, 26% of its energy/mass consisted of dark matter (zinos, photinos, and three permanent Higgsino types.

The larger the quark star's mass, the lower was its temperature and longer its life time. As our precursor universe's super supermassive quark star (matter) accumulated matter, its mass and life time approached near infinite whereas its temperature approached near zero. Entropy increased proportionally to the event horizon area in the Bekenstein-Hawking formula or to quark star volume in Boltzmann's equation as described in Section XVII. An amplified black hole entropy. During the super supermassive quark star (matter) to black hole (energy) gravitational collapse; mass, life time, temperature, and entropy values flipped. Mass, life time, and entropy approached near zero whereas temperature approached near infinite. However, total energy/mass was conserved. In the maximum entropy super supermassive quark star (matter), energy/mass was spread over a near infinite number of Planck cubes. In the minimum entropy super supermassive black hole (energy), energy was concentrated in a doughnut physical singularity in a Planck cube. During the deflationary period collapse, each matter particle, its associated Higgs force, and three permanent Higgsino types with three SM forces evaporated to super force energy leaving a zero-point energy bubble in its wake. Since the super supermassive black hole's (energy) near infinite temperature (10^{94} K) was much higher than the surrounding zero-point energy's temperature of 0 K, it transitioned to the white hole and initiated our universe's thermodynamic arrow of time. Our universe was created by a 10^{54} kg (10^{24} $M_\odot$) super force doughnut physical singularity surrounded by a spherical zero-point energy bubble. This complied with Einstein's time symmetric Theory of General Relativity. In essence, the super supermassive black hole (energy) "resurrected" life via creation of "mother" super force particles in a subset volume of our precursor universe. Thus, the super supermassive quark star (matter)/black hole (energy) had a dual nature: decomposition of matter structure (information) via evaporation of eight permanent matter particles, their eight associated super supersymmetric Higgs forces, and three permanent super supersymmetric Higgsino types with three SM forces in the quark star (matter) state; and resurrection of life in the black hole (energy) state.

This integrated arrow of time with superstring, Higgs forces, dark energy, stellar black holes, black hole entropy, cosmological constant problem, black hole information paradox, baryogenesis, and quantum gravity theories, (see Table VII).

A. A new cosmology theory justification

The prevailing cosmology theory "The Ultimate Free Lunch" [47] satisfies only the third of three laws of physics and should be amplified to "A TOE physics solution using a two-step integrated physics/mathematics methodology" which satisfies all three [48].

Table VI compares the Ultimate Free Lunch theory versus A TOE physics solution using a two-step integrated physics/mathematics methodology. Three laws of physics are listed in column one, the

TABLE VI. The Ultimate Free Lunch theory versus a TOE physics solution using a two-step integrated physics/mathematics methodology.

Law	The Ultimate Free Lunch theory	A TOE physics solution using a two-step integrated physics/mathematics methodology
Conservation of Energy/Mass	violates	satisfies
Einstein's Theory of General Relativity	violates	satisfies
Second Law of Thermodynamics	satisfies	satisfies

Ultimate Free Lunch theory in column two, and a TOE physics solution in column three. The Ultimate Free Lunch theory stated the near infinite energy of our universe was created from nothing or more precisely from vacuum fluctuations. Thus, the Ultimate Free Lunch theory violated Conservation of Energy/Mass at $t = 0$. A TOE physics solution using a two-step integrated physics/mathematics methodology satisfied Conservation of Energy/Mass because the energy/mass in our precursor universe's super supermassive quark star (matter)/black hole (energy) was identical to our universe's energy.

Einstein's Theory of General Relativity is time symmetrical about $t = 0$ and consists of a black hole, a white hole, and an Einstein-Rosen bridge (i.e., a wormhole or doughnut physical singularity) connecting the two universes. The Ultimate Free Lunch theory violated Einstein's Theory of General Relativity because nothing preceded our universe. In contrast, a TOE physics solution using a two-step integrated physics/mathematics methodology included a black hole, a white hole, and a wormhole or a super force doughnut physical singularity in a Planck cube.

The Ultimate Free Lunch satisfied the Second Law of Thermodynamics because of its assumed primacy over the laws of Conservation of Energy/Mass and Einstein's Theory of General Relativity. The logic was if our universe's entropy was minimum at time $t = 0$, nothing could have preceded our big bang because entropy increases irreversibly with time. A TOE physics solution using a two-step integrated physics/mathematics methodology also satisfied the Second Law of Thermodynamics. In our precursor universe, the maximum entropy super supermassive quark star (matter) evaporated, deflated, and gravitationally collapsed to the minimum entropy super supermassive black hole (energy). The volume of our precursor universe was much larger than the volume of the super supermassive quark star (matter) so the entropy decrease in the latter did not negate the entropy increase in the former.

XIX. AN AMPLIFIED COSMOLOGICAL CONSTANT PROBLEM

Our universe was nested in our older and larger precursor universe which was nested in the still older and larger Super Universe. The cosmological constant problem existed because the Super Universe's volume was 10^{120} larger than our universe [49]. The Super Universe of parallel universes was created by time sequential and concurrent cycles of big bangs through stellar black holes. Hubble's law was not a constant but a variable in time between 200 million years and 13.8 billion years. An amplified Hubble's law existed for precursor universes within the Super Universe, universes within our precursor universe, and galaxies within universes including our universe. There were "n" time sequential precursor universes between the Super Universe and our universe. An estimate of the number of precursor universe lineal descendants was provided. Proof of the Super Universe's parallel universes was via an existing multi-wavelength technique.

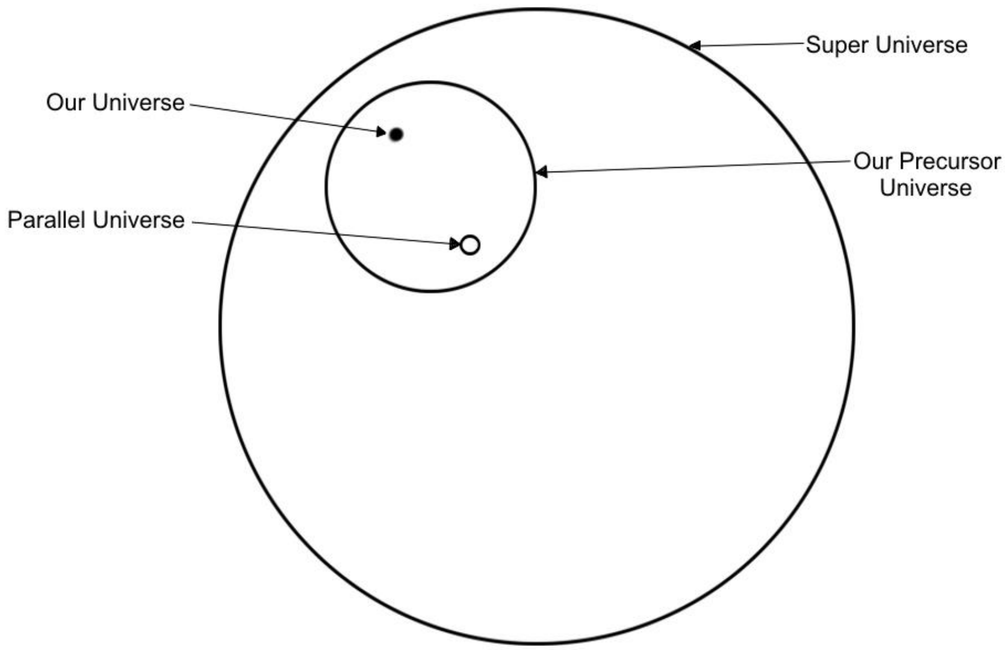


FIG. 16. Three nested universes at t = 0.

Our universe was nested in our older and larger precursor universe which was nested in the still older and larger Super Universe. Figure 16 shows three nested universes at t = 0 in two instead of three dimensions and not to scale. Our universe and a parallel universe were nested in our older precursor universe. At t = 0, our universe was a doughnut physical singularity at the center of a Planck cube. The parallel universe was of finite size and was created before t = 0. Our precursor universe was nested in the still older and larger Super Universe.

Our universe obeyed the cosmological principle, that is, the distribution of matter was homogeneous and isotropic on a large scale. In addition our universe had a center at its doughnut physical singularity location and a spherical boundary with a radius of 46.5 billion ly. Large scale was defined as a cube with a 490 million ly side according to Anderson's baryon acoustic oscillation spectroscopic survey [12]. Since dark energy (i.e., sum of eight Higgs force energies) and matter were created simultaneously and proportionally related by the constant c = .26 as described in Section V. An amplified Higgs forces (bosons), dark energy was also uniformly distributed on a large scale. Any 490 million ly cube in our universe had identical percentages of atomic/subatomic matter 5%, dark matter 26%, and dark energy 69%.

Since dark energy was a constant 69% of total Super Universe energy/mass, as the Super Universe expanded, dark energy density decreased with time. Dark energy was uniformly distributed on a large scale throughout the Super Universe, all precursor universes, and all universes including our universe. Matter and dark energy were uniformly distributed on a large but undefined scale in our precursor universe just prior to t = 0. However, matter and dark energy were not uniformly distributed on a small scale. A maximum entropy super supermassive quark star (matter) formed in one of our precursor universe's small scale volumes. At the 10^{24} solar mass threshold, it instantaneously evaporated, deflated, and gravitationally collapsed to its associated minimum entropy super supermassive black hole (energy) creating a zero-point energy bubble and our universe's "big bang" (white hole).

According to Steinhardt, the cosmological constant problem existed because the Super Universe was older than expected because of precursor cyclical universes [50]. Cyclical universes were special cases of nested universes where the collapsed volume was the total precursor universe. Steinhardt's cyclical universes were amplified to nested universes for two reasons. First, since the Super Universe was expanding and older than our universe, sufficient time was provided for the initial Super Universe dark energy density to decrease to our universe's currently observed dark energy density. Second, a dark energy reduction factor between our precursor universe and our universe was provided. Because of uniform distribution of dark energy in our precursor universe, the dark energy reduction factor was the ratio of the super supermassive quark star's (matter) volume which created our universe divided by the total precursor universe's volume.

The cosmological constant problem existed because the Super Universe was older and its volume 10^{120} larger than our universe. According to Carroll, the expected dark energy density (ρ_Λ) which was proportional to the cosmological constant (Λ), was ~ 2 x 10^{110} erg/cm^3 and the observed dark energy density was ~ 2 x 10^{-10} erg/cm^3. This produced a cosmological constant discrepancy of 10^{120} between the expected and observed values of dark energy density although Carroll states the discrepancy could be a fairer ~10^{30}. Assuming the observed dark energy density was correct, there was a disagreement between Carroll and this author on the expected dark energy density. Carroll assumed quantum theory was valid up to the Planck time (5.4 x 10^{-44} s) and the expected dark energy density was proportional to Planck time energy 10^{18} GeV or, $\rho_\Lambda \sim (10^{18}\text{ GeV})^4 \sim 2 \times 10^{110}$ erg/cm^3 [51]. Contrary to Carroll's assumptions, at the Planck time: our universe consisted of a spherical super force physical singularity smaller than a Planck cube, quantum gravity was invalid, and neither matter nor Higgs forces (dark energy) had been created. As described in Fig. 6 and Section VI. An amplified spontaneous symmetry breaking, matter/Higgs force and dark energy creation began at 10^{-33} s. Substituting the energy/mass (~10^{12} GeV) at 10^{-33} s in Carroll's formula for expected dark energy density, produced a density $\rho_\Lambda \sim (10^{12}\text{ GeV})^4 \sim 2 \times 10^{86}$ erg/cm^3 and a cosmological constant discrepancy of 10^{96}. However, Carroll's universally accepted 10^{120} factor will be used until a new factor (e.g., Carroll's 10^{30} or this author's 2 x 10^{86}) becomes accepted by the physics community.

Figure 17 shows three nested universes: the Super Universe, our precursor universe, and our universe at four sequential big bang times in two instead of three dimensions and not to scale. Super force superstring doughnut physical singularities at the center of Planck cubes existed at the start of the Super Universe, all precursor universes, and all universes including our universe. The Super Universe's big bang occurred approximately at -10^{50} years. At an arbitrary selected t = -10^{25} years, a super super supermassive black hole (energy) was created in the Super Universe preceded by its associated super super supermassive quark star (matter). By t = 0, that super super supermassive black hole (energy) expanded into our precursor universe. In our precursor universe, a super supermassive black hole (energy) was created preceded by its associated super supermassive quark star (matter). The super supermassive black hole (energy) transitioned to our big bang's white hole as described in Section XVI. An amplified stellar black holes (stars and galaxies). After 13.8 billion years of expansion, our universe exists. Figure 17 also shows our precursor universe spawned a parallel universe at a time prior to t = 0. Within our universe and the parallel universe were galaxies. Eventually, the big bang time scale of Fig. 17 where our universe's big bang occurred at t = 0, should be replaced by the Super Universe's big bang time scale where t = 0 occurred approximately 10^{50} years ago.

Since the Super Universe's volume was 10^{120} larger than our universe and spherical volumes were proportional to their radii cubed, the ratio of the Super Universe's radius R_{su} to our universe's radius R_{ou} (46.5 x 10^9 ly) was $(10^{120})^{1/3}$ or 10^{40}. The Super Universe's radius was $R_{su} = (10^{40})$ (46.5 x 10^9 ly) or

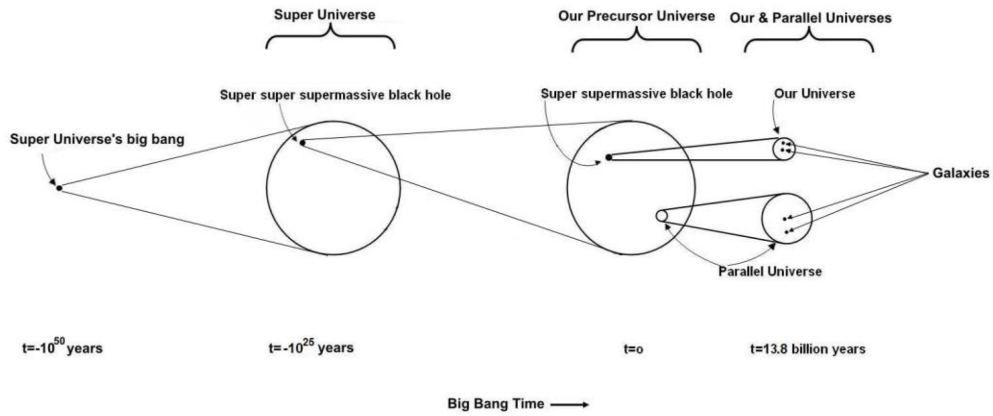


FIG. 17. Super Universe and nested universes.

approximately 10^{50} ly. Assuming equal expansion rates or our universe's radius/our universe's age = Super Universe's radius/Super Universe's age, the Super Universe's age was approximately 10^{50} years.

There were approximately 10^{120} parallel universes the size of our universe in the Super Universe. Galaxies of all parallel universes were uniformly distributed in the Super Universe on a large scale.

The Super Universe of parallel universes was created by time sequential and concurrent cycles of big bangs through stellar black holes. Three time sequential cycles are explicitly shown in Fig. 17. In the first cycle, the Super Universe's big bang created the Super Universe and at t = -10^{25} years, a super super supermassive quark star (matter). Second, the latter's associated super super supermassive black hole (energy) created our precursor universe and at t = 0, a super supermassive quark star (matter). Third, the latter's associated super supermassive black hole (energy) created our universe and by t = 13.8 billion years, supermassive quark stars (matter) existed at the center of each of our universe's galaxies. The concurrent cycles of big bangs through stellar black holes are implicit in Fig. 17. For example, at approximately t = -10^{25} years, a second super super supermassive black hole (energy) created a second parallel precursor universe and subsequently, a super supermassive quark star (matter). The latter's associated super supermassive black hole (energy) created a parallel universe in the second parallel precursor universe.

Hubble's law was not a constant but nonlinear in time or distance between 200 million years and 13.8 billion years. An amplified Hubble's law existed for precursor universes within the Super Universe, universes within our precursor universe, and galaxies within our universe as explicitly shown in Fig. 18. Implicit in Fig. 18 is amplified Hubble's laws existed for universes within all precursor universes and galaxies within all parallel universes. The X axis represents big bang time (years) or distance and the Y axis represents velocity or redshift. Traditional Hubble's Law diagrams display Δ velocity/Δ distance and are referenced from our Milky Way location with the X axis as distance. That is, velocities of galaxies measured from our Milky Way are proportional to their distances from our Milky Way. Since our universe's expansion is homogeneous and isotropic and identical from any universe point, the reference point was shifted to the universal big bang doughnut physical singularity location. In addition, the X axis was represented by time to display the accelerating nature of our universe. Fig. 18 Amplified Hubble's Law displays acceleration or Δ velocity/Δ time in contrast to traditional Hubble's law diagrams which display Δ velocity/Δ distance. For example, following t = 0 (actually 200 million years) in Fig. 18, galaxies formed and expanded from our universe's doughnut physical singularity and their velocities were proportional to their transit times from the singularity. Similarly following our precursor universe's

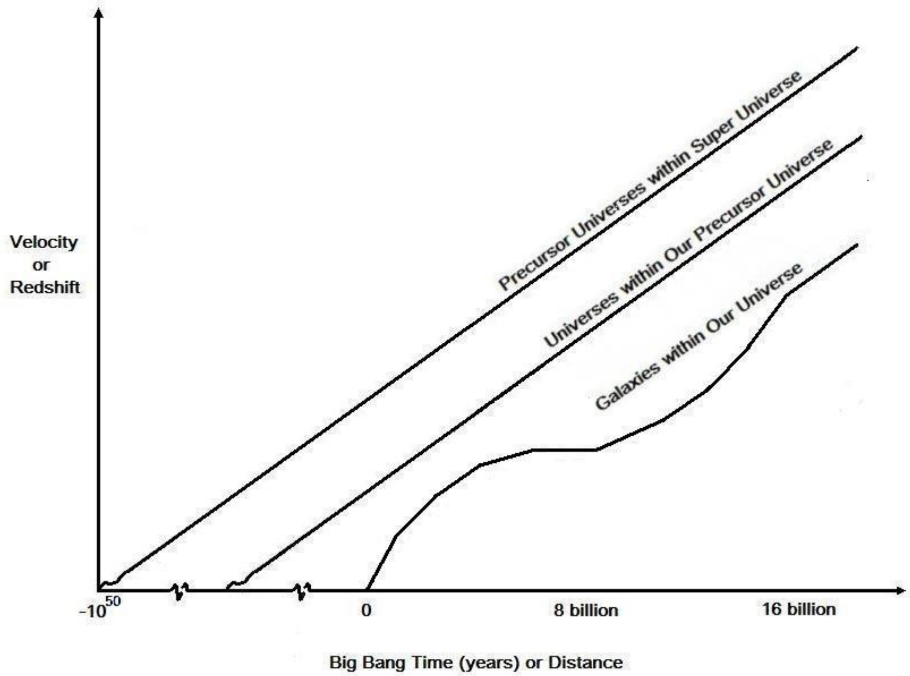


FIG. 18. Amplified Hubble's law.

undefined doughnut physical singularity time, universes formed and expanded from that singularity and their velocities were proportional to their transit times from that singularity. Following the Super Universe's doughnut physical singularity time or approximately -10^{50} years, precursor universes formed and expanded from that singularity and their velocities were proportional to their transit times from that singularity.

Our universe was created 13.8 billion years ago by a super force doughnut physical singularity surrounded by a spherical zero-point energy bubble. As shown in Fig. 18 after t = 0, our universe expanded at a decelerating rate until it reached an inflection point at t = 8 billion years and then expanded at an accelerating rate to the present t = 13.8 billion years. This is shown by the inverted S curve straight line approximations. After t = 0, the first line's slope or acceleration (Δ velocity/Δ time) is a maximum. As time increases, the slope or acceleration of the straight line segments decrease until t = 8 billion years where the slope or acceleration is zero. Following t = 8 billion years, slope or acceleration steadily increases. Galaxies within expanding parallel universes always accelerate with the exception of the inflection point where the acceleration is zero. The inverted S curve also occurred at the start of the precursor universes within the Super Universe and universes within our precursor universe as shown in Fig. 18. The amplified Hubble's law of Fig. 18 is not a constant but nonlinear with time in our universe between t = 200 million years and 13.8 billion years. Traditional Hubble's law diagrams show galaxy velocity proportional to the galaxy's distance from our Milky Way galaxy. That is, velocity divided by distance is the Hubble constant $H_0 = v/d$ where H_0 is the Hubble constant today. Substituting dark energy expansion equations (2) for velocity and distance ($v/d = c + 2dt + 3et^2 + 4ft^3 \ldots\ldots / b + ct + dt^2 + et^3 + ft^4 \ldots\ldots$) defines a nonlinear traditional Hubble's law with distance. Both the Amplified Hubble's law diagram (Δ velocity/Δ time) and the traditional Hubble's law diagram (Δ velocity/Δ distance) are nonlinear in time or distance. Thus, the 9 percent discrepancy in Hubble's constant calculated using various measurement techniques (e.g., Hubble Space Telescope, Planck spacecraft) [52], may not be caused by measurement techniques but by a nonlinear traditional Hubble's law with distance.

Currently, a zero-point energy spherical shell exists between the outer boundary of our spherical universe (46.5 billion ly radius) and the inner undefined spherical boundary of our precursor universe. As our universe accelerates, the spherical shell thickness approaches zero. Our universe's acceleration will stop increasing when our universe's outer boundary merges with our precursor universe's inner boundary. If our universe's deceleration/acceleration is assumed symmetrical, our universe will merge with our precursor universe in approximately 2.2 billion years (i.e., our universe decelerated during its first 8 billion years and accelerated during its last 5.8 billion years plus the future 2.2 billion years). Then, the acceleration of galaxies within our universe will become a constant and identical to the constant acceleration of universes within our precursor universe and precursor universes within the Super Universe. This is shown in Fig. 18 by three equal slopes or constant accelerations after t = 16 billion years.

Our universe, all universes, and all precursor universes obey the Second Law of Thermodynamics. Life exists in our solar system which is one of approximately 10^{22} stars in our universe. Our solar system has low entropy because life exists. Life is synonymous with low entropy or available energy and death with high entropy or unavailable energy. In our universe, the ratio of low entropy stars with life to high entropy stars with death is estimated as $\geq 10^{-22}$. Our universe's ratio of low entropy stars to high entropy stars is the counterpart of our precursor universe's dark energy reduction factor and the two are estimated to be equal, $\geq 10^{-22}$.

There were "n" time sequential precursor universes between the Super Universe and our universe. Figures 16 and Fig. 17 show a simplified Super Universe with only one nested precursor universe between the Super Universe and our universe. One precursor universe or two time intervals are shown in Fig. 17, and the nested precursor universe formed at an arbitrarily selected $t = -10^{25}$ years. There were realistically "n" time sequential nested precursor universes between the Super Universe and our universe. The dark energy reduction factor was a function of the number of nested precursor universes. The "straw man" number of nested precursor universes was arbitrarily selected as 4.

Figure 19 shows four nested children precursor universes at t = 0 in two instead of three dimensions and not to scale. The Super Universe is the largest circle. Children precursor universes (PU) nested in the Super Universe are PU_1, PU_2, PU_3, PU_4, PU_5, and PU_6. Subscripts identify children, grandchildren, great-grandchildren, and great-great-grandchildren precursor universes. The first subscript identifies children, the second grandchildren, the third great-grandchildren, and the fourth great-great-grandchildren precursor universes. For example, in the first child precursor universe PU_1 are three grandchildren precursor universes PU_{11}, PU_{12}, and PU_{13}. In the first grandchild precursor universe PU_{11} are three great-grandchildren precursor universes PU_{111}, PU_{112}, and PU_{113}. In the first great-grandchild precursor universe PU_{111} are three great-great-grandchildren precursor universes PU_{1111}, PU_{1112}, and PU_{1113}. In the first great-great-grandchild precursor universe P_{1111} are our universe and a parallel universe. A variety of quark stars (matter)/black holes (energy) sizes created a variety of nested precursor universe sizes shown in Fig. 19.

Amplification of Fig. 19 is required as follows. First, the figure is shown in two instead of three dimensions and not to scale since the Super Universe's volume is 10^{120} larger than our universe. Second, empty spaces do not exist in the Super Universe. For example, between the six children precursor universes (PU_1 to PU_6) matter and dark energy must be uniformly distributed on a large scale. Empty spaces in Fig. 19 must be filled with children, grandchildren, etc., precursor universes.

This integrated the cosmological constant problem with superstring, dark matter, dark energy, stellar black holes, black hole entropy, arrow of time, and quantum gravity theories, (see Table VII).

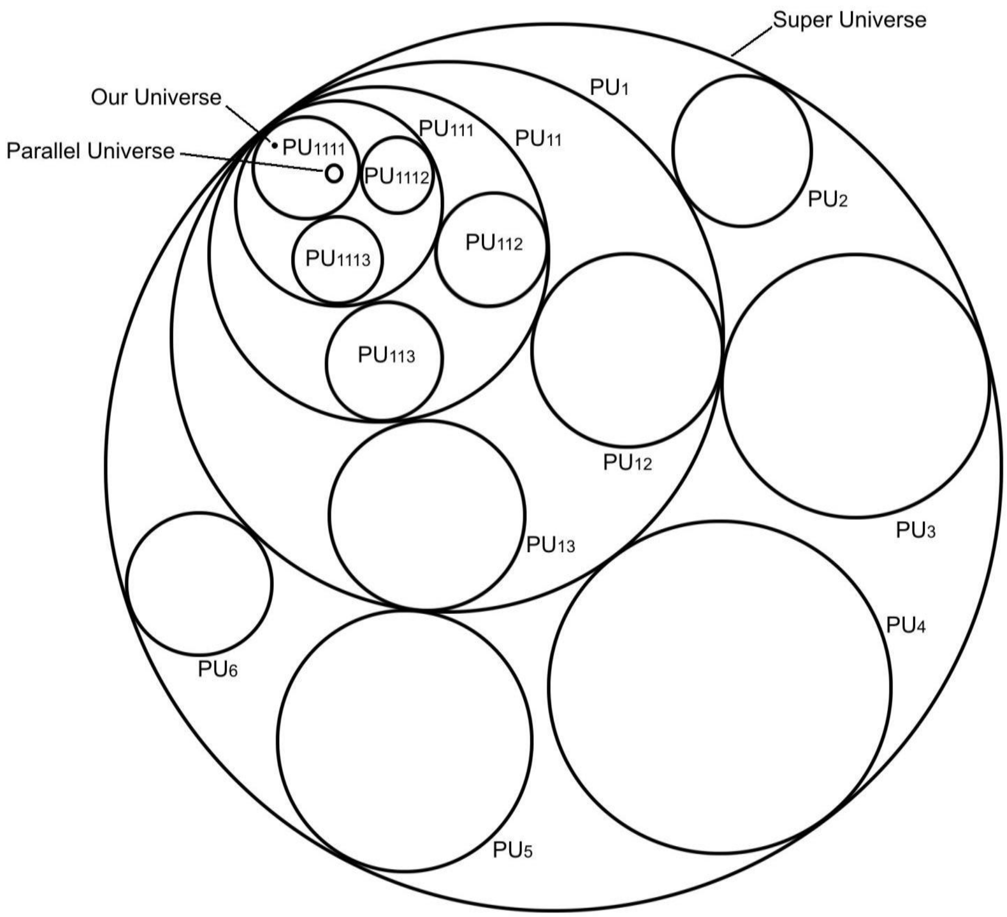


FIG. 19. Four nested children precursor universes at t = 0.

A. Proof of parallel universes

Proof of the Super Universe's parallel universes is via an existing multi-wavelength technique, the NASA/IPAC Extragalactic Database (NED). In NED, the prevalent red shifted galaxies are analyzed whereas blue shifted galaxies are ignored. Galaxies within our universe are accelerating from our universe's doughnut physical singularity origin. Since parallel universes were assumed to be formed similarly to our universe (e.g., doughnut physical singularity, inflation, particle creation, star formation, and galaxy formation), galaxies of all parallel universe are accelerating from their doughnut physical singularity origins. Parallel universes are uniformly distributed in the Super Universe between our universe's boundary (radius of 46.5 billion ly plus a zero-point energy spherical shell thickness) and the spherical Super Universe's boundary (radius of 10^{50} ly). Across the zero-point energy spherical shell is the closest galaxy of the closest parallel universe to our Milky Way galaxy. Our Milky Way galaxy is accelerating toward the closest galaxy and the latter is accelerating toward the Milky Way galaxy as described in the narrative associated with Fig. 18 Amplified Hubble's law. Since the two galaxies are accelerating towards each other, a search of blue shift galaxies is required. The blue shift galaxy radiation strength is dependent on the galaxy's size and its distance from our Milky Way galaxy. That distance is dependent on the undefined location of our Milky Way galaxy in our universe and the undefined zero-point energy spherical shell thickness. The closer our Milky Way galaxy is to our universe's boundary and the smaller the zero-point energy spherical shell thickness, the greater is the signal from the closest galaxy. The direction of the closest galaxy of the closest parallel universe from our Milky Way galaxy, is opposite to the direction to our big bang location. Existing data (e.g., NED) may already contain received blue shifted galaxies from parallel universes and should be re-analyzed.

Deceleration of our universe occurred during the first 8 billion years and acceleration during the last 5.8 billion years as shown in Fig. 18. If deceleration/acceleration of our universe is assumed symmetrical, our universe will merge with our precursor universe in approximately 2.2 billion years. If the Milky Way galaxy is at our universe's boundary, the closest galaxy of the closest parallel universe is only 2.2 billion ly away, well within the 13.2 billion light year detection range of the Hubble Ultra Deep Field telescope.

B. Comparison of three multiverse theories

The three following multiverse theories were compared and only the third selected as viable.

1. Quantum or many worlds interpretation (Everett)
2. Inflationary bubble nucleation and pocket universes (Guth)
3. Super Universe of nested universes (Colella).

First is the many worlds interpretation of H. Everett. According to Zurek, the border between quantum mechanics (gravity) and classical physics where the Schrodinger equation is not applicable, has not been defined [53]. In contrast, the many worlds interpretation or the many universes theory originated by H. Everett's in his PhD thesis under his advisor J. A. Wheeler, eliminates the border between quantum mechanics and classical physics. As described in Section XXII.B. Quantum gravity interpretations, the border between quantum mechanics and classical physics was defined as the "independent Planck cube" containing one of 22 permanent matter and force particle superstring types. That definition invalidated Everett's many worlds interpretation.

Second is Guth's inflationary bubble nucleation and pocket universes theory. His theory states the unstable false vacuum state (the energy of Higgs fields) decays similarly to boiling water. Small bubbles of matter form in the false vacuum, as bubbles of steam form in boiling water. Once a matter bubble forms, it grows immediately. At a speed approaching light, the bubble wall moves outward. The uniformity of the false vacuum is preserved if these bubbles smoothly coalesce. The large energy density of the false vacuum is released as the bubbles form and grow. The released energy is not distributed uniformly through space but concentrated in the bubble walls, which acquire more energy as the bubbles expand. Only when bubble walls collide does the energy spread uniformly through space. The collisions convert the energy to particles, which then collide with each other. Through their random motion, the particles spread to fill space uniformly. Understanding the details of the bubble wall collisions is therefore, most important. Also, the false vacuum produces an infinite number of pocket universes during our universe's inflation [54].

Three criticisms of the inflationary bubble nucleation and pocket universes theory follow. First, there were two different potential field functions for spontaneous symmetry breaking and inflation as described in Section IV.A. Spontaneous symmetry breaking and inflation functions. During inflation, no matter particles or their associated Higgs forces were created and the concept of true and false vacuum was not applicable. As described in Section VI. An amplified spontaneous symmetry breaking, matter particles and their associated Higgs forces (true vacuum state) were created simultaneously, not sequentially as suggested by Guth. Also, since inflation expanded space faster than the speed of light and matter particles could not travel faster than the speed of light, if matter particles were created during inflation they would not be uniformly distributed in space. The latter is contrary to the measured homogeneous and isotropic nature of our universe on a large scale (490 million light year cube). In contrast, Guth combines inflation and spontaneous symmetry breaking functions. For example, Fig. 10 Up quark baryogenesis and spontaneous symmetry breaking was derived from Guth's Fig. 12.1 Energy density of Higgs fields for the new inflationary theory. The latter suggests Guth's combining inflation and spontaneous symmetry breaking functions. Furthermore, as described in Section XIX. An amplified cosmological constant problem, the Super Universe of parallel universes was created by time sequential and concurrent cycles of big bangs through stellar black holes in the Super Universe and precursor universes. Parallel or pocket universes were not created during our universe's inflation as proposed by Guth.

Second, the inflation period (t = 5 x 10^{-36} to 10^{-33} s) had too high a condensation temperature for creation of SM and supersymmetric particles (see Section XIII. An amplified relative strengths of forces/Hierarchy problem). Since there was an intimate relationship between particle creation time and the particle's energy/mass or temperature, particles created during inflation would have improbable temperatures of 10^{27} to 10^{25} K or energy/masses of 10^{23} to 10^{21} eV (see Fig. 6).

Third, according to Guth, the bubble wall of normal matter moved outward at a speed approaching light which was improbable for extremely heavy matter particles with energy/masses of 10^{23} to 10^{21} eV created at high inflation temperatures of 10^{27} to 10^{25} K.

Thus, only the Super Universe of nested universes (Colella) theory described in Sections XV through XXII was selected as viable.

XX. AN AMPLIFIED BLACK HOLE INFORMATION PARADOX

Intrinsic or structural information was lost in a super supermassive quark star (matter)/black hole (energy) formation and none was emitted as Hawking radiation. In 1975, Hawking correctly stated Hawking radiation contained no information swallowed by a black hole. In 2005, his position reversed and he incorrectly stated Hawking radiation contained information. This was the black hole information paradox caused by misunderstanding of an object's intrinsic and extrinsic information.

The "No Hair" theorem states a stellar black hole (energy) has three information parameters; mass, charge, and spin, whereas our universe contains near infinite information. Any universe object's (e.g., an encyclopedia) intrinsic information at a time t consists of the contents and locations of all the object's contiguous Planck cubes. Intrinsic information consists primarily of the unique relative orientation of up quarks, down quarks, and electrons to each other or an object's molecular, atomic, nuclear, and fundamental matter (e.g., up quark) structure. In contrast, a universe object's (e.g., an encyclopedia) extrinsic information consists of its written words. For example, extrinsic information consists of English words, French words, or binary coded data. Extrinsic information is the basis of Shannon's information theory. Stellar black holes are "dumb" and can neither read nor store extrinsic information.

Each up quark, down quark, and electron resides as a closed superstring within a specific Planck cube of the encyclopedia's ink, paper, binding, etc. molecules. Encyclopedia intrinsic information is lost in four star collapse stages during decomposition of its molecules to atoms, to protons/neutrons and electrons, to up and down quarks, and to super force particles. In a white dwarf star, molecules decompose to atoms and molecular intrinsic structural information is lost. In a neutron star, atoms decompose to neutrons, protons, and electrons and atomic intrinsic structural information is lost. In a super supermassive quark star (matter), protons and neutrons decompose to up and down quarks and nuclear intrinsic structural information is lost. In a super supermassive black hole (energy), up and down quarks decompose or evaporate to super force particles and fundamental matter intrinsic structural information is lost. Intrinsic or structural information is lost in a super supermassive quark star (matter)/black hole (energy) formation and none is emitted as Hawking radiation. Hawking's 1975 solution is correct, not his 2005 solution.

The above matter decomposition description was intimately related to and the reverse of our universe's matter creation as follows. From t = 10^{-33} s and t = 100 s, matter creation was the condensation of super force particles into eight permanent matter particles/Higgs forces and three permanent

Higgsinos/associated forces (graviton, gluon, and photon). During the hadron era, up quarks and down quarks combined to form protons and neutrons. After 380,000 years, protons and helium nuclei recombined with electrons to form hydrogen and helium atoms. Hydrogen atoms combined to form hydrogen molecules. Starting at 200 million years, molecular hydrogen clouds formed stars. Stellar core and supernova nucleosynthesis primarily created Periodic Table elements above hydrogen and helium. These atoms combined to form complex molecules.

Two theories of black hole evaporation are described by Hawking: Giant black holes are stable and won't evaporate away, whereas small black holes are unstable [55]. There is agreement with Hawking for giant black holes in our universe, but not for all giant black holes in precursor universes. Giant black holes or supermassive quark stars (matter) at the centers of each of our universe's over one hundred billion galaxies have energy/masses between 10^6 to 10^{10} $M_\odot$ and are stable. However in our precursor universe and before our big bang, a maximum entropy super supermassive quark star (matter) with our universe's energy/mass (10^{24} $M_\odot$) instantaneously evaporated, deflated, and gravitationally collapsed to its associated minimum entropy super supermassive black hole's (energy) doughnut physical singularity. Permanent matter particles/Higgs forces and permanent Higgsinos/associated forces evaporation in the super supermassive quark star (matter) occurred as temperatures rose from 10^{10} to 10^{25} K. This was the reverse of permanent matter particles/Higgs forces and permanent Higgsinos/associated forces condensation in our early universe (See Fig. 15 and Section XVIII. An amplified arrow of time). There were approximately 10^{120} parallel universes in the Super Universe. Each was created by a maximum entropy super supermassive quark star's (matter) or a giant black hole's instantaneous evaporation, deflation, and gravitational collapse to its associated minimum entropy super supermassive black hole (energy), or a doughnut physical singularity.

There are also objections to Hawking's small black hole evaporation theory. One interpretation of Hawking's small black hole evaporation is quantum fluctuations cause a particle-antiparticle pair to appear at a small black hole's event horizon. One of the pair escapes whereas the second falls into the black hole. For conservation of energy/mass, the particle that fell into the black hole has negative energy and the black hole appears to emit or radiate a particle [56]. One objection to Hawking's small black hole theory is anti-particles exist only during baryogenesis in our early universe at temperatures greater than 10^{10} K. Anti-particles do not exist at Hawking undefined small black hole temperatures. A second objection is high temperatures not quantum fluctuations create particle-antiparticle pairs.

This integrated black hole information paradox with superstring, particle creation, stellar black holes, black hole entropy, arrow of time, baryogenesis, and quantum gravity theories, (see Table VII).

XXI. AN AMPLIFIED BARYOGENESIS

Charge, parity, and time (CPT) violation caused baryogenesis [57]. Baryogenesis is the asymmetric production of baryons and anti-baryons in our early universe expressed as the baryon to photon ratio $\eta = 6.1 \times 10^{-10}$. Asymmetric production of quarks and anti-quarks is more appropriate, however, since baryons and anti-baryons were defined before quarks and anti-quarks, the baryogenesis definition is retained. Big bang nucleosynthesis determined η and the Wilkinson Microwave Anisotropy Probe measured it accurately [58]. There are 44 identified baryogenesis theories [59] of which six are prominent: electroweak, GUT, quantum gravity, leptogenesis, Affleck-Dine, and CPT violation [60]. Electroweak occurs insufficiently in the SM and is considered unlikely without supersymmetry. Inflationary scenarios disfavor GUT and quantum gravity theories. Leptogenesis and Affleck-Dine are viable but not well understood. The sixth baryogenesis theory is CPT violation having three arguments which support each other and this article's conclusions.

The first argument according to T. D. Lee stated the CPT theorem was invalid at the Planck scale [61]. In this article, a Planck cube defined the quantum of matter particle, force particle, and space. Our universe originated as a super supermassive black hole (energy) or a super force doughnut physical singularity at the center of a Planck cube as described in Section II. An amplified superstring. As described in Section III. An amplified particle creation, quantum gravity theory was invalid between our universe's origin at t = 0 s and the start of inflation at t = 5 x 10^{-36} s because our universe was smaller than a Planck cube quantum. For example during that time interval, our universe was a spherical physical singularity centered in a Planck cube. Therefore, T. D. Lee's argument that the CPT theorem was invalid at the Planck scale or 5.4 x 10^{-44} s must be amplified to 5 x 10^{-36} s, to be in agreement with the following two other arguments and this article.

The second argument according to N. E. Mavromatos [62] is in the CPT theorem, laws of physics are unchanged by combined CPT operations provided locality, unitarity (sum of all possible outcomes of any event is one), and Lorentz invariance are respected. Highly curved spacetimes such as a super supermassive black hole (energy) or a spherical physical singularity violate CPT because of apparent violations of unitarity caused by incoming matter information disappearance. From Section XX. An amplified black hole information paradox's conclusion, incoming matter information is lost in the gravitational collapse of a super supermassive quark star (matter) to a super supermassive black hole (energy) in agreement with Mavromatos. As described in Section XVIII. An amplified arrow of time and shown in Fig. 15, a super supermassive black hole (energy) or spherical physical singularity first existed at t = -5 x 10^{-36} s, or before the big bang at t = 0. Its super supermassive white hole (energy) counterpart or spherical physical singularity last existed at t = 5 x 10^{-36} s, after the big bang at t = 0.

The third argument according to F. Hulpke [63] was a quantum gravity theory axiom stated the transformation from one state to another respected unitarity and entropy preservation. According to Section XVIII. An amplified arrow of time, the maximum entropy super supermassive quark star (matter) evaporated, deflated, and gravitationally collapsed to its associated minimum entropy super supermassive black hole (energy). Entropy was reset to a minimum as the super supermassive black hole (energy) "resurrected" life via creation of super force particles. During the collapse, energy/mass quanta in Planck cubes gravitationally collapsed to a super force spherical physical singularity in a volume smaller than a Planck cube quantum. During the collapse, quantum gravity theory was invalid and both unitarity and entropy preservation were not respected in agreement with Hulpke.

All of the three above baryogenesis arguments support each other and this article's conclusion. CPT, unitarity, and entropy preservation were violated in the highly curved spacetimes of both our precursor universe's super supermassive black hole (energy) and its symmetric big bang super supermassive white hole (energy) counterpart. The evaporation of permanent matter particles/Higgs forces and permanent Higgsinos/associated forces to super force particles and the condensation of super force particles to permanent matter particles/Higgs forces and permanent Higgsinos/associated forces violated CPT. This provided sufficient CPT violations to produce our universe's baryon to photon ratio of 6.1 x 10^{-10}.

This integrated baryogenesis with superstring, particle creation, Higgs forces, spontaneous symmetry breaking, dark matter, dark energy, stellar black holes, black hole entropy, arrow of time, black hole information paradox, and quantum gravity theories, (see Table VII).

XXII. AN AMPLIFIED QUANTUM GRAVITY

Superstring theory and a TOE solution as described in this article are identical to quantum gravity, or quantum mechanics with an included graviton. This is because all three unify all known physical phenomena from the near infinitely small Planck cube scale (quantum gravity) to the near infinitely large Super Universe scale (Einstein's General Relativity).

All 129 matter and force particles exist as closed superstrings and reside within our universe's fundamental building block, the Planck cube. Since the Planck cube is the quantum or unit of matter particles, force particles, and space, its actions are described by quantum gravity. In contrast, physical singularities of extremely massive collapsed stars are only described by Einstein's law of General

Relativity. These extremely massive collapsed stars include: super supermassive black holes (energy) which created universes, super super supermassive black holes (energy) which created precursor universes, and the super super super supermassive black hole (energy) which created the Super Universe.

Superstring theory defined each of 129 transient and permanent fundamental matter and force particle types or 22 permanent fundamental matter and force particle types as a closed superstring in a Planck cube. Any object in the Super Universe was defined by a fixed background volume of contiguous Planck cubes containing these fundamental matter or force particle superstrings [e.g., Fig. 4 Our universe's IfQ concept and the super supermassive quark star (matter) of Fig. 14a]. Figure 14a exemplified a TOE physics solution using a two-step integrated physics/mathematics methodology because it unified quantum gravity of the near infinitely small Planck cube scale (e.g., fundamental matter and force superstring particles in Planck cubes) with Einstein's General Relativity of the near infinitely large super supermassive quark star (matter).

This integrated quantum gravity with all other nineteen theories in an Integrated TOE, (see Table VII).

A. Singularity characteristics

This section describes: Definitions of singularities, four spacetime examples in a fixed background volume of contiguous Planck cubes, a singularity's laws of physics, the quantum gravity/general relativity boundary, and a contrast with Hawking's quantum gravity theory.

As described in Section XVI.A. Einstein's General Relativity, the FLRW metric defines a physical singularity and that definition is consistent with Section III. An amplified particle creation. Specifically, both the first and second FLRW scenario solutions begin with physical singularities. The Schwarzschild radius r_s is defined as $r_s = 2GM/c^2$ where G is the gravitational constant, M is mass, and c is the velocity of light. If an object radius is smaller than its Schwarzschild radius, the object is a black hole and the surface at the Schwarzschild radius is the event horizon. If the Schwarzschild's radius is inserted in Einstein's equations, a mathematical singularity is produced. However, mathematical singularities have no physical significance and a mathematical singularity is different than a physical singularity. Both a super supermassive quark star (matter) and its associated super supermassive black hole (energy) have identical mathematical singularities and event horizons because both stellar black hole types have identical energy/masses. A super supermassive black hole's (energy) doughnut physical singularity of superimposed super force particles existed at the center of a Planck cube at the beginning of our universe (See Fig. 14b). Only a super supermassive black hole (energy), not its associated super supermassive quark star (matter), had a doughnut physical singularity. The "No Hair" theorem with three information parameters of mass, charge, and spin was applicable only to a super supermassive black hole (energy), not to its associated super supermassive quark star (matter).

Figure 14a shows a super supermassive quark star (matter) approximately one second before t = 0, containing 22 permanent matter and force superstring particle types in Planck cubes. A matter particle is shown as an m, a Higgs force as an h, and a force particle as an f in their Planck cubes. The m represents one of eight types of permanent matter particles or three permanent Higgsino types and h represents superimposed Higgs forces of each permanent matter particle (eight types). The f represents one of three permanent force particles graviton, gluon, or photon.

A proposed three dimensional spacetime model is defined by the relative number of matter (m) to Higgs force (h) particles or the number of super force particles (s) in a fixed background volume of contiguous Planck cubes. This is proposed because a three dimensional spacetime model does not currently exist. However, a two dimensional spacetime model is illustrated by fixed Planck squares on a two dimensional (x, y) rubber fabric which sags in the z direction under a lead ball weight representing, for example, a super supermassive quark star (matter).

Following are four spacetime examples, each of which exists in a fixed background volume of contiguous Planck cubes. Both curved and flat spacetimes are defined by the relative number of matter (m) to Higgs force (h) particles or the number of super force particles (s). The first example (high curved spacetime), is the super supermassive quark star (matter) in our precursor universe of Fig.14a, where each of 22 permanent matter and force particles exists as a closed superstring in a Planck cube. The number of m particles is relatively high in comparison to h particles. This is because in the spherical volume of the super supermassive quark star (matter), matter particles have been compacted into a volume inside the event horizon. Second (low curved spacetime), if a star sized spherical volume of contiguous Planck cubes was centered and enclosed a Milky Way galaxy star, the relative number of m particles to h particles would be relatively low because the star was not compacted. Third (flat spacetime), if a star sized spherical volume of contiguous Planck cubes was centered about a point in the vacuum of intergalactic space, the relative number of m particles to h particles would be near zero. The fourth example (very high curved spacetime), is the super supermassive black hole's (energy) of Fig. 14b which was a physical doughnut singularity consisting of superimposed super force particles at the center of a single Planck cube. To differentiate between variations in super supermassive black holes' (energies), an energy (e.g. 10^{24} $M_{\odot}$) could be included in the specific Planck cube containing the super force singularity of our universe or, for example, 10^{30} $M_{\odot}$ for a larger parallel universe's singularity.

Inside the super supermassive quark star's (matter) core of Fig. 14a, laws of physics involving the 11 matter and 11 force particles were applicable, for example, Newton's gravitational and Coulomb's force equations. An interpretation of Kepler's equivalency principle was two stones near each other on a frictionless earth surface would meet because of Newton's gravitational force. Similarly, an up and down quark on a frictionless super supermassive quark star's (matter) surface would be gravitationally attracted to each other.

Gravity's source is mass for Newtonian gravity and energy/mass curvature of spacetime (e/m_{cs}) for Einstein's General Relativity, where e/m is energy/mass and cs is curvature of spacetime. For example, the curvature of spacetime of a super supermassive quark star (matter) and a super supermassive black hole (energy) are equivalent to an energy/mass e/m_{cs}. Neither of the two can emit photons or gravitons because both are stellar black holes. However, a super supermassive quark star (matter) does attract particles (e.g., an electron) outside its core. The curvature of spacetime equivalently transmits gravitons to the electron. This is visualized by replacing the curvature of spacetime by an energy/mass e/m_{cs} which transmits gravitons similarly to those described in Section XII.A. Gravitational/electromagnetic between two fundamental particles the up quark and down quark. The greater the super supermassive quark star's (matter) energy/mass, the greater its curvature of its spacetime, and the greater its e/m_{cs}. Similarly, the greater the super supermassive black hole (energy), the greater its curvature of its spacetime, and the greater its e/m_{cs}.

The energy/mass of a super supermassive quark star (matter) is identical to its associated super supermassive black hole (energy). Since a super supermassive black hole (energy) has all its energy in a physical doughnut singularity at the center of a Planck cube, its curvature of spacetime (e/m_{cs}) is much greater than that of its associated super supermassive quark star (matter) because the latter's energy/mass was distributed in a volume inside the event horizon. However, from the left side of Fig. 15, the transient super supermassive black hole (energy) existed for only 10^{-33} s.

Figure 14b shows a super supermassive black hole (energy) at t = 0, or a super force doughnut physical singularity, or a Kerr-Newman black hole. The energy of the physical singularity was 10^{90} eV or 10^{62} greater than the Planck energy of 10^{28} eV at the Planck time of 5.4×10^{-44} s. In the physical singularity, a limited number of the laws of physics are applicable. Since the super supermassive black hole (energy) contained only super force superstrings, laws of physics involving matter and other force particles are not applicable, for example, Newton's gravitational force and Coulomb's force equations. One law which is applicable is the Conservation of Energy/Mass between the super supermassive quark star (matter) and its associated super supermassive black hole (energy).

The quantum gravity/general relativity boundary was the start of inflation at t = 5 x 10^{-36} s where our universe was a spherical physical singularity inside a Planck cube. General relativity was applicable for all times in our universe between t = 0 and t = 13.8 billion years, whereas quantum gravity theory was applicable for all times except between 0 and 5 x 10^{-36} s. Figure 6 illustrated general relativity and quantum gravity theory applicability. At t = 0, our universe was a doughnut physical singularity at a Planck cube center. At the beginning of inflation or 5 x 10^{-36} s, our universe was a spherical physical singularity smaller than a Planck cube. Between 0 and 5 x 10^{-36} s, quantum gravity was not applicable because our universe was a singularity smaller than the Planck cube quantum.

The above is in contrast to Hawking's theory that: No singularity existed at the beginning of our universe, all known laws of physics break down at the singularity, and the singularity can disappear because of the imaginary time of a quantum theory for the start of our universe [64]. Hawking initially believed in singularities (e.g., singularity theorems), however he subsequently replaced them with a quantum theory.

In summary, our universe originated from a physical singularity and not from Hawking's quantum gravity theory. Both the first and second FLRW scenario solutions defined physical singularities and a physical singularity was consistent with Section III. An amplified particle creation. Mathematical and physical singularities were defined. In the physical singularity, a limited number of the laws of physics were applicable. Four spacetime examples in a fixed background volume of contiguous Planck cubes were described. The quantum gravity/general relativity boundary was the start of inflation at t = 5 x 10^{-36} s where our universe was a spherical physical singularity inside and smaller than a Planck cube.

B. Quantum gravity interpretations

Quantum gravity (mechanics), the most controversial of a Two-Step Integrated TOE's 20 theories, required interpretations. Einstein was dissatisfied with quantum mechanics "God does not play dice with the universe" and Feynman said "Nobody understands quantum mechanics" [65]. These dissatisfactions require interpretations of:

1. Double-slit experiments
2. Quantum fluctuations
3. Schrodinger's wave functions
4. Entanglement.

Each of 129 fundamental matter and force particle types exists as a unique closed superstring in a Planck cube as described in Section II. An amplified superstring. Currently, measurements are not possible at the Planck scale (Planck length 1.6 x 10^{-35} m and Planck time 5.4 x 10^{-44} s). Thus, there is an inability to either produce or measure a single photon. A single photon, or an indivisible fundamental particle in a Planck cube, directed towards a double slit will go through a single slit with no interference pattern. A stream of single photons directed towards a double slit will go through both slits and produce an interference pattern. Single photon sources in the literature do not function as described. These single photon sources are light pulses with picoseconds resolution which produce streams of photons, not a single photon in a Planck cube [66]. Similarly, single electron sources produce streams of electrons, not a single electron in a Planck cube.

Quantum fluctuations are jitter caused by the uncertainty principle of a dynamic point particle's position and momentum in a Planck cube. The 129 fundamental matter and force particle types are equivalently represented as dynamic point particles, unique closed superstrings, or Calabi-Yau membranes (clouds) in Planck cubes. For example, an electron's dynamic point particle positions are periodic points along the electron's closed superstring as shown in Fig. 2 and described in Section II. An amplified superstring and Section II.A. Universal rectangular coordinate system. That is, each point along the electron's closed superstring jitters in position and momentum according to the uncertainty principle

$\Delta y \Delta p_y \geq h/4\pi$ [67] to produce the vibrating superstring shown as the closed dashed line superstring of Fig. 2.

Quantum fluctuations also apply to quantum field theory (e.g., an electron's electric field). The electron's electric field radiates outward from the electron and its strength is diminished by the propagation factor $1/R^2$ where R is the distance between the electron position in a Planck cube and a point in the electric field as described in Section XII.D. Summary of fields. There are two dynamic motions of this electric field. In the first dynamic motion, the electric field moves in an oscillatory pattern in space as the instantaneous electron position moves along the electron superstring, for example, from the right side of the Planck cube to the left side. The maximum deviation of this oscillatory electric field is a Planck length. The second dynamic motion is the instantaneous electron position which jitters in synchronism with the electric field jitters in space. The second dynamic motion modulates the first dynamic motion.

There were 22 permanent matter and force closed superstring particles in our universe following the end of matter creation at t = 100 s. There were three types of Planck cubes following galaxy formation. Planck cube type 1 contained one of eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino), each of which had an associated three dimensional Higgs force. The zino and photino were 2 of 5 dark matter particles. Planck cube type 2 contained one of three Higgsinos associated with the graviton, gluon, and photon. These were 3 of 5 dark matter particles which had no associated three dimensional Higgs forces. Planck cube type 3 contained superimposed Higgs forces associated with Planck cube type 1 (see Section XVI.A. Einstein's General Relativity). Quantum fluctuations occurred in all 129 fundamental matter and force particles including all 22 permanent matter and force particles.

Schrodinger equations are applicable for each of the 129 fundamental matter and force particle types (e.g., Higgs force, electron, etc.). Schrodinger equations are wave functions or particle probability magnitude (more precisely the square of the magnitude). The probability of finding a particle (e.g., electron) is greater where the wave function is large than where the wave function is small [68].

Figure 20 shows the Schrodinger wave function for a "theoretical" zero mass, zero spin particle. The particle is "theoretical" because none of the 129 fundamental matter and force particles have both zero mass and zero spin. The "theoretical" particle is represented by a dynamic point particle with amplitude normalized to 1 along the Planck cube's x_p axis. This is equivalent to a constant radius superstring like the graviton in Fig. 1a, with no hills and valleys (zero mass) but no spin (graviton has a spin 2). The wave function without quantum fluctuations or the most likely "theoretical" particle position, is a 1 on the Planck cube's x_p axis with azimuth and elevation angles both zero. Zero spin means the wave function does not spin in either azimuth (rotation around the z_p axis) or elevation angles (rotation around the y_p axis). Thus, the most likely "theoretical" particle position without quantum fluctuations is a point with a radius = 1, azimuth = 0, elevation = 0. Quantum fluctuations modulate the most likely "theoretical" particle position by (Δ x, Δ y, Δ z, Δv_x, Δv_y, Δv_z) or equivalently, its spherical coordinate counterparts (e.g., Δ range, Δ azimuth, Δ elevation, etc.), to produce the Figure 20 Schrodinger wave function for a "theoretical" zero mass, zero spin particle.

The Schrodinger wave function probability distribution for each of 129 fundamental matter and force particles are dependent on particle:

1. Spin
2. Energy/mass.

First, for a spin 1 particle with 0 mass (e.g., photon), the wave function (Fig. 20) spins in azimuth angle around the z_p axis. For a spin 2 particle with zero mass (e.g., graviton), the wave function spins twice as fast as a spin 1 particle.

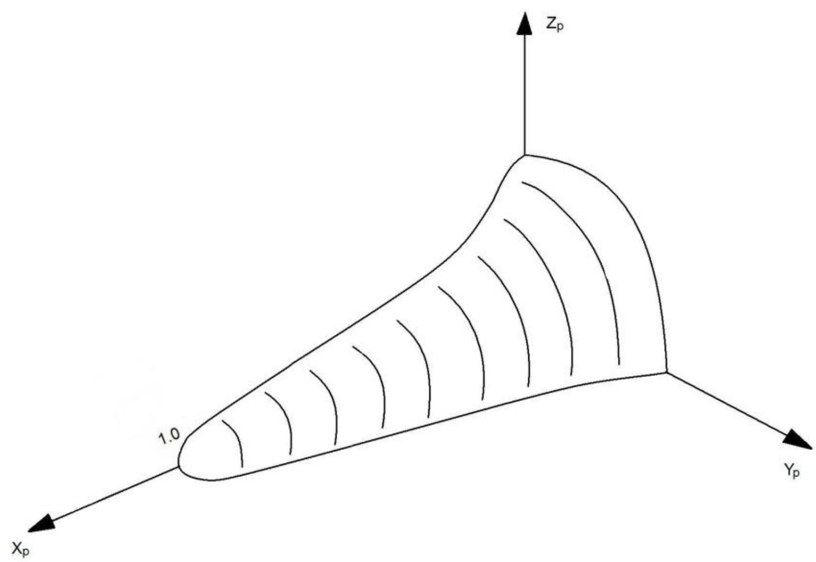


FIG. 20. Schrodinger wave function for a “theoretical” zero mass, zero spin particle.

Second, the wave function is dependent on particle energy/mass. Figure 21 shows the Schrodinger wave function for a Higgs force 125 GeV, zero spin particle. A Higgs force is a superstring with periodic hills and valleys where the unknown amplitude of the hills and valleys was arbitrarily selected as plus or minus .1 from the zero energy normalized value of 1. Two wave functions are shown in the top and bottom portions of Fig. 21, which define the maximum and minimum wave function amplitudes. The instantaneous wave function is a sinusoidal variation in time at the Higgs force superstring frequency between the maximum (1.1) and minimum (.9) wave function amplitudes. Since the Higgs force had zero spin, its wave function does not spin in either azimuth or elevation angle. Figure 21 shows the wave function or the probability distribution of a Higgs force (125 GeV, zero spin) dynamic point particle position with quantum fluctuations.

For a more general spin 1/2 particle with mass (e.g., electron), the wave function spins in both azimuth and elevation angles. One rotation in azimuth around the z_p axis and two rotations in elevation around the y_p axis brings the wave function back to its starting point (azimuth = 0, elevation = 0). As in Fig. 21, the instantaneous wave function is a sinusoidal variation in time at the electron superstring frequency between its maximum and minimum wave function amplitudes.

The quantum gravity/classical mechanics border started at approximately matter creation time or t = 10^{-33} s when the heaviest permanent matter particles (e.g. zino, photino, or Higgsino) were first created and ended by nucleosynthesis at t = 200 s when the proton/neutron ratio stabilized at seven to one. Current interpretation of the Schrodinger wave function is there are no restrictions on object size. In contrast, the border between quantum gravity (Schrodinger wave function applicability) and classical physics was defined as the “independent Planck cube” as follows.

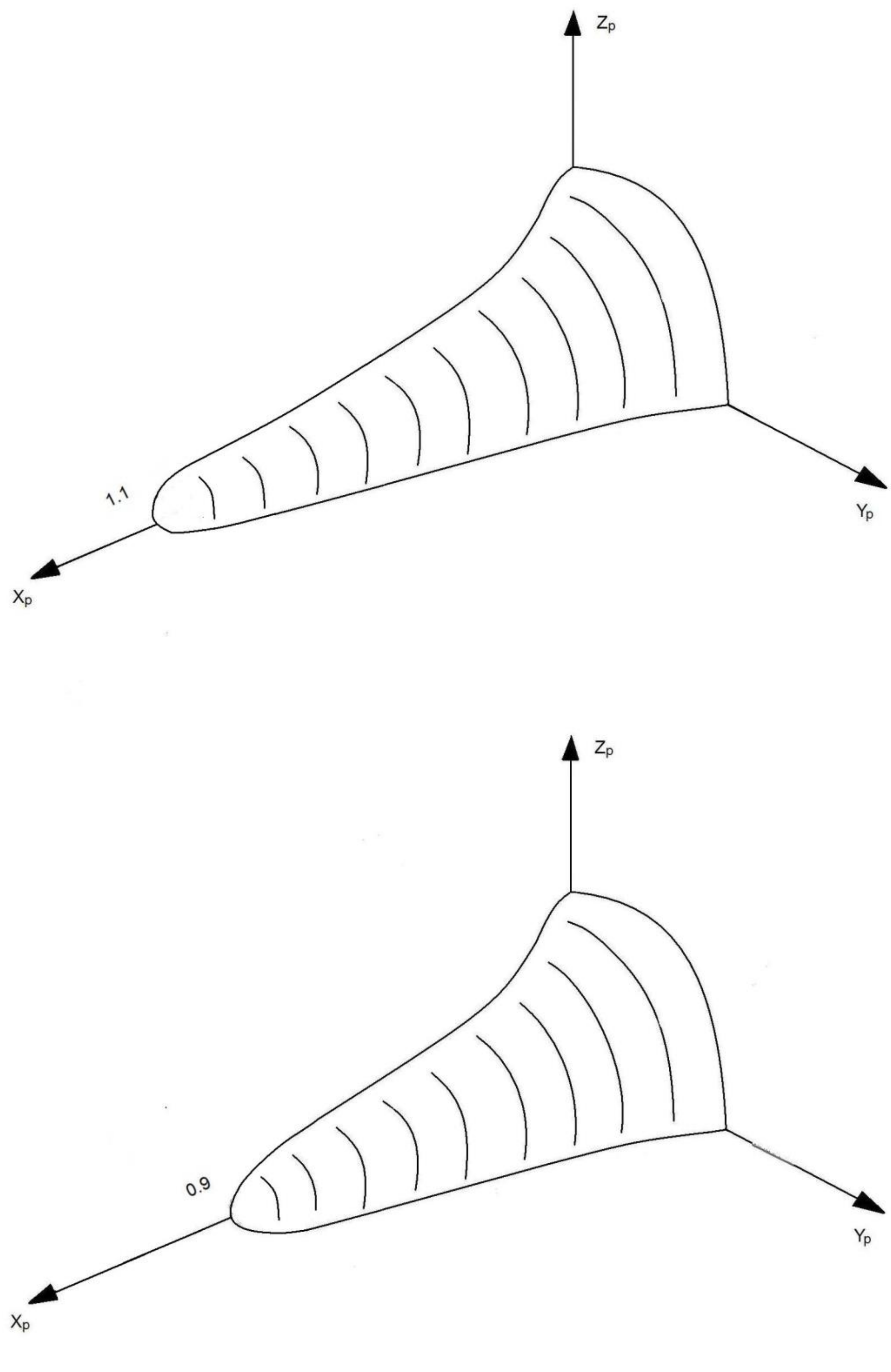


FIG. 21. Schrodinger wave function for a Higgs force 125 GeV, zero spin.

"Independent Planck cubes" first existed during matter creation between approximately t = 10^{-33} and 200 s and consisted of 22 independent permanent matter and force particle closed superstrings (e.g. zino, up quark, down quark, Higgs force, etc.). After t = 200 s, each permanent macroscopic object in our universe consisted of a fixed background volume of contiguous Planck cubes containing a maximum of 22 permanent matter and force particle superstring types. There is a macroscopic object size where quantum gravity becomes invalid and classical physics becomes valid. Greenstein and Zajonc describe three examples: interference, uncertainty principle, and quantum tunneling where macroscopic objects larger than a baseball agree with classical mechanics and do not obey quantum gravity or the Schrodinger wave functions [69]. According to Samarin, the motion of the center of a macroscopic object does not depend on the wave functions of the quantum particles forming the macroscopic object [70]. A proton is the smallest macroscopic object that behaves as a unified object of contiguous Planck cube particles instead of "independent Planck cube" particles. From Greenstein/Zajonc and Samarin's conclusions, the largest object size which obeys quantum gravity and the Schrodinger wave function is an "independent Planck cube." After t = 200 s, there were 22 permanent matter/force particles in our universe. Six permanent matter particles (electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino), their six associated Higgs forces, three permanent Higgsinos types, and their three associated forces (graviton, gluon, and photon) were "independent Planck cubes." In contrast, two permanent matter particle types (up quark and down quark) and their two associated Higgs forces, were in protons and neutrons and were not "independent Planck cubes."

Matter behaves like a wave and produces interference patterns. This concept was proposed by de Broglie and these matter waves were called de Broglie waves or $\lambda = h/mv$ where λ is wavelength, m is mass, v is velocity, and h is the Planck constant. The wavelength λ approaches zero as mass increases. Both a stream of photons in independent Planck cubes and high-mass molecules (exceeding 10,000 atomic mass units) produce interference patterns [71]. A stream of individual photons consists of photons with different phases. These phases are uniformly distributed in time so that a photon stream directed towards a double slit will have statistically identical distributions of photons and phases going through each slit to produce interference patterns.

However, the interference patterns of a stream of photons in independent Planck cubes (quantum interference) is different than the interference patterns of high-mass molecules (molecular de Broglie interference). High-mass molecules are a composite of a large number of different matter/force particle closed superstrings (e.g., electrons, up quarks, photons, etc.) each in a Planck cube. Whereas the individual matter/force particle closed superstrings in Planck cubes of a high-mass molecule obey quantum gravity and the Schrodinger wave function, the composite of different matter/force particle superstrings does not. This is because the border between quantum gravity and classical physics was defined above as the "independent Planck cube." Since the different matter/force particle superstrings of a high-mass molecule (e.g., electrons, up quarks, photons, etc.) are independent in energy/mass magnitude and phase from each other, the Schrodinger wave function is not applicable to high-mass molecules. Thus, matter particles (e.g., high-mass molecules) have de Broglie waves, but the Schrodinger wave function applies only to matter/force particles in "independent Planck cubes."

A Schrodinger electron cloud model for a hydrogen atom (the currently accepted model), is a variation of the Bohr model. In the Bohr model, electrons are in discrete energy shells. In the Schrodinger electron cloud model for a hydrogen atom, electron position is distributed around an average distance of the electron from the proton, from the proton radius to several electron shell radii. This author's model is a variation of the Bohr and Schrodinger models, where the electron position or cloud is distributed only inside a Planck cube centered on an energy shell. This author's model is also applicable for free electrons in our early universe's quark-gluon plasma, that is, electron position or cloud is distributed only inside a Planck cube. In contrast, the Schrodinger electron cloud model for a hydrogen atom is not suitable for free electrons because neither a proton in a hydrogen atom nor an average distance of the electron from the proton exists.

Whether Schrodinger's wave function has a physical interpretation is still being debated. Many physicists stated the Schrodinger wave function is a mathematical tool for calculating the probabilities of outcomes of certain experiments and cannot be associated with physical reality. Aharonov stated it was possible to measure the Schrodinger wave of a single particle [72]. This agreed with the physical representation of all 129 fundamental matter/force particle wave functions based on variations of Fig. 20. Schrodinger wave function for a "theoretical" zero mass, zero spin particle and Fig. 21. Schrodinger wave function for a Higgs force 125 GeV, zero spin.

Via conservation laws of energy/mass, charge, and angular momentum (see Section XXIV. Validation of a TOE physics solution using a two-step integrated physics/mathematics methodology, independent analysis/validation, Longo), the energy/mass, charge, and spin of our universe's doughnut physical singularity was distributed to the energy/masses, charges, and spins of fundamental particles, atoms, molecules, stars, and galaxies in our universe. This was an entangled relationship. However, there was no entanglement between individual particles in our universe. When a down quark's rest mass is converted to energy and radiation, they are absorbed by other particles in the first particle's vicinity (locality principle). Einstein's theory of special relativity limits the upper speed of information propagation to the speed of light. Current quantum entanglement measurements contradict that definition by using single photon sources which produce streams of photons, not single photons.

In conclusion: a single photon does not produce an interference pattern in a double-slit experiment; quantum fluctuations are jitter caused by the uncertainty principle of a fundamental particle's dynamic point particle position and momentum in a Planck cube; Schrodinger's wave function is applicable only to an "independent Planck cube" containing one of 22 permanent matter and force particle closed superstring types; and there is no entanglement between individual particles in our universe.

XXIII. A TOE PHYSICS SOLUTION USING A TWO-STEP INTEGRATED PHYSICS/MATHEMATICS METHODOLOGY: SECOND MATHEMATICS STEP

Two steps are required for a TOE physics solution using a two-step integrated physics/mathematics methodology, a conceptual physics step and a two part mathematics step. The two parts of the mathematics step are: an amplified SM (BSM) mathematics or gauge group SU(3) x SU(2) x U(1) for particles; and an amplified N-body simulation for cosmology.

SM mathematics or gauge group SU(3) x SU(2) x U(1) consists of three terms associated with the strong, weak, and electromagnetic forces. The first part of the mathematical solution is an amplification of this existing SM mathematical solution as follows.

There are six time periods in our universe containing different fundamental matter and force particle types. These six time periods are prioritized and each separately analyzed mathematically. The first four periods are shown in Fig. 6. The six periods are: Start of our universe at t = 0 to the beginning of inflation or 5 x 10^{-36} s; the inflationary period between 5 x 10^{-36} and 10^{-33}; matter creation between 10^{-33} and 100 s; nucleosynthesis between 100 and 200s; the opaque era from 200 s to approximately 380,000 years; and 380,000 years to 13.8 billion years. During the first period, our universe consisted of super force particles or their derivatives (e.g., gravitons, gluons, etc.) in a doughnut or spherical physical singularity. By the end of the second inflationary period, our universe consisted of individual super force, gravitons, and gluon force particles in individual Planck cubes. During the third matter creation period, our universe consisted of super force condensations and decays, creating a time varying plasma of 40 fundamental transient and permanent matter and force particles (excluding 40 anti-particles), each in their Planck cubes. Only 22 permanent fundamental matter and force particles remained by 100 s. During the fourth nucleosynthesis period, neutrons converted into protons until the proton/neutron ratio was seven to one. During the fifth opaque period, our universe consisted of 22 permanent fundamental matter and force particles and radiation. During the sixth period, our universe consisted of 22 permanent fundamental matter and force particles.

Following is a Beyond the Standard Model (BSM) mathematics solution plan. The first, second, and fourth periods contain the least important particle types, are relatively simple to analyze in comparison to the three other periods, and are temporarily ignored. Of the remaining three periods, the sixth is the most comprehensive but simplest to analyze and is selected to be analyzed first.

The sixth period had 22 permanent fundamental matter and force particles which included SM, SUSY, and SSUSY particles. That is, between 380,000 years and our universe's current age of 13.8 billion years or approximately 99.99% of our universe's lifetime, 22 permanent fundamental matter and force particles defined our universe's evolution. SM mathematics or gauge group SU(3) x SU(2) x U(1) must be amplified to include all 22 BSM permanent fundamental matter and force particles. In contrast, the SM consisted of 16 transient and permanent matter and force particles or: six permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, and tau-neutrino); six transient matter particles (charm quark, strange quark, top quark, bottom quark, muon, and tau); two permanent force particles (photon and gluon); and two transient force particles (W/Z's and Higgs). The BSM solution consisted of 22 permanent matter and force particles or: 11 permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, photino, and three permanent Higgsinos); and 11 permanent force particles (eight permanent Higgs forces associated with eight permanent matter particles and the graviton, gluon, and photon associated with three permanent Higgsinos). As described in this article, the independent BSM constituent theories must first be amplified by defining for example: a viable replacement for the existing ambiguous spontaneous symmetry breaking function; permanent Higgs forces giving mass to permanent matter particles (e.g., up quark and electron); etc. Second, SM mathematics must then be amplified to the new BSM solution consisting of 22 permanent matter and force particles. The fifth period is analyzed next because it consisted of the sixth period's 22 permanent fundamental matter and force particles and radiation.

The third period is analyzed last because it consists of a complex time varying plasma of 40 fundamental transient and permanent matter and force particles (excluding 40 anti-particles). Figure 12 Beyond the SM physics solution defined 64 fundamental SM/SUSY/SSUSY matter and force particles. The figure consisted of a circular area which defined 22 permanent matter and force particles and an annular area which defined 44 transient matter and force particles. However, twelve superpartner forces and their 12 associated Higgsinos were X bosons or inflatons which expanded our universe during the inflationary period. Therefore, there were only 40 (64 – 24 = 40) fundamental transient and permanent matter and force particles during the third matter creation period. SM mathematics or gauge group SU(3) x SU(2) x U(1) must be amplified by two separate functions, first inclusion of all 40 fundamental transient and permanent matter and force particles. Since during the third matter creation period, our universe consisted of super force condensations and decays which created a time varying plasma of 40 fundamental matter and force particles each in their Planck cubes, the SM mathematics required a second or f(t) amplification. Transient particles (e.g., W^-) could be represented on Fig. 6 Big Bang not as a line as shown, but a Gaussian distribution having a finite time bandwidth at its creation (10^{-12} s) and equivalent energy/mass (80 GeV). Permanent particles (e.g., electron) could be represented by a time step function having a finite rise time at its creation (100 s) and its equivalent energy/mass (0.51 MeV).

The second part of the second mathematics step is an amplified N-body numerical simulation for cosmology similar to Illustris and described by Vogelsberger [73]. Illustris, or the calculation of our universe's structure formation, simulates 13 billion years of cosmic evolution using both baryonic and dark matter. This is accomplished on both a large scale (350 million light years) and small scale (individual galaxy formation) basis. However, dark energy prediction is excluded as a simulation input.

A large scale, homogeneous, ΛCDM model is required. Since this article provides the dark energy theoretical roots for the universally accepted Planck satellite ΛCDM cosmological model [74], complex inhomogeneous models (e.g., modified gravity theories) are not required. This article's amplified requirements must be added to the Illustris N-body simulation and include: Dark energy was the sum of eight Higgs force energies associated with eight permanent matter particles; Higgs forces were created during matter creation; dark energy was 69% of our universe's energy/mass at t = approximately 380,000 years and remained constant for the next 13.8 billion years (no quintessence); atomic/subatomic matter, dark matter, and dark energy were uniformly distributed on a large scale (490 million light years); two opposing forces (gravity/matter and anti-gravity/dark energy) shaped our universe following the end of the radiation force at approximately 380,000 years; dark energy density and the cosmological constant decreased with time as our universe expanded, etc.. The amplified Illustris N-body simulation with the inclusion of dark energy should predict galaxy positions using the dark energy expansion equations (2) as described in Section XVI.A. Einstein's General Relativity. Illustris including dark energy should then predict galaxy positions which are compared with observed positions. In the current Illustris N-body simulation, computed and observed galaxy positions are used to define dark energy instead of predicting and using dark energy as a simulation input. Eventually, the amplified Illustris N-body simulation should also include the Super Universe with nested precursor universes.

Because of its intellectual formidability, a TOE physics solution using a two-step integrated physics/mathematics methodology consisting of: the conceptual physics step provided by this article, the proposed particle mathematics step, and the proposed cosmology mathematics step, remains a work in progress.

XXIV. VALIDATION OF A TOE PHYSICS SOLUTION USING A TWO-STEP INTEGRATED PHYSICS/MATHEMATICS METHODOLOGY

There were four existing and four proposed validations. The four existing independent validations agreed with this article's conclusions as follows. Leahy and Ouyed measured a quark nova or an explosive transition from a neutron star to a quark star in their article "Supernova SN2006gy as a first ever Quark Nova?" [75]. The origin of the doughnut physical singularity at a Planck cube center at t = 0 was described in Section III. An amplified particle creation. The singularity was created when a maximum entropy super supermassive quark star (matter) instantaneously evaporated, deflated, and gravitationally collapsed to its associated minimum entropy super supermassive black hole's (energy) doughnut physical singularity, which created our universe. The singularity's creation was described in Section XVIII. An amplified arrow of time. Morandi and Sun in their article "Probing dark energy via galaxy cluster outskirts" [76] concluded there was no quintessence or dynamic dark energy in our universe as described in Section XI. An amplified dark energy. Edmonds et. al. in their article "Testing Modified Dark Matter with Galaxy Clusters" concluded a relationship existed between the cosmological constant and dark matter [77]. Dark energy was defined in Section V. An amplified Higgs forces (bosons). The cosmological constant lambda (Λ) was proportional to the vacuum or dark energy density (ρ_Λ), or $\Lambda = 8\pi G\rho_\Lambda$, where G is the gravitational constant. Since dark energy was a constant, dark energy density and the proportional cosmological constant decreased in time as our universe expanded. That is the cosmological constant was not a constant, in contrast to current astrophysics theory. Since the zino and photino dark matter particles had associated Higgs forces or dark energy components, there was a relationship between the cosmological constant and dark matter. This was described in Section XI. An amplified dark energy. Finally, Longo stated our universe was born spinning in his article "Detection of a Dipole in the Handedness of Spiral Galaxies with Redshifts $z \sim 0.04$" [78]. The doughnut physical singularity at a Planck cube center at t = 0 was defined in Section III. An amplified particle creation. This singularity and its relationships via conservation laws of energy/mass, charge, and angular momentum with fundamental particles, atoms, molecules, stars, and galaxies in our universe were described in Section XXII.B. Quantum gravity interpretations. The above four existing independent validations provided a preliminary validation to this article and gave it credibility.

The first proposed validation used Section XIX.A. Proof of parallel universes' existing multi-wavelength technique NED. Galaxies within our universe are accelerating from our universe's doughnut physical singularity origin. Since parallel universes were assumed to be formed similarly to our universe (e.g., doughnut physical singularity, inflation, particle creation, star formation, and galaxy formation), galaxies of all parallel universe are accelerating from their doughnut physical singularity origins. Our

Milky Way galaxy is accelerating toward the closest galaxy of the closest parallel universe and the latter is accelerating toward the Milky Way galaxy. Since the two galaxies are accelerating towards each other, a search of blue shift galaxies is required. Existing data (e.g., NED) may already contain received galaxy blue shifts from the closest galaxy of the closest parallel universe and should be re-analyzed.

The second proposed validation is the BICEP2/Planck B-mode technique. Two types of B-mode polarization measure our universe's matter distribution (see Section XVI.A Einstein's General Relativity) and primordial gravitational waves stretched by inflation [42]. Primordial gravitational waves are being investigated by the BICEP2 experiment at the South Pole and the Planck satellite. However, according to Mortonson and Seljak, the BICEP2 results are not a definite proof of inflation because the measured B-mode polarization may have been caused by dust polarization contributions [79]. Future B-mode polarization measurements and analyses should define inflation and the exponential inflation factor. One of three exponential inflation factors described in Section IV. An amplified inflation should be validated (Liddle and Lyth 10^{26}, Colella 10^{36}, or Guth 10^{53}).

The third proposed validation uses this article as a benchmark. This article defined 20 interrelated amplified theories and their intimate physical relationships with each other. All 19 key outstanding TOE physics questions were answered including what are: Higgs forces, the fundamental matter and force particles equivalent of Mendeleev's Periodic Table of elements, stellar black holes, inflation and spontaneous symmetry breaking potential field functions, quantum fluctuations of fundamental particles, physical and mathematical singularities, and the seven extra dimensions; what is: dark energy, dark matter, SSUSY of Higgs particles, the border between quantum gravity and classical physics or Schrodinger wave function applicability, the boundary between quantum gravity and general relativity, our universe's implementation of the It from Qubit (IfQ) concept, and particle entanglement; and what caused: the start of our universe, hierarchy problem, black hole information paradox, baryogenesis, and the cosmological constant problem? If a critical peer review agrees with the 20 interrelated amplified theories, answers to the 19 questions, and the two part math step (an amplified SM (BSM) mathematics for particles and an amplified N-body simulation for cosmology), this article is validated. This critical peer review requires an estimated several weeks to prove this article is incorrect. Six to twelve months are required to prove this article is correct. If this article is peer reviewed to be correct, this provides an estimated 80 to 90% validation.

The fourth proposed validation requires an updated Snowmass estimate [80]. The first Snowmass estimated supersymmetric particles' energy/masses between 100 and 1,500 GeV. Since no supersymmetric particles were detected at the Large Hadron Collider (LHC), an updated Snowmass estimate is required. Dependent on the updated supersymmetric particles energy/mass estimates, either the LHC or an advanced collider detector is required to detect the 16 supersymmetric particles.

The additional 32 super supersymmetric Higgs particles proposed in this article may be detected differently than the 16 supersymmetric particles. This is because the relationship of a permanent matter particle's (e.g., up quark p_{11}) energy/mass with its associated permanent Higgs force (h_{11}) energy was the constant .26 as described in Section V An amplified Higgs forces (bosons). Emphasis on super supersymmetric particles detection should be on permanent Higgs forces and Higgsinos, rather than transient (e.g. 125 GeV) Higgs force.

The fourth proposed validation is formidable requiring an estimated 5 to 50 years. This is dependent on whether the LHC is versatile and powerful enough to detect transient and permanent supersymmetric and super supersymmetric particles, or a new accelerator and detector are required. This fourth proposed validation provides 100% validation.

XXV. CONCLUSIONS

First, as described in Section I.A. Introduction - Amplifications of 20 independent theories, each of twenty theories' requirements or equivalently each of twenty jigsaw puzzle pieces, was selectively amplified via "New Physics" without sacrificing the individual theory's integrity. This provided twenty snuggly fitting interrelated amplified theories of Table VII and Fig. 22.

Second, Hawking's TOE single mathematics step methodology should be replaced by a TOE physics solution using a two-step integrated physics/mathematics methodology. The first physics step is essential to amplify, integrate, and test the 20 constituent TOE theories and answer the 19 key outstanding physics questions (e.g., what is dark energy?). The second mathematics step is dependent on definition of the 20 constituent TOE theories and answers to the 19 questions, however, the mathematics step cannot answer them by itself.

Third, Fig. 11 SM matter and force particles should be amplified to Fig. 12 Beyond the SM physics solution.

Fourth, acceptance is required that the cosmological constant and Hubble's law were not constants. From Section XI. An amplified dark energy, the cosmological constant lambda was proportional to the vacuum or dark energy density. Dark energy was a constant during our universe's life time. Dark energy density decreased with time along with the cosmological constant as our universe expanded. From Section XIX. An amplified cosmological constant problem, Hubble's law was not a constant but nonlinear in time or distance between 200 million years and 13.8 billion years.

Fifth, a TOE physics solution using a two-step integrated physics/mathematics methodology validation should be initiated. There are eight validation techniques, four existing and four proposed as described in Section XXIV. Validation of a TOE physics solution using a two-step integrated physics/mathematics methodology.

The first validation technique is independent analyses/validations by physicists and four currently exist. Leahy and Ouyed measured a quark nova in their article "Supernova SN2006gy as a first ever Quark Nova?" as predicted in Section XVI. An amplified stellar black holes (stars and galaxies). Morandi and Sun in their article "Probing dark energy via galaxy cluster outskirts" concluded there was no quintessence or dynamic dark energy in our universe as predicted in Section XI. An amplified dark energy. Edmonds et. al. in their article "Testing Modified Dark Matter with Galaxy Clusters" concluded a relationship existed between the cosmological constant and dark matter as predicted in Section XI. An amplified dark energy. Finally, Longo stated our universe was born spinning in his article "Detection of a Dipole in the Handedness of Spiral Galaxies with Redshifts $z \sim 0.04$" as described in Section XXII.B Quantum gravity interpretation.

The first proposed validation used an existing multi-wavelength technique NED described in Section XIX.A. Proof of parallel universes. Our Milky Way galaxy is accelerating toward the closest galaxy of the closest parallel universe and the latter is accelerating toward the Milky Way galaxy. Since the two galaxies are accelerating towards each other, a search of blue shift galaxies is required. Existing data (e.g., NED) may already contain received galaxy blue shifts from parallel universes and should be re-analyzed.

The second proposed validation is the BICEP2/Planck B-mode technique. Two types of B-mode polarization measure our universe's matter distribution (see Section XVI.A Einstein's General Relativity) and primordial gravitational waves stretched by inflation. Primordial gravitational waves are being investigated by the BICEP2 experiment at the South Pole and the Planck satellite. However, according to Mortonson and Seljak, the BICEP2 results are not a definite proof of inflation because the measured B-

TABLE VII. Primary interrelationships between 20 interrelated amplified theories.

	Superstring	Particle creation	Inflation	Higgs forces	Spontaneous symmetry breaking	Superpartner and SM decays	Neutrino oscillations	Dark matter	Universe expansions	Dark energy	Messenger particles	Relative strengths of forces	Super Universe	Stellar black holes	Black hole entropy	Arrow of time	Cosmological constant problem	Black hole information paradox	Baryogenesis	Quantum gravity
Superstring	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Particle creation	x	x	x	x	x	x	x	x	x	x		x		x	x			x	x	x
Inflation	x	x	x						x											x
Higgs forces	x	x		x	x	x		x	x	x	x					x			x	x
Spontaneous symmetry breaking	x	x		x	x	x	x	x	x	x									x	x
Superpartner and SM decays	x	x		x	x	x														x
Neutrino oscillations	x	x			x		x	x												x
Dark matter	x	x		x	x		x	x	x	x							x		x	x
Universe expansions	x	x	x	x	x			x	x	x		x								x
Dark energy	x	x		x	x			x	x	x			x	x		x	x		x	x
Messenger particles	x			x							x									x
Relative strengths of forces	x	x							x			x								x
Super Universe	x									x			x							x
Stellar black holes	x	x								x				x	x	x	x	x	x	x
Black hole entropy	x	x												x	x	x	x	x	x	x
Arrow of time	x			x						x				x	x	x	x	x	x	x
Cosmological constant problem	x							x		x				x	x	x	x			x
Black hole information paradox	x	x												x	x	x		x	x	x
Baryogenesis	x	x		x	x			x		x				x	x	x		x	x	x
Quantum gravity	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

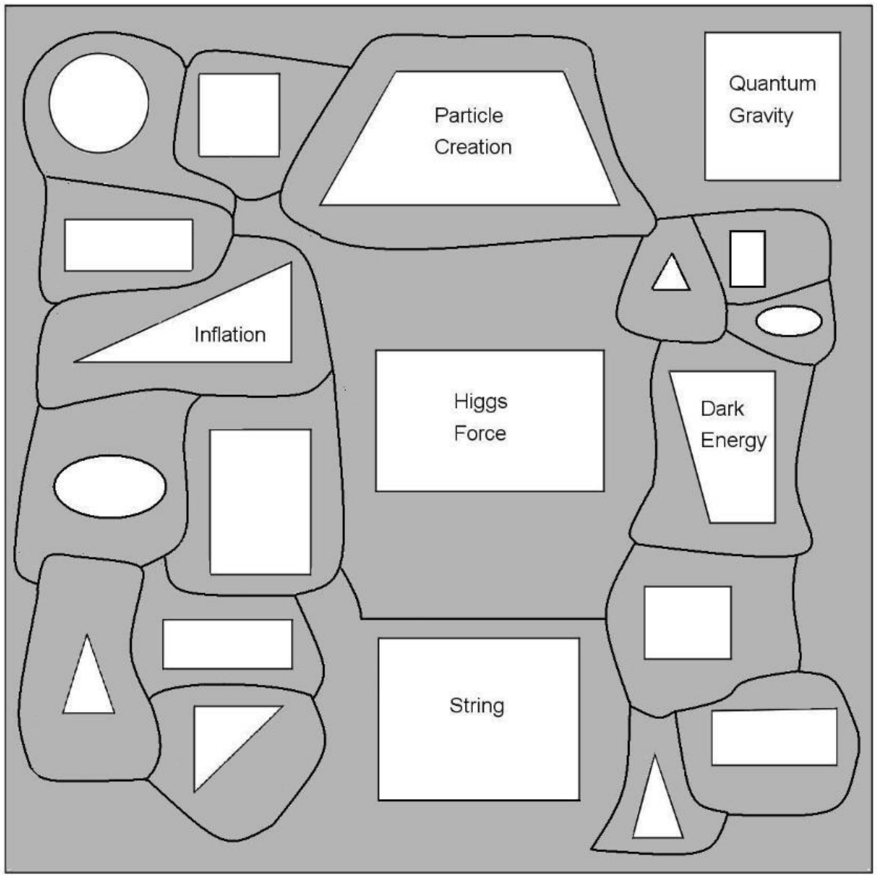


FIG. 22. A Two-step integrated TOE jigsaw puzzle.

mode polarization may have been caused by dust polarization contributions. However, future B-mode polarization measurements and analyses should define inflation and the exponential inflation factor. One of three exponential inflation factors described in Section IV. An amplified inflation should be validated (Liddle and Lyth 10^{26}, Colella 10^{36}, or Guth 10^{53}).

The third proposed validation used this article as a critical peer review benchmark. This article defined 20 interrelated amplified theories and their intimate physical relationships with each other. All 19 key outstanding TOE physics questions were answered. This critical peer review requires an estimated several weeks to prove this article is incorrect. Six to twelve months are required to prove this article is correct. If this article is peer reviewed to be correct, this provides an estimated 80 to 90% validation.

The fourth proposed validation requires an updated Snowmass estimate. Since no supersymmetric particles were detected at the Large Hadron Collider (LHC), an updated Snowmass estimate is required. Dependent on the updated supersymmetric particles energy/mass estimates, either the LHC or an advanced collider detector should detect the 16 supersymmetric particles. The additional 32 super supersymmetric Higgs particles proposed in this article may be detected with equipment different than a LHC. This is a formidable validation requiring an estimated 5 to 50 years. This is dependent on whether the LHC is versatile and powerful enough to detect transient and permanent supersymmetric and super supersymmetric particles, or a new accelerator and detector are required. This fourth proposed validation provides 100% validation.

Sixth, a TOE physics solution using a two-step integrated physics/mathematics methodology should be initiated. This is the formidable integration of the conceptual physics step described by this article, with the proposed an amplified BSM for the particles math step and the proposed “Illustris” N-Body simulation for the cosmology math step. The latter two are described in Section XXIII. A TOE physics solution using a two-step integrated physics/mathematics methodology: Second mathematics step.

This article’s first conceptual physics step of a TOE physics solution using a two-step integrated physics/mathematics methodology, provides the framework for the final TOE which includes integration with the two proposed mathematics steps. Open, frank, and cooperative discussions are required between physicists working in the 20 interrelated amplified theories and this author. These physicists should provide the formidable mathematics details to this TOE framework. Only then will a TOE solution using a two-step integrated physics/mathematics methodology, the final theory, the crowning achievement of science, the ultimate triumph of human reasoning, and knowledge of God’s mind be resolved.

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