An Integrated Theory of Everything

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Abstract

An Integrated Theory of Everything (TOE) unifies all known physical phenomena from the infinitely small or Planck cube scale to the infinitely large or Super Universe scale. Each of 129 fundamental matter and force particles is represented by its unique string in a Planck cube. Any object in the Super Universe can be represented by a volume of contiguous Planck cubes containing fundamental matter or force particle strings. Super force string 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 foundations of the theoretical Integrated TOE are the following twenty independent existing theories; string, particle creation, inflation, spontaneous symmetry breaking, Higgs forces/supersymmetric Higgs particles, superpartner and quark decays, neutrino oscillations, dark matter, universe expansions, dark energy, messenger particle operational mechanism, relative strengths of forces, Super Universe (multiverse), stellar black holes, black hole entropy, arrow of time, cosmological constant problem/nested universes, black hole information paradox, baryogenesis, and quantum gravity. The premise of an Integrated TOE is without sacrificing their integrities; these twenty independent existing theories are replaced by twenty interrelated amplified theories.

An Integrated TOE was developed by a top down, iterative, systems engineering technique which selectively amplified each independent existing theory to integrate it with interrelated theories without sacrificing the existing theory's integrity. An example of requirement amplification was matter particle creation theory was amplified to be time synchronous with inflation theory. The results of an Integrated TOE were summarized in Table IV, Primary interrelationships between twenty amplified theories.

Key words. string theory, particle creation, inflation, bidirectional spontaneous symmetry breaking, Higgs forces/supersymmetric Higgs particles, superpartner and quark decays, neutrino oscillations, dark matter, universe expansions, dark energy, messenger particle operational mechanism, relative strengths of forces, Super Universe (multiverse), stellar black holes, black hole entropy, arrow of time, cosmological constant problem/nested universes, black hole information paradox, baryogenesis, quantum gravity, deflation, and unified theory.

Introduction

An Integrated TOE unifies all known physical phenomena from the infinitely small or Planck cube scale to the infinitely large or Super Universe scale. Each matter and force particle exists within the universe's fundamental building block, the Planck cube. Any universe object is representable by a volume of contiguous Planck cubes. The Planck cube is the quantum or unit of matter particle, force particle, and space [1]. An Integrated TOE unifies 16 Standard Model particles, 16 supersymmetric particles, 32 anti-particles, their 64 associated supersymmetric Higgs particles, and the super force or mother particle for 129 particles.

The foundations of an Integrated TOE are the following twenty independent, existing theories; string, particle creation, inflation, spontaneous symmetry breaking, Higgs forces/supersymmetric Higgs particles, superpartner and quark decays, neutrino oscillations, dark matter, universe expansions, dark

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energy, messenger particle operational mechanism, relative strengths of forces, Super Universe (multiverse), stellar black holes, black hole entropy, arrow of time, cosmological constant problem/nested universes, black hole information paradox, baryogenesis, and quantum gravity. These twenty independent existing theories were developed by physicists primarily for internal integrity with minor emphasis on interrelated theories.

An Integrated TOE was developed as follows. A top down, iterative, systems engineering technique selectively amplified each independent existing theory to integrate it with interrelated theories without sacrificing the existing theory's integrity. For example, the key Higgs forces/supersymmetric Higgs particles theory was amplified to include; Higgs force particles were residual super force particles, matter particles and their associated Higgs forces were one and inseparable and spontaneous symmetry breaking was bidirectional.

The foundations of an Integrated TOE include twenty independent existing theories and their accepted experimental data or observations. An Integrated TOE's predictions are experimentally distinguishable from existing knowledge. This article's motivation and justification is the 20 independent existing theories are now an Integrated TOE consisting of 20 interrelated amplified theories as summarized in Table IV, Primary interrelationships between twenty amplified theories.

String theory

Each of 129 fundamental matter and force particles is represented by its unique string or associated Calabi-Yau membrane in a Planck cube. A string or associated Calabi-Yau membrane's energy/mass is primarily a function of its diameter and secondarily its hills and valley's amplitude displacement and frequency. The big bang's near zero diameter singularity of superimposed super force strings consisted of our universe's near infinite energy. Any object in the Super Universe can be represented by a volume of contiguous Planck cubes containing fundamental matter or force particle strings. Super force string singularities at the center of Planck cubes existed at the start of the Super Universe, all precursor universes, and all universes including our universe (see Cosmological constant problem/nested universes).

The inertially stabilized X_u, Y_u, Z_u universal rectangular coordinate system of Fig. 1 originates at our universe's big bang at $x_u = 0$, $y_u = 0$, $z_u = 0$, $t = 0$ [2]. A Planck length ($l_p = 1.6 \times 10^{-35}$ meters) cube is centered at x_u, y_u, z_u at time t with the 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}. At $t = 0$, our universe consisted of a super force singularity centered in a Planck cube at $x_u = 0$, $y_u = 0$, and $z_u = 0$. At the present time t = 13.7 billion years, our universe consists of approximately 10^{185} contiguous Planck cubes.

Each of the 129 Standard Model/supersymmetric particles listed in Table I exists within a Planck cube and is equivalently represented by a dynamic phantom point particle, its unique string, or its associated Calabi-Yau membrane. In traditional string theory descriptions, a one brane vibrating string generates a two brane Calabi-Yau membrane over time. A zero brane dynamic phantom point particle generates quantized particle positions for both a one brane vibrating string and a two brane Calabi-Yau membrane over time. String theory's six extra dimensions are the dynamic phantom point particle position (x_p, y_p, z_p) and velocity (v_{xp}, v_{yp}, v_{zp}) coordinates.

A basic Calabi-Yau membrane type is a Planck cube sized beach ball to which periodic surface hills and valleys are added to synthesize any particle. A string can be visualized as a thin sticky band wrapped around a Calabi-Yau membrane. For example, a circle with periodic hills and valleys is the string associated with a beach ball membrane with periodic surface hills and valleys.

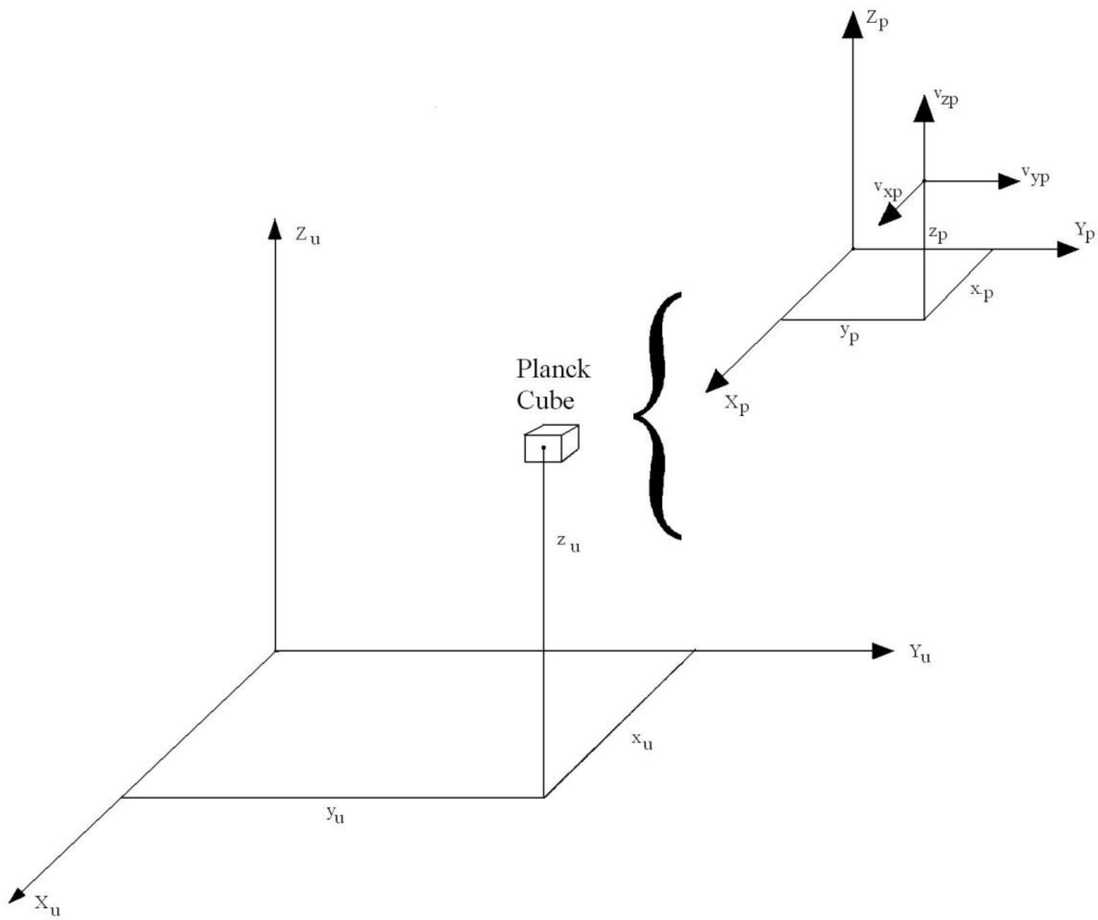

FIG. 1. Universal rectangular coordinate system.

A membrane's potential energy/mass can be represented by three springs aligned along the X_p, Y_p, and Z_p axes, and connected together at $x_p = 0$, $y_p = 0$, and $z_p = 0$. A Calabi-Yau membrane's energy/mass is primarily a function inversely proportional to its diameter and secondarily directly proportional to its surface hills and valley's amplitude displacement and frequency [3]. A particle's energy/mass is amplified from two to three Calabi-Yau membrane or string parameters by addition of the diameter parameter. Diameter defines the basic energy/mass level whereas the amplitude displacement and frequency fine tunes it. A Calabi-Yau membrane just touching the Planck cube sides with zero amplitude displacement and frequency represents zero tension or energy/mass. A range of amplitude displacements and frequencies about this level defines the 32 fundamental matter and force particles' energy/masses, from the lightest photon (zero) to the top quark (173 GeV) to supersymmetric particles (100 to 1500 GeV).

In contrast, the big bang's near zero diameter singularity of superimposed super force strings consisted of our universe's near infinite energy of approximately 10^{54} kilograms, or 10^{24} $M_{\odot}$, or 10^{90} eV [4]. The super force singularity was a rotating, charged, doughnut shaped Calabi-Yau membrane or Kerr-Newman black hole. Pauli's exclusion principle states no two matter particles can have identical quantum numbers, which was assumed equivalent to occupying the same Planck cube [5]. In contrast, Pauli's exclusion principle permits force particles to exist within the same Planck cube such as the super force singularity. This integrates string with particle creation and stellar black holes theories (see Table IV).

A proton consisting of quarks, photons, and gluons can be represented by a volume of contiguous Planck cubes (see Fig. 5). An atom can be represented by a volume of contiguous Planck cubes consisting of protons, neutrons, and orbital shell electrons. By extension, any object in the Super Universe (e.g. molecule, encyclopedia, star, galaxy, or the Super Universe) can be represented by a volume of contiguous Planck cubes containing fundamental matter or force particles. The contiguous Planck cubes can be visualized as extremely small, cubic, Lego blocks. Quantized time is represented by Planck time.

Proposed standard/supersymmetric particle symbols

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

Table I shows the proposed symbols with Standard Model particles on the left and supersymmetric particles on the right. The subscript xx explicitly identifies a specific matter or force particle (e.g. the number 11 identifies the up quark p_{11}). Adding sixteen to the Standard Model particle subscript identifies its supersymmetric partner (e.g. up squark p_{27}). Replacing p with h identifies the associated 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 up squark p_{27} replaces a u with a tilde over it, the up quark anti-particle p_{11bar} replaces a u with a bar over it, and the photon p_{16} replaces γ.

The first reason for the proposed symbols is explicit Higgs particle symbols are not available in existing symbols. In the proposed symbols, there is a Higgs particle for each matter and force particles. Since there are 16 Standard Model particles, 16 supersymmetric particles, and 32 anti-particles, there are 64 supersymmetric Higgs particles. Each matter particle has an associated Higgs force and each force particle has an associated Higgsino or Higgs matter particle. Explicit Higgs particles are essential because as subsequently described, the sum of Higgs force energies associated with eight permanent matter particles is dark energy and Higgsinos experience spontaneous symmetry breaking.

The second reason for the proposed symbols is elimination of existing symbol ambiguities via standardization of subscripts and capitals. 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 divided 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. 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 is not defined in existing symbols and annihilation of matter and anti-matter particles produces super force particles (p_{sf}) not electromagnetic radiation (γ).

A third example is there are seventeen different types of super force particles which condense into seventeen different matter particles. The seventeen super forces types are identified for example by p_{sfp11} where the subscripts (sf) signify super force and the following subscripts (e.g. p11) signify the condensed matter particle. There is only one super force in existing symbols.

A fourth example is total particle energy/mass is represented by upper case letter symbols, for example, total up quark energy/mass is P_{11}. The subsequently described big bang time line of Fig. 2 uses total

TABLE I. Proposed Standard Model/supersymmetric particle symbols.

Symbol	Standard Model	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}	top squark		x
p_4	bottom quark	x		p_{20}	bottom squark		x
p_5	tau	x		p_{21}	stau		x
p_6	charm quark	x		p_{22}	charm squark		x
p_7	strange quark	x		p_{23}	strange squark		x
p_8	muon	x		p_{24}	smuon		x
p_9	tau-neutrino	x		p_{25}	tau-sneutrino		x
p_{10}	down quark	x		p_{26}	down squark		x
p_{11}	up quark	x		p_{27}	up squark		x
p_{12}	electron	x		p_{28}	selectron		x
p_{13}	muon-neutrino	x		p_{29}	muon-sneutrino		x
p_{14}	electron-neutrino	x		p_{30}	electron-sneutrino		x
p_{15} [6]	W/Z bosons		x	p_{31}	wino/zinos	x	
p_{16}	photon		x	p_{32}	photino	x	

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

129	total	

energy/mass for 32 matter and force particles. Total energy/mass for an individual particle is not available in existing symbols.

A fifth example is there are seventeen different super force densities which condense into seventeen different matter particles. The seventeen super force densities are identified for example by P_{sfdp11} where the subscripts (sfd) signify super force density and the following subscripts (e.g. p11) signify the condensed matter particle. Seventeen super force densities are subsequently described in the spontaneous symmetry breaking section. Only one super force density is available in existing symbols.

Particle creation/Inflation

The big bang created our universe's 128 particles from the super force having energy of 10^{54} kilograms. Matter creation was time synchronous with both the inflationary period start time and the one to seven Planck cubes energy to matter expansion. By t = 100 seconds, all super force energy had condensed into eight permanent matter particles and their eight associated Higgs force energies.

Fig. 2 Big bang shows creation of our universe's 128 particles from the super force P_{sf} having energy of 10^{54} kilograms [7]. Upper case letters are exclusively used because particle creation involves total

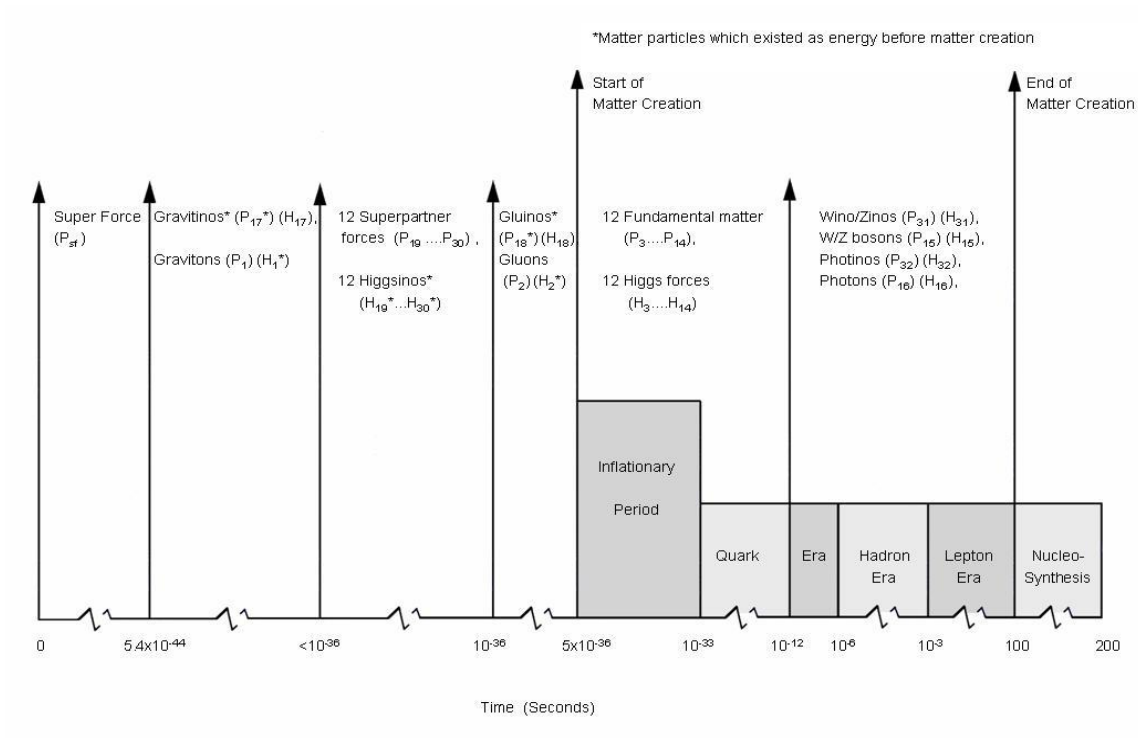

FIG. 2. Big bang.

particle energy/mass, for example, total up quark energy/mass 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) energies for each up quark particle p_{11} multiplied by the number of up quark particles n_{11}. Matter particles are described by energy/mass whereas force particles are described by energy. Up quark energy density P_{11d} is total up quark energy/mass P_{11} divided by our universe's volume at the time of up quark creation.

Fig. 2 shows creation of energy/masses for gravitinos* (P_{17}*)/gravitons (P_1) at t = 5.4 x 10^{-44} seconds and gluinos* (P_{18}*) /gluons (P_2) at t = 10^{-36} seconds. The asterisk (*) signifies matter particles which existed as energy before matter creation. Twelve superpartner force energies (P_{19}….P_{30}) were created at < 10^{-36} seconds and consisted of X bosons. Grand Unified Theory (GUT) bosons included 8 gluons p_2, 3 W/Z bosons p_{15} [8], and photons p_{16}. A portion of the GUT bosons and their superpartners, gluons and gluinos, condensed at t = 10^{-36} seconds. A second portion consisting of W/Z bosons, wino/zinos, photons, and photinos condensed at t = 10^{-12} seconds.

Matter creation theory was amplified to be time synchronous with both the inflationary period start time (5 x 10^{-36} seconds) and the one to seven Planck cubes energy to matter expansion. This eliminated a separate reheating phase following inflation. Since Pauli's exclusion principle prohibited matter particles from existing within the same Planck cube, matter did not exist when our universe was smaller than one Planck cube or when our universe's radius was .8 x10^{-35} meters, see Fig. 3 [9]. The one to seven Planck cubes energy to matter expansion consisted of six contiguous Planck cubes attached to the six faces of our universe's original Planck cube. The original Planck cube contained superimposed super force particles whereas the six contiguous cubes contained six newly created matter particles. Following the start of

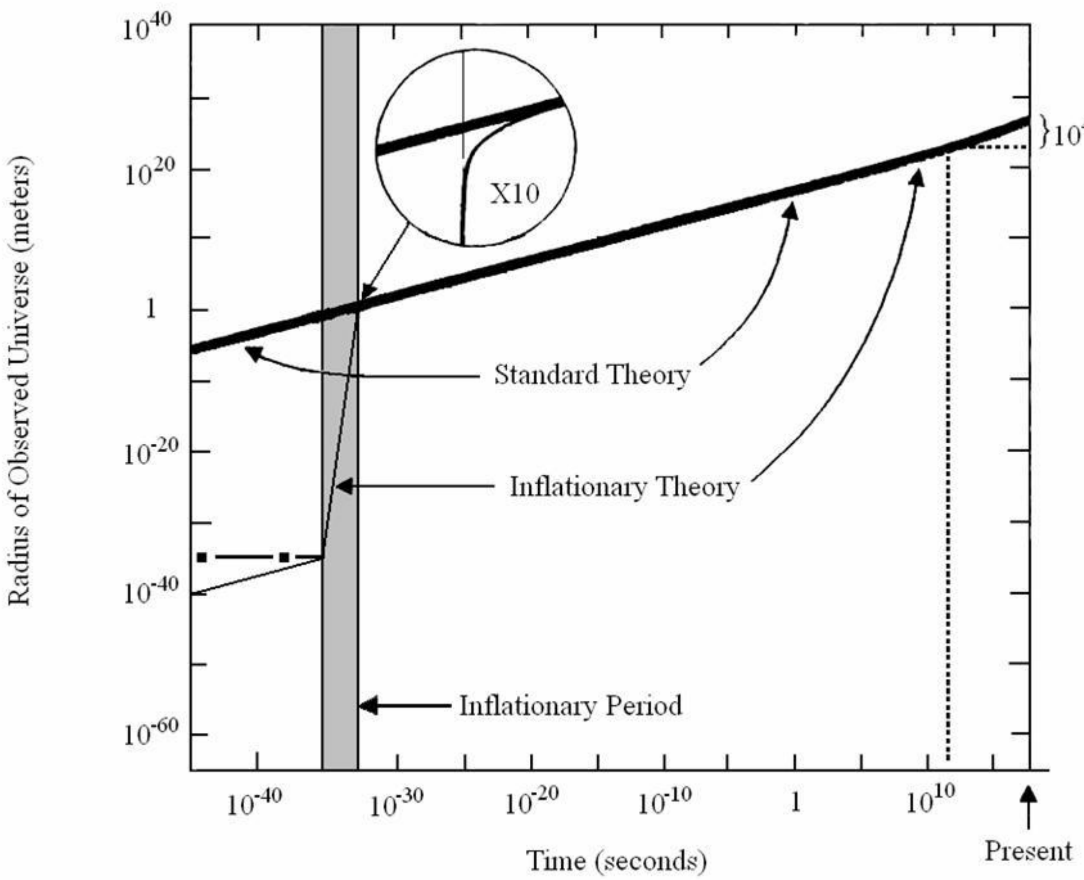

FIG. 3. Size of universe in the standard and inflationary theories.

matter creation, gravitinos* (P_{17}*), gluinos* (P_{18}*), and 12 fundamental matter (6 quarks and 6 leptons) particles (P_3….P_{14}) energy/masses were condensed to matter particles. At t = 10^{-12} seconds, W/Z bosons (P_{15}), winos/zinos (P_{31}) and photino (P_{32}) energy/masses were condensed to matter particles. This integrated inflation and particle creation theories, (see Table IV).

Particle/anti-particle pairs condensed from super force energy and evaporated back to the super force. As our universe expanded and cooled this baryogenesis process was predominantly from energy to matter rather than to anti-matter (see Spontaneous symmetry breaking/Higgs forces and Baryogenesis sections). Particles/anti-particles were the intermediate or false vacuum state (quantum fluctuations) prior to the permanent matter plus true vacuum state. During matter creation (5 x 10^{-36} to 100 seconds), our universe consisted of a time varying particle soup. The end of matter creation was defined as 100 seconds because by: 10^{-3} seconds, up and down quarks formed protons and neutrons; 1 second, neutrinos decoupled from matter; 100 seconds, only electrons remained following electron anti-electron annihilations [10]. By t = 100 seconds, all super force energy had condensed into eight permanent matter particles and their eight associated Higgs force energies. Also at t = 100 seconds, nucleosynthesis began.

Spontaneous symmetry breaking/Higgs forces

The process of generating 17 matter particles and their 17 associated Higgs forces is spontaneous symmetry breaking or the Higgs mechanism [11]. The sum of eight permanent Higgs forces' energies associated with eight permanent matter particles: atomic matter (up quark, down quark, electron); dark matter (zino, photino); and neutrino matter (tau-neutrino, muon-neutrino, electron-neutrino) constitutes dark or vacuum energy.

Amplifications of Higgs force theory are: Higgs force particles are residual super force particles containing characteristics (e.g. mass, charge, spin) of their associated matter particles; matter particles and their associated Higgs forces are one and inseparable; spontaneous symmetry breaking is bidirectional supporting condensations from and evaporations to the super force; super force condensations occur for 17 matter particles and their associated Higgs forces; and the sum of eight permanent Higgs force energies is dark energy.

Fig. 2 shows energy/masses of 32 matter and force particles designated as $P_1....P_{32}$. These included gravitons P_1, gluons P_2, twelve fundamental matter particles ($P_3….P_{14}$), W/Z bosons P_{15}, photons P_{16}, 4 supersymmetric matter particles (P_{17}*, P_{18}*, P_{31}, and P_{32}), and 12 supersymmetric force particles ($P_{19}….P_{30}$) energy/masses. The 17 Higgs force energies ($H_3….H_{14,}$ H_{17}, H_{18}, H_{31}, H_{32}, H_{15}) were super force energy residuals following condensations of 12 fundamental matter, four supersymmetric matter, and W/Z bosons energy/masses. 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 Higgs particles. Thirty two anti-particles condensed with their 32 associated Higgs particles at the same temperature and time as their identical energy/mass particles but were not explicitly shown in Fig. 2 because baryogenesis eliminated them. Thus, super force (P_{sf}) energy equaled 32 Standard Model/supersymmetric matter and force particles and their 32 associated Higgs particle energy/masses or, $P_{sf} = (P_1 + H_1^*)….(P_{32} + H_{32})$. From Fig. 2 at $t = 5.4 \times 10^{-44}$ seconds, one super force pair's energy ($P_1 + H_1$*) condensed into gravitons' energy (P_1) and its associated Higgsino* energy/mass (H_1*) and a second super force pair (P_{17}* + H_{17}) condensed into the gravitinos* energy/mass (P_{17}*) and its associated Higgs force energy (H_{17}). At $t = 10^{-36}$ seconds, a third super force pair's energy ($P_2 + H_2$*) condensed into gluons' energy (P_2) and its associated Higgsino* energy/mass (H_2*) and a fourth super force pair (P_{18}* + H_{18}) condensed into gluinos* energy/mass (P_{18}*) and its associated Higgs force energy (H_{18}). At $t < 10^{-36}$ seconds, twelve super force energy pairs [($P_{19} + H_{19}$*) ….($P_{30} + H_{30}$*)] were created as X bosons and their associated Higgsinos [12]. During our universe's matter creation period (5×10^{-36} to 100 seconds), four supersymmetric matter energy/masses (P_{17}*, P_{18}*, P_{31}, P_{32}), their associated Higgs force energies (H_{17}, H_{18}, H_{31}, H_{32}), 12 fundamental matter energy/masses ($P_3....P_{14}$) and their associated Higgs force energies ($H_3….H_{14}$) created four supersymmetric matter, 12 fundamental matter, and 16 associated Higgs force particles. At $t=10^{-12}$ seconds, two super force pairs of energy ($P_{15} + H_{15}$) and ($P_{16} + H_{16}$) condensed into W/Z bosons (P_{15}), photons (P_{16}), and their two associated Higgs particles (H_{15}, H_{16}).

The up quark spontaneous symmetry breaking function is shown in Fig. 4 [13]. The Z axis represents energy density of the super force (i.e. P_{sfdp11}) available for condensation to up quarks and their associated Higgs force particles. The X axis represents one Higgs force particle's energy h_{11} associated with an up quark particle p_{11}. Similarly, the Y axis represents one Higgs force particle's energy h_{11bar} associated with the anti-up quark particle p_{11bar}. Because of the early universe's baryogenesis, anti-particles quickly disappear and Fig. 4 compresses to the two dimensional Z versus X diagram shown in the Fig. 4 inset [14]. The Z axis represents: prior to condensation, the up quark and its associated Higgs force energy densities [$P_{sfdp11} = (P_{11d} + H_{11d})$]; or following condensation, the associated Higgs force energy density (H_{11d}). At the peak position, all the energy density is super force density (P_{sfdp11}). At the position shown by the ball ($h_{11} = -2$, $h_{11bar} = 0$, $Z = 1.5$), condensation of up quark p_{11} particles is complete, the residual energy density is H_{11d}, and the associated h_{11} is non-zero. Following condensation, the h_{11} non-zero value (-2) remains constant, (i.e. ball slowly over 13.7 billion years moves vertically down and approaches the vacuum circle for up quarks) while the associated Higgs energy density (H_{11d}) decreases as our universe

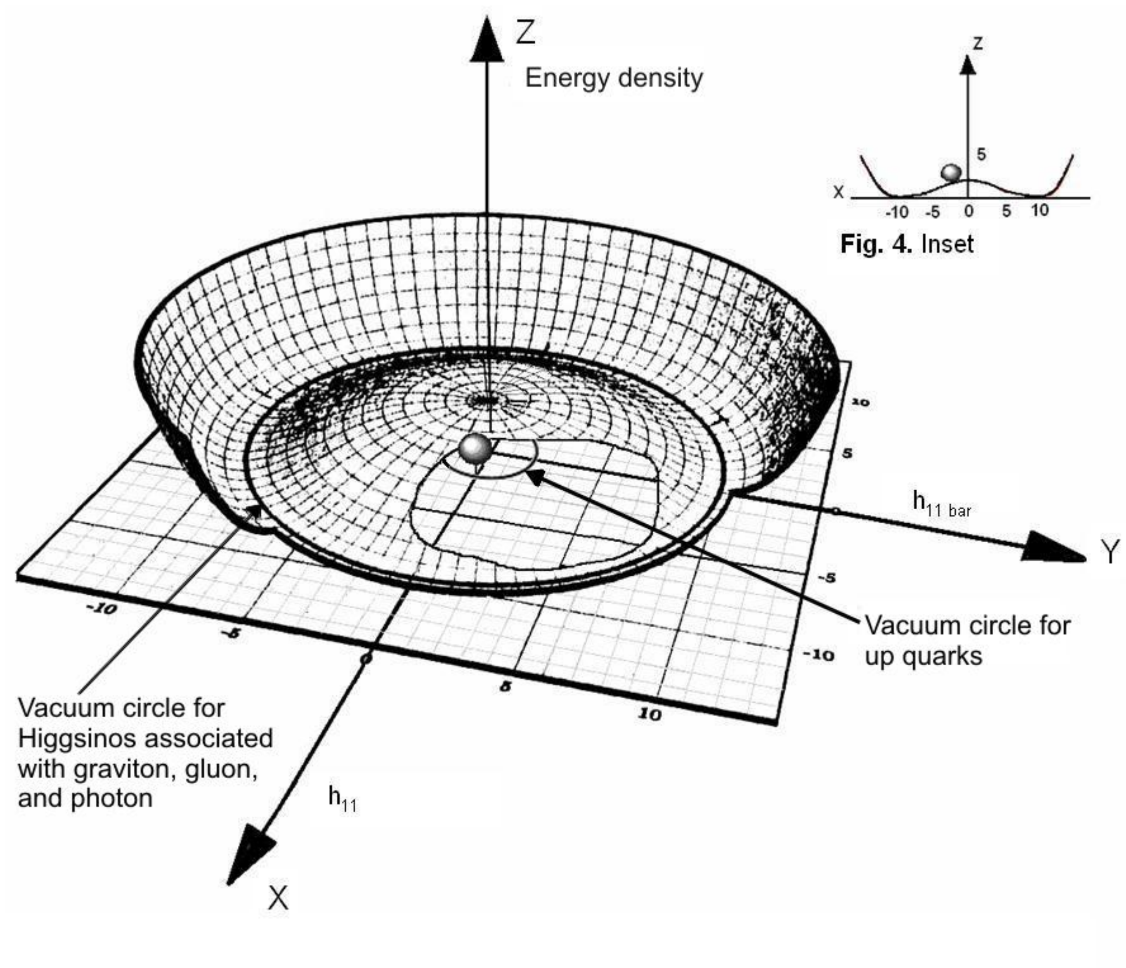

FIG. 4. Up quark spontaneous symmetry breaking function.

expands. Each Higgs force h_{11} contains the characteristics (e.g. mass, charges, and spin) of its associated particle p_{11} and itself (see Fig. 5 Inset). The Higgs force h_{11} is visualized as a three dimensional field surrounding and inseparable from the p_{11} particle or symbolically as a single Planck cube attached to its p_{11} particle [15].

Super force density condensations occurred for 17 matter particles (p_3….p_{14}, p_{15}, p_{17}, p_{18}, p_{31}, p_{32}) and produced 17 associated Higgs force particles (h_3….h_{14}, h_{15}, h_{17}, h_{18}, h_{31}, h_{32}). The assumed heaviest matter particle's (e.g. gravitino p_{17}) spontaneous symmetry breaking function occurred first during matter creation. There were 17 unique spontaneous symmetry breaking functions having the generic shape of Fig. 4, which occurred at different times or temperatures during matter creation.

The false vacuum was an intermediate state where the super force condensed either to transient matter particles or particles/antiparticles and bidirectionally evaporated back to the super force. During matter creation, nine transient matter particles (top quark p_3, bottom quark p_4, charm quark p_6, strange quark p_7, tau p_5, muon p_8, gravitino p_{17}, gluino p_{18}, and W/Z bosons p_{15}) and their nine associated Higgs forces condensed from and evaporated back to the super force [16].

The true or permanent vacuum state was space without matter or the lowest energy/temperature density state. The sum of eight permanent Higgs force energies (H_{11}, H_{10}, H_{12}, H_{31}, H_{32}, H_9, H_{13}, H_{14}) associated with eight permanent matter particles: atomic matter (up quark p_{11}, down quark p_{10}, electron p_{12}); dark matter (zino p_{31}, photino p_{32}); and neutrino matter (tau-neutrino p_9, muon-neutrino p_{13}, electron-neutrino p_{14}) constituted dark or vacuum energy. This integrates spontaneous symmetry breaking, Higgs forces/supersymmetric Higgs particles, particle creation, inflation, dark matter, dark energy, and baryogenesis theories, (see Table IV).

Each of the 129 particles was assumed to exist within a Planck cube although each may exist in a larger augmented Planck cube defined by (l_{ap}). Scattering experiments reveal quarks and leptons to be smaller than 10^{-18} meters [17]. If higher resolution scattering reveals matter particles are larger than a Planck cube, all analyses remains valid by replacing a Planck cube with an augmented Planck cube [18].

Supersymmetric Higgs particles

The 32 standard and supersymmetric matter and force particles and their 32 anti-particles are supersymmetric with 64 associated Higgs particles and the latter are supersymmetric with themselves. There are three types of spontaneous symmetry breaking functions for three types of matter particles: 17 standard and supersymmetric matter particles, 3 Standard Model Higgsinos, and 12 supersymmetric Higgsinos. Higgs forces/supersymmetric Higgs particles theory is amplified from just the first type of spontaneous symmetry breaking function to all three types.

If a standard or supersymmetric particle is a matter particle (e.g. an up quark p_{11}), its associated Higgs particle is a force particle (e.g. h_{11}). If a standard or supersymmetic particle is a force particle (e.g. a graviton p_1), its associated Higgs particle is a Higgsino (e.g. h_1). If a Higgs particle is a Higgsino (e.g. the Higgsino h_1 associated with the graviton p_1), the Higgs superpartner is a Higgs force (e.g. the Higgs force h_{17} associated with the gravitino p_{17}). If a Higgs particle is a force particle (e.g. the Higgs force h_{11} associated with the up quark p_{11}), the Higgs superpartner is a Higgsino (e.g. the Higgsino h_{27} associated with the up squark p_{27}). The 32 Higgs particles associated with 32 standard and supersymmetric anti-particles are ignored because baryogenesis eliminated them.

Type 1 matter particles or the 17 standard and supersymmetric matter particles include the: top quark p_3, bottom quark p_4, charm quark p_6, strange quark p_7, down quark p_{10}, up quark p_{11}, tau p_5, muon p_8, electron p_{12}, tau-neutrino p_9, muon-neutrino p_{13}, electron-neutrino p_{14}, gravitino p_{17}, gluino p_{18}, wino/zinos p_{31}, photino p_{32}, and W/Z bosons p_{15}. These 17 standard and supersymmetric matter particles and their 17 associated Higgs forces experience spontaneous symmetry breaking as described in the previous section.

Type 2 matter particles or 3 Standard Model Higgsinos (h_1, h_2, and h_{16}) associated with three Standard Model force particles (graviton p_1, gluon p_2, and photon p_{16}), experience spontaneous symmetry breaking as follows. The ball in Fig. 4 starts at the peak position and comes down the spontaneous symmetry breaking function along the X axis until it reaches the point where the Mexican hat intersects the XY plane (X = -10, Y = 0, Z = 0). This is on the vacuum circle for Higgsinos associated with the zero energy graviton, gluon, and photon. In effect, all a super force particle’s energy is condensed to a Higgsino and none to the associated force particle (graviton p_1, gluon p_2, or photon p_{16}).

Type 3 matter particles or 12 supersymmetric Higgsinos (h_{19}….h_{30}) associated with 12 squarks and sleptons (p_{19}….p_{30}) experience spontaneous symmetry breaking as follows [19]. The ball in Fig. 4 starts at the peak position and comes down the spontaneous symmetry breaking function along the X axis to an undefined point between the maximum (X =0, Y = 0, Z = 2) and minimum (X = -10, Y = 0, Z = 0) values. That is, a super force particle condenses into a supersymmetric Higgsino and an associated squark or slepton. The 12 squarks and sleptons are X bosons. X bosons are the latent energy (inflatons) which expanded our universe during the inflationary period and then disappeared. X bosons are to the inflation period as Higgs forces (dark energy) are to our universe’s expansion following inflation. X bosons are also the intermediate force particles (W/Z_{ss} bosons) for supersymmetric (ss) particles as described in the next section. This integrates Higgs forces/supersymmetric Higgs particles with the universe expansions theory, (see Table IV).

Superpartner and quark decays/Neutrino oscillations

Intermediate force particles are W/Z bosons for Standard Model particles and supersymmetric W/Z_{ss} bosons for supersymmetric particles. Decays are a series of evaporations of matter particles and their associated Higgs forces to the super force and condensations from the super force to less massive matter particles and their associated Higgs forces. The neutral heavy lepton is a constituent of dark matter. The theory of Superpartner and quark decays is amplified to include supersymmetric W/Z_{ss} bosons and simultaneous decay of matter particles with their associated 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 mediated by gauge interactions. Heavier matter particles decayed in a cascading process to lower energy/mass matter particles and intermediate force particles. Intermediate force particles were W/Z bosons for Standard Model particles and supersymmetric W/Z_{ss} bosons (X bosons) for supersymmetric particles. For example, in a Beta minus decay, the W^- boson decays to an electron and an anti-electron-neutrino. Similarly, the supersymmetric W/Z_{ss} boson decays to a quark and lepton. Superpartners decayed into lower energy/mass superpartners. The decay chain ended with the stable Lightest Supersymmetric Particle (LSP) [20] and Standard Model particles [21].

Heavy quarks decayed into lower energy/mass quarks and W bosons defined by the Cabibbo-Kobayashi-Maskawa (CKM) matrix. Quark decays were described by modified weak force Feynman diagrams which consisted of evaporations of matter particles and their associated Higgs forces to the super force and condensations from the super force to less massive matter particles and their associated Higgs forces. Modified Beta minus decay was as follows. The down quark p_{10} and its associated Higgs force h_{10} evaporated to a super force particle p_{sfp10} having energy $(p_{10} + h_{10})$. Division of energy not matter occurred as one energy portion condensed into the up quark p_{11} and its associated Higgs force h_{11}, and a second portion condensed into the W^- particle p_{15} and its associated Higgs force h_{15}. Within 10^{-25} seconds, the W^- and its associated Higgs force evaporated back to a super force particle having energy $(p_{15} + h_{15})$. This energy then condensed into an electron p_{12}, its associated Higgs force h_{12}, an anti-electron-neutrino p_{14bar}, and its associated Higgs force h_{14bar}. This integrates superpartner and quark decays and spontaneous symmetry breaking theories, (see Table IV)

There were three neutrino flavors: electron-neutrino, muon-neutrino, and tau-neutrino. Neutrinos oscillated between three flavors via the seesaw model using a neutral heavy lepton (NHL). According to this seesaw model, neutrino mass was $(m_D)^2/M_{NHL}$, where m_D was the Standard Model Dirac mass (i.e. p_{14}, p_{13}, p_9) and M_{NHL} was the neutral heavy lepton mass [22]. The neutral heavy lepton appeared in some Standard Model extensions and was assumed to be the stable fourth family neutrino and a constituent of dark matter [23]. This integrates neutrino oscillations, spontaneous symmetry breaking, and dark matter theories, (see Table IV).

Dark matter

Dark matter consisted of zinos and photinos. Dark matter agglomeration formed the framework of galaxies.

Superpartners decay into the LSP and Standard Model 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 possibly other particles including Higgsinos [24]. Dark matter is assumed to consist of two supersymmetric matter particles (p_{31}, p_{32}) and neutral heavy leptons (either p_{31} or p_{32}).

Start of dark matter agglomeration defined the transition between our universe's uniform and non-uniform distribution of matter expansions. Following this transition, galactic regions were represented by static spatial cubes whereas intergalactic regions were represented by dynamic spatial cubes. Assuming a dark matter agglomeration start time of 30,000 years [25], the Fig. 3 dotted lines show a 10^4 universe range factor expansion from 30,000 years (~ 10^{12} seconds) to the present.

Dark matter agglomeration formed the framework of galaxies. 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].

Universe expansions

There were four sequential universe expansions. Entropy increase of the super force and its derivatives drove the expansion within our universe's first Planck cube. X bosons' (inflatons) latent heat drove the inflationary period's exponential expansion. Dark energy drove both the uniform and non-uniform distribution of matter expansions. String theory's seventh extra dimension was the product of our universe's non-uniform distribution of matter expansion rate and the graviton's intergalactic propagation time. Universe expansions theory was amplified to include expansion within our universe's first Planck cube and identification of X bosons (12 squarks and sleptons) as the latent heat source during inflation.

During the first expansion, our universe's size expanded from a doughnut shaped singularity at t = 0, to a sphere with a radius of .8 x 10^{-35} meters at the start of matter creation (Figs. 2 and 3). Entropy increase of the super, 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 strings.

The inflationary period expansion was similar 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 squarks and sleptons or 12 superpartner forces) were the latent heat energy source during inflation [27]. During the one to seven Planck cube expansion, six matter particles were created (i.e. condensed or froze) and expelled from the original Planck cube to the surrounding Planck cube shell. Then, the first matter shell was pushed out to enable creation of the second matter Planck cube shell. This process continued until the end of inflation when enough Planck cubes existed for all matter particles.

Universe expansion occurred from 10^{-33} seconds to 30,000 years for the uniform distribution of matter and from 30,000 years to the present for the non-uniform distribution of matter. Dark energy (i.e. Higgs forces) drove both the uniform and non-uniform distribution of matter expansions.

Our universe's non-uniform distribution of matter expansion can be represented by a marbles/dough/balloon model consisting of marbles mixed in electromagnetically 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 [28].

Einstein's general relativity representation of static galactic spatial squares (cubes) on a rubber fabric must transition into dynamic spatial squares of intergalactic regions. 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 non-uniform distribution of matter expansion rate (e_r) [29] multiplied by the graviton's intergalactic propagation time (t_i). This product is string theory's seventh extra dimension which dilutes the intergalactic gravitational force because of our universe's non-uniform distribution of matter expansion. This integrates universe expansions with particle creation, inflation, and Higgs forces/supersymmetric Higgs particles theories (see Table IV).

Dark energy

By the end of matter creation or t = 100 seconds, our universe consisted of baryonic matter (4.6 %), cold dark matter (22.8%), and dark energy (72.6%), and these percentages remained constant for 13.7 billion years. The cosmological constant was proportional to vacuum or dark energy density. Dark energy density was the sum of eight permanent Higgs force densities.

By t = 100 seconds, only eight permanent matter particles and their Higgs forces (dark energy) remained. Following t = 100 seconds, baryonic matter could be 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 significantly changing total baryonic energy/mass. This was because only 1% percent of a proton/neutron's energy/mass was rest mass and 99% was nuclear binding energy. Also, nuclear binding energy was a fraction of total kinetic and potential energy [30]. Dark matter could not change following t = 100 seconds because of insufficient temperatures. Thus by the end of matter creation, our universe consisted of baryonic matter (4.6 %), cold dark matter (22.8%), and dark energy (72.6%), and these percentages remained constant for 13.7 billion years.

At t = 100 seconds, our universe consisted of uniformly distributed matter particles (e.g. electrons, protons, neutrons, neutrinos, and dark matter) and their Higgs forces in the space between matter particles (true vacuum). Our universe's uniform 10^{10} K temperature caused radiation emission/absorption between electrons and protons. At 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. Currently, that vacuum temperature is 2.73 K. Dark energy was a constant for 13.7 billion years, however as our universe expanded, dark energy density decreased.

The cosmological constant lambda (Λ) was proportional to the vacuum or dark energy density (ρ_Λ), or $\Lambda = (8\pi G/3c^2)\,\rho_\Lambda$, where G is the gravitational constant and c is the speed of light [31]. Dark energy density: was uniformly distributed in our universe; was the sum of eight permanent Higgs force 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.

Messenger particle operational mechanism

Messenger particles were amplified with embedded clock/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 [32].

Gravitational/electromagnetic

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

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 range between masses/charges, G is the gravitational constant, and C is Coulomb's constant. The graviton extracts mass m_1 and the photon extracts charge q_1 from the attached Higgs force particle (e.g. h_{11} of Fig. 5 Inset) associated with the transmitting particle (e.g. p_{11}). The Higgs force particle includes mass, charges, and spin of both the particle p_{11} and its associated Higgs force h_{11}, and messenger particle p_1, p_2, p_{15}, p_{16} templates [33]. The

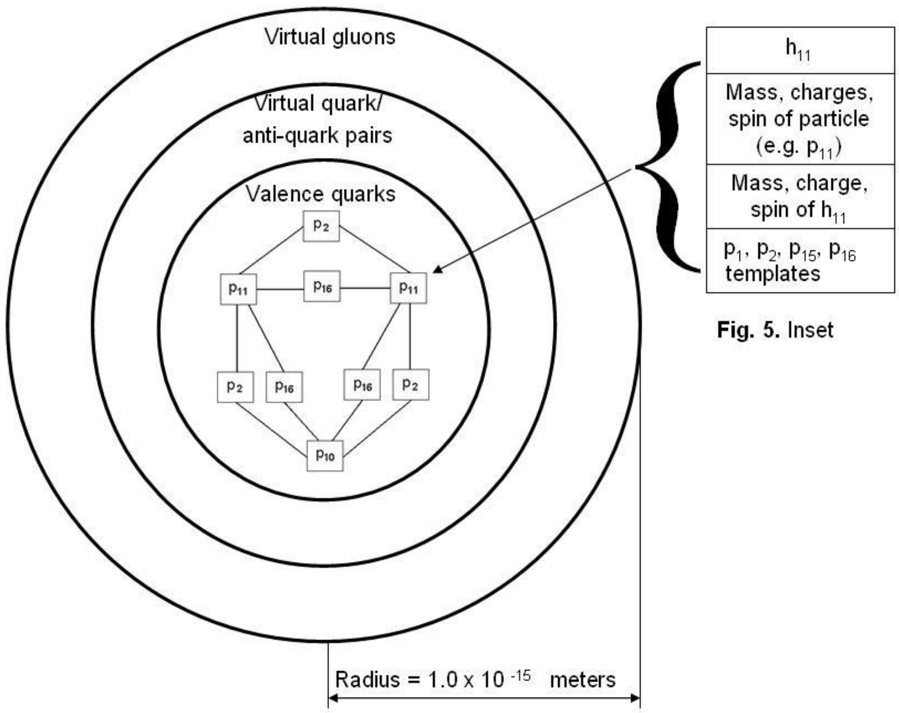

FIG. 5. Hydrogen nucleus (proton).

graviton or photon also extracts G or C in the graviton p_1 and photon p_{16} templates. 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/photon reception the receiving mass m_2 or charge q_2 are extracted from the Higgs force particle associated with the receiving particle. The graviton/photon clock/computer calculates Newton's gravitational or Coulomb's force and provides it to the receiving particle. This integrates messenger particles and Higgs forces/supersymmetric Higgs particles theories, (see Table IV).

Strong

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

The Fig. 5 hydrogen nucleus (proton) consists of contiguous Planck cubes in three nested spheres where the third sphere's radius is 1.0×10^{-15} meters. Fig. 5 is shown in two instead of three dimensions and not to scale. Up quarks p_{11}, down quarks p_{10}, photons p_{16}, and gluons p_2 exist within Planck squares. Gravitons are not included because the gravitational force is negligible within the proton radius. The proton's inner sphere contains two up and one down valence quarks. Quarks have color charges transmitted via gluons. Together, the three valance quarks are colorless. The second spherical volume contains a cloud of virtual quark/anti-quark pairs. A virtual gluon cloud exists in the third spherical volume and the two clouds adopt color charges of the valence quarks.

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 quark separation, 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, the gluon clock/computer provides the constant –k force to the receiving quark. For short 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 [34].

Relative strengths of forces/Hierarchy problem

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

Column two of Table II shows relative strengths of forces. At unification, all force strengths were equal. From Fig. 2, the graviton was created at 5.4×10^{-44} seconds but activated during quark creation at approximately the beginning of the quark era or 10^{-33} seconds. At electromagnetic/weak force creation/activation time or 10^{-12} seconds, the gravitational force had already been diluted by $(t_1/t_2)^2 = (10^{-33}/10^{-12})^2$ or 10^{-42} which is the hierarchy factor. The Fig. 2 derived values in column 3 were comparable to column 2 values, considering the uncertainties of the column 2 reference and Fig. 2. This integrates relative strengths of forces with particle creation and universe expansion theories (see Table IV).

TABLE II. Relative strengths of forces.

Force	Physics handbook [35]	Figure 2 derived
Strong	1	1
Electromagnetic/weak	10^{-3} to 10^{-2}	10^{-2}
Gravitational	10^{-42}	10^{-44}

Super Universe

Universal laws of physics and structure were assumed across the Super Universe (multiverse). Our universe was nested in our precursor universe which was nested in the Super Universe. The Super Universe obeyed conservation of energy/mass, contained 129 particles, and had a constant dark energy to total energy/mass percentage (72.6%) just like our universe.

Stellar black holes

A stellar black hole was a quark star (matter) or black hole (energy) both of which were "black." Six types of 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). Our precursor universe's super supermassive quark star (matter)/black hole (energy) created our universe's "big bang" (white hole) via conservation of energy/mass.

Currently, a stellar black hole is defined as a region of space-time where gravity is so strong not even light can escape and having no support level below neutron degeneracy. The black hole space-time region is a three dimensional sphere which appears as a two dimensional hole. Because of black hole definition inconsistencies (e.g. a singularity is inconsistent with significant area or volume); stellar black hole theory was amplified to define a stellar black hole as a quark star (matter) or black hole (energy) both of which are "black." Their differences are a quark star (matter) has mass, volume, near zero temperature, permanence, and maximum entropy. A black hole (energy) has energy, a Planck cube singularity with minimal volume, near infinite temperature, transientness, and minimal entropy. Six types of stellar black holes are: 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) [36].

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 [37], it stops contracting and becomes a white dwarf supported by electron degeneracy pressure. If the star is between 8 and 20 solar masses, it gravitationally collapses to a neutron star supported by neutron degeneracy pressure, followed by a supernova explosion. Between 20 and 100 solar masses, the star gravitationally collapses to a quark star (matter) supported by quark degeneracy pressure, followed by a quark-nova explosion [38].

Supermassive quark stars (matter) contain 10^6 to 10^{10} solar masses. They may be "fossil quasars" [39], and their masses are proportional to their host galaxies' masses [40]. 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, created over 100 billion neutron and quark stars (matter) and their protogalaxies or supernova and quark-nova remnants, and reionized our universe [41]. Over the next 13.5 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 current universe. That is, over the last 13.5 billion years, approximately 10^6 to 10^{10} solar masses fell into the original neutron and quark stars (matter) [42].

Quark stars (matter) contain between several and 10^6 solar masses. For example, 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 star or quark star (matter) galaxies during the next 13.5 billion years.

Super supermassive quark stars (matter) contain 10^{10} to 10^{24} solar masses. Our precursor universe's super supermassive quark star (matter)/black hole (energy) consisted of a quark star (matter) or a cold quark-gluon plasma [43], which collapsed to its associated black hole (energy). The super supermassive quark star (matter) increased in size via accretion of stars/matter and merger with galaxies. At the 10^{24} solar mass threshold, quark degeneracy pressure was insufficient to stop further collapse. The super supermassive quark star (matter) instantaneously evaporated, deflated, and collapsed to its associated super supermassive black hole (energy). Our precursor universe's super supermassive quark star (matter)/black hole (energy) created our universe's "big bang" (white hole) via conservation of energy/mass. Super supermassive quark stars (matter)/black holes (energy) having approximately 10^{24} solar masses were to universes as supermassive quark stars (matter) were to galaxies.

Our Super Universe's super super supermassive quark stars (matter) collapsed to their associated super super supermassive black holes (energy) to create precursor universes. Super super supermassive quark stars (matter)/black holes (energy) were to precursor universes as super supermassive quark stars (matter)/black holes (energy) were to universes.

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 [44]. BH stands for either "black hole" or "Bekenstein-Hawking."

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 particles can arrange themselves. For the quark star (matter), the total number of ways of distributing N matter particles each in a Planck cube with volume $(l_p)^3$ within a quark star of volume $V = (4\pi r^3/3)$ is [45]:

$S = k \log \Omega$ where

$\Omega = (1/N!)(V/(l_p)^3)^N$ or

$\Omega = (1/N!)(4\pi r^3/3(l_p)^3)^N$

Arrow of time

In our universe and our precursor universe, entropy increased with time. Our universe was created by a doughnut shaped super force singularity of a super supermassive black hole (energy), surrounded by a spherical "perfect" vacuum. Our precursor universe's maximum entropy super supermassive quark star (matter) evaporated, deflated, and collapsed to the minimum entropy black hole (energy), "resurrecting" life.

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 singularity) connecting the two universes [46].

During a specific time interval within a subset volume of our universe, entropy decreased without negating our universe's Second Law of Thermodynamics [47]. 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 and death with high entropy. Since our solar system was one of approximately 100 billion Milky Way galaxy 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. Similarly, entropy increased in our precursor universe whereas entropy decreased in our precursor universe's subset volume containing the super supermassive black hole (energy).

The Hawking temperature of a quark star (matter) with mass M was $T=10^{-7}$ (M_Θ /M) K and its life time t was approximately 10^{66} $(M/M_\Theta)^3$ years, where M_Θ was solar mass, and K was degrees Kelvin [48]. 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 zero. Entropy increased proportional to the event horizon area in the Bekenstein-Hawking formula or to quark star volume in Boltzmann's equation. During the super supermassive quark star (matter) to black hole (energy) collapse; mass, life time, temperature, and entropy values flipped. Mass, life time, and entropy approached zero whereas temperature approached near infinite. However, total energy/mass was conserved. In the super supermassive quark star (matter), energy/mass was spread over a near infinite number of Planck cubes. In the super supermassive black hole (energy), energy was concentrated in a doughnut shaped singularity in a Planck cube. During the deflationary period collapse, each matter particle and its associated Higgs force evaporated to super force energy leaving a "perfect" vacuum in its wake. A "perfect" vacuum is completely empty whereas a true vacuum contains dark energy or Higgs forces. Since the super supermassive black hole's (energy) near infinite temperature was much higher than the surrounding "perfect" vacuum's temperature of 0^{o} K, it transitioned to the white hole and initiated our universe's thermodynamic arrow of time. Our universe was created by a 10^{54} kilogram (10^{24} $M_{\odot}$) doughnut shaped super force singularity surrounded by a spherical "perfect" vacuum. This complied with Einstein's time symmetric Theory of General Relativity.

Fig. 6 shows our precursor universe's super supermassive quark star/black hole to our universe's big bang (white hole) transition. Fig. 6 shows time symmetry between -10^{-33} and 10^{-33} seconds. The number of super force particles was a maximum between -5×10^{-36} and 5×10^{-36} seconds. The number of super force particles decreased during inflation and reached zero at 100 seconds [49].

Matter evaporation between $< -2 \times 10^{-33}$ and -5×10^{-36} seconds was the counterpart of matter creation between 5×10^{-36} and 100 seconds. Deflation occurred during all of matter evaporation whereas inflation occurred only at the beginning of matter creation. Deflation differed from inflation because its duration was longer and had two phases. The second deflation phase (-10^{-33} to -5×10^{-36} seconds) was the time reverse of inflation (5×10^{-36} to 10^{-33} seconds). That is, at -10^{-33} seconds, the super supermassive quark star (matter) consisted of a hot quark-gluon plasma with a radius of 8 meters identical to our universe at 10^{-33} seconds [50]. At -5×10^{-36} seconds, the super supermassive black hole (energy) was identical to our universe's white hole (energy) at 5×10^{-36} seconds. However, the first deflation phase was unique. The start of matter evaporation coincided with the first deflation phase at $t < -2 \times 10^{-33}$ seconds. Deflation of the near zero temperature super supermassive quark star (matter) began when its energy/mass reached the threshold of 10^{54} kilograms. A single electron-neutrino at the center of the super supermassive quark star (matter) was subjected to the highest pressure or temperature. This electron-neutrino and its associated Higgs force evaporated to the super force, incrementally raising the temperature of the super supermassive quark star (matter) center. This began a chain reaction which instantaneously evaporated, deflated, and collapsed the super supermassive quark star (matter) at near zero temperature first to a compact hot quark-gluon plasma at -10^{-33} seconds and then to a super supermassive black hole (energy) at -5×10^{-36} seconds. The deflationary period time was longer than the inflationary period time because it consisted of two phases instead of one.

The maximum entropy super supermassive quark star (matter) evaporated, deflated, and collapsed to the minimum entropy black hole (energy). 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; destruction of structure (information) in the quark star (matter) state and resurrection of life in the black hole (energy) state [51]. This integrated the arrow of time theory with stellar black holes and black hole entropy theories (see Table IV).

Super Supermassive Quark Star (Matter)/Black Hole (Energy) Justification

An Integrated TOE satisfied Conservation of Energy/Mass, Einstein's Theory of General Relativity, and the Second Law of Thermodynamics for our precursor universe's super supermassive quark star (matter)/black hole (energy) transition to the big bang.

Table III compares the Ultimate Free Lunch versus an Integrated TOE. Three laws of physics are listed in column one, the Ultimate Free Lunch Theory [52] in column two, and an Integrated TOE in column three. The prevailing cosmological theory or the Ultimate Free Lunch stated nothing existed before the big bang. The near infinite energy of our universe was created from nothing, or more precisely, from random energy fluctuations. Thus, the Ultimate Free Lunch theory violated Conservation of Energy/Mass. An Integrated TOE satisfied Conservation of Energy/Mass because the energy/mass (10^{24}

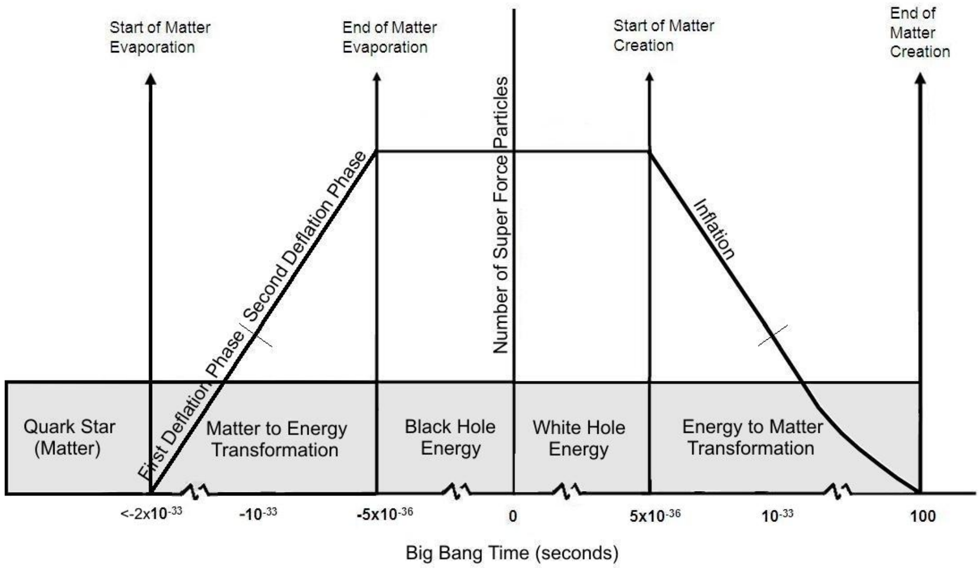

FIG. 6. Quark star/black hole to big bang (white hole) transition.

solar masses) in our precursor universe's super supermassive quark star (matter)/black hole (energy) equaled that in our universe.

TABLE III. Ultimate Free Lunch versus an Integrated Theory of Everything.

Law	The Ultimate Free Lunch Theory	An Integrated TOE
Conservation of Energy/Mass	violates	satisfies
Einstein's Theory of General Relativity	violates	satisfies
Second Law of Thermodynamics	satisfies	satisfies

Einstein's Theory of General Relativity is time symmetrical about t = 0 and consists of a black hole, a white hole, and a wormhole connecting two universes. The Ultimate Free Lunch theory violated Einstein's Theory of General Relativity because nothing preceded our universe. In contrast, an Integrated TOE included a black hole, a white hole, and a wormhole or a doughnut shaped super force singularity in a Planck cube.

The Ultimate Free Lunch satisfied the Second Law of Thermodynamics because it assumed primacy of the latter over the laws of Conservation of Energy/Mass and Einstein's Theory of General Relativity. The logic was if our universe's entropy was a minimum at time t = 0, nothing could have preceded the big bang. Thus, the task was to prove an Integrated TOE complied with the Second Law of Thermodynamics without violating the laws of Conservation of Energy/Mass and Einstein's Theory of Relativity.

In our precursor universe, a super supermassive quark star (matter)/black hole (energy) had two time sequential states; quark star (matter) and black hole (energy). During the super supermassive quark star (matter) to black hole (energy) collapse, the maximum entropy quark star (matter) state evaporated and deflated to the minimum entropy black hole (energy) state. In a subset volume of our precursor universe, the super supermassive quark star (matter) to black hole (energy) collapse reset entropy from maximum to minimum and "resurrected" life via creation of super force or mother particles.

Big Bang Detection via Gravity Waves

The estimated big bang gravitational waveform consists of a pulse and decaying step function, both having equal maximum amplitudes. This waveform should be detectable at the big bang's location and time by an advanced extraordinarily high frequency gravitational observatory.

As shown in Fig. 7, the estimated big bang gravitational energy waveform consisted of a pulse and decaying step function. Time symmetry existed between -10^{-33} and 10^{-33} seconds because the super supermassive quark star (matter) composition at -10^{-33} seconds was identical to the hot quark-gluon plasma at 10^{-33} seconds. Gravitational energy was a maximum at -10^{-33} and 10^{-33} seconds. Between $t = 0$ and $t = 5 \times 10^{-36}$ seconds, gravitational energy was zero because matter particles had not been created. Super force particles began condensing into matter particles and their associated Higgs forces during inflation (5×10^{-36} to 10^{-33} seconds), or during the white hole (energy) to hot quark-gluon plasma (matter) transformation. At the start of the hot quark-gluon plasma (10^{-33} seconds), the heaviest matter particles were in the most compact sphere with a radius of 8 meters (see Fig. 3) and gravitational energy was a maximum. As our universe expanded following 10^{-33} seconds, matter particles moved further apart from each other and gravitational energy decreased. Thus, matter density and gravitational energy were a maximum at 10^{-33} seconds and at the corresponding hot quark-gluon plasma of the super supermassive quark star (matter) at time -10^{-33} seconds.

Prior to the deflation start time at $< -2 \times 10^{-33}$ seconds, the super supermassive quark star (matter) steadily added energy/mass and its gravitational energy increased. At the first deflation phase start time, our universe's energy/mass was spread over an extremely large (radius $<< 10^{26}$ meters) super supermassive quark star (matter) at near zero temperature (cold quark-gluon plasma) [53]. During the first deflation phase between $< -2 \times 10^{-33}$ and -10^{-33} seconds, the super supermassive quark star (matter) at near zero temperature collapsed to a compact hot quark-gluon plasma with a corresponding increase in gravitational energy. Lighter matter particles and their associated Higgs forces evaporated to the super force which then condensed to heavier matter particles and their associated Higgs forces. Since matter particles were further apart at the start of the first deflation phase than at the end, its gravitational energy was less. Matter evaporation during the second deflation phase was the reverse of matter creation during inflation. That is, heavier matter particles and their associated Higgs forces evaporated to super force particles between -10^{-33} and -5×10^{-36} seconds with a decrease in gravitational energy to zero at $t = -5 \times 10^{-36}$ seconds. Between -5×10^{-36} and 5×10^{-36} seconds, all our universe's energy (10^{54} kilograms) was in the form of super force particles and no matter particles or gravitational energy existed. That time period was also the transient life time (approximately 10^{-35} seconds) of the super supermassive black hole (energy)/white hole (energy).

The location of the estimated big bang gravitational waveform was the origin ($x_u = 0$, $y_u = 0$, $z_u = 0$, $t = 0$) of our universe's big bang, see Fig. 1. The estimated gravitational energy waveform occurred at the big bang time $t = 0$, or 13.7 billion years ago. If all our universe's galaxy positions are extrapolated backwards in three dimensional space, they intersect at the origin. The estimated gravitational energy waveform should be detectable at the big bang's location and time by an advanced extraordinarily high

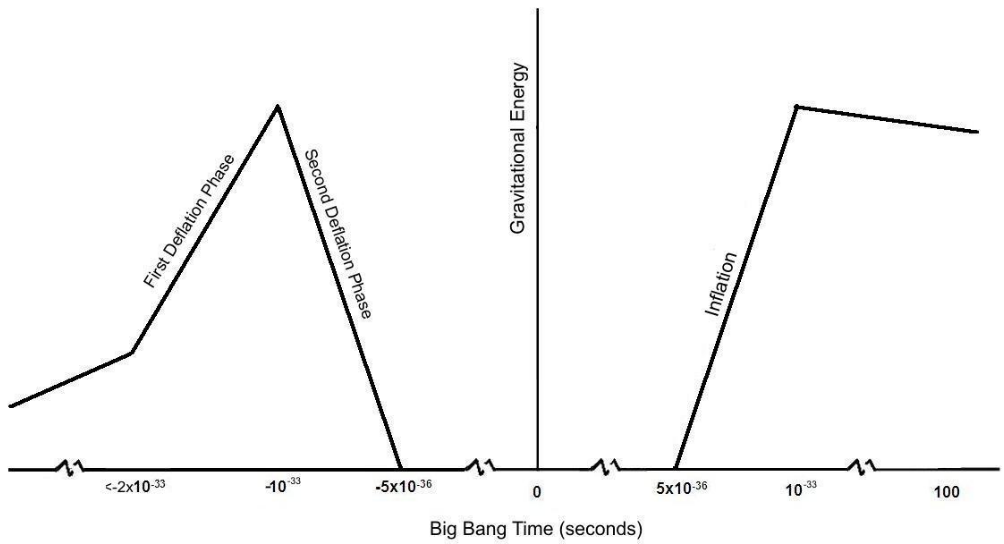

FIG. 7. Estimated big bang gravitational energy waveform.

frequency (> 10^{33} Hertz) Laser Interferometer Gravitational Observatory (LIGO) or Laser Interferometer Space Antenna (LISA).

Cosmological constant problem/Nested universes

Our universe was nested in our precursor universe which was nested in the Super Universe. The cosmological constant problem existed because the Super Universe's volume was 10^{120} larger than our universe's volume. Hubble's law existed for precursor universes within the Super Universe, universes within precursor universes, and galaxies within universes.

The observed cosmological constant was 10^{-120} of the expected value (2 x 10^{110} erg/cm^3) and known as the cosmological constant problem [54]. According to Steinhardt, this problem existed because our universe was older than expected because of precursor cyclical universes [55]. Cyclical universes were amplified to nested universes. Cyclical universes were special cases of nested universes where the super supermassive quark star (matter)/black hole (energy) subset volume equaled the total precursor universe volume.

Fig. 8 shows three nested universes consisting of 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). The Super Universe's big bang occurred at -10^{-50} years [56]. At an assumed t = -15 billion years, a super super supermassive black hole (energy) existed in the Super Universe which was preceded by its associated super super supermassive quark star (matter) [57]. By t = 0, that super super supermassive black hole (energy) expanded into our precursor universe. Within our precursor universe, a super supermassive black hole (energy) formed preceded by its associated super supermassive quark star (matter). The super supermassive black hole (energy) transitioned to our big bang's white hole and after 13.7 billion years of expansion, our present universe exists. Fig. 8 also shows our precursor universe spawning a parallel universe at a time prior to t = 0. Within our universe and the parallel universe were galaxies. Super force

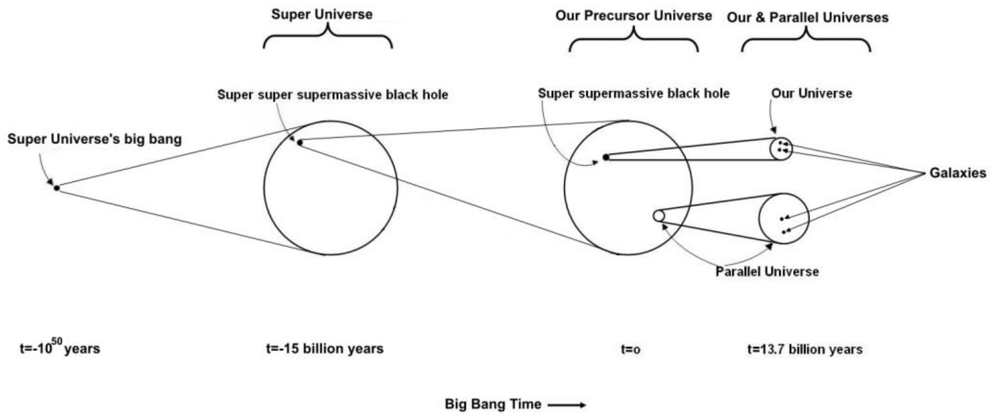

FIG. 8. Super Universe and nested universes.

string singularities at the center of Planck cubes existed at the start of the Super Universe, all precursor universes, and all universes including our universe.

Fig. 9 shows three nested universes at t = 0. Our universe and a parallel universe were nested within our precursor universe. Our precursor universe was nested within the Super Universe. Dark energy density was uniformly distributed throughout the Super Universe, our precursor universe, and our universe. As the Super Universe expanded via eternal inflation, dark energy density decreased with time. Since matter was not uniformly distributed in our precursor universe, subset volumes formed super supermassive quark stars (matter)/black holes (energy) which transitioned to white holes (e.g. our universe) [58].

The cosmological constant problem existed because the Super Universe's volume was 10^{120} larger than our universe's volume. Since 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 light years) was $(10^{120})^{1/3}$ or 10^{40}. The Super Universe's radius was $R_{su} = (10^{40})$ (46.5 x 10^9 light years) or approximately 10^{50} light years. Assuming equal expansion rates, that is, 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.

Since the Super Universe's volume was 10^{120} larger than our universe, there were approximately 10^{120} parallel universes in the Super Universe. Galaxies of these parallel universes were uniformly distributed in the Super Universe between our universe's boundary (our universe's radius of 46.5 billion light years plus the unknown thickness of the spherical shell "perfect" vacuum) and the spherical Super Universe's boundary (radius of 10^{50} light years).

Hubble's law exists for precursor universes within the Super Universe, universes within our precursor universe, and galaxies within our universe as shown in Fig. 10. At the Super Universe's big bang 10^{50} years ago, all the Super Universe's energy (10^{54} kilograms)(10^{120}) = 10^{174} kilograms was in the Super Universe's super force singularity. Precursor universes within the Super Universe were created by precursor universes' big bangs. There was a Hubble's law or a linear relationship between the velocity or red shift of these precursor universes and time or distance. Similarly, there was a Hubble's law for universes within our precursor universe.

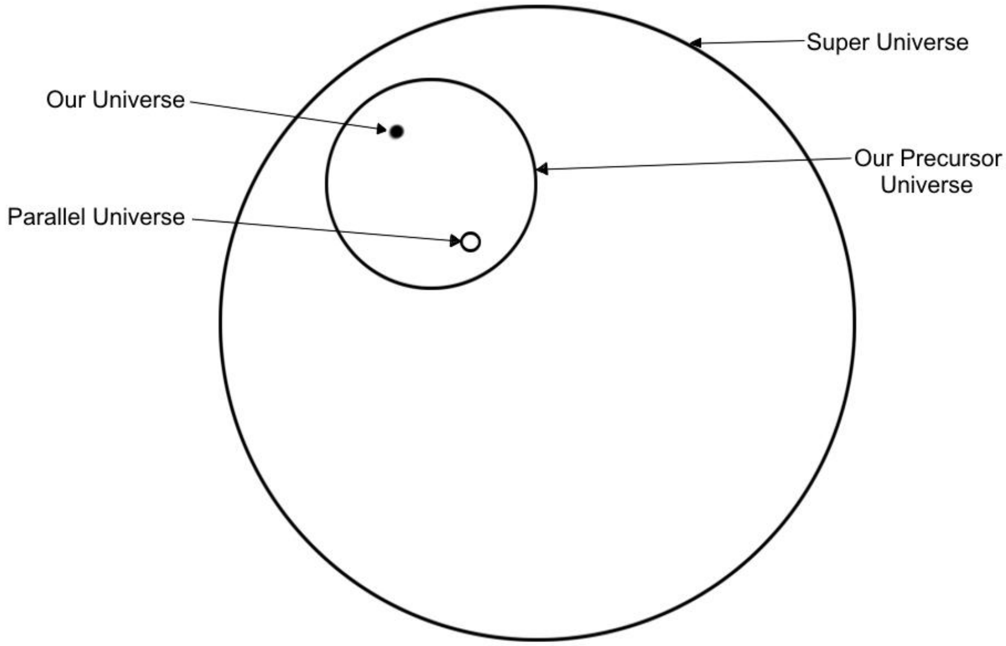

FIG. 9. Three nested universes at t = 0.

Our universe was created 13.7 billion years ago by a doughnut shaped super force singularity surrounded by a spherical “perfect” vacuum. As shown in Fig. 10, our universe decelerated for its first eight billion years and accelerated during the next 6 billion years. Currently, a spherical shell “perfect” vacuum exists between our universe and the inner boundary of our precursor universe. As our universe accelerates, the spherical shell thickness will approach zero. Our universe’s acceleration will stop when our universe’s boundary merges with our precursor universe’s inner boundary. Eventually, the expansion rate of galaxies within our universe will become identical to the expansion rates of universes within our precursor universe and precursor universes within the Super Universe. This is shown by three equal slopes at a time greater than 13.7 billion years [59].

The Hubble Ultra Deep Field telescope can detect galaxies with an age of 13.1 billion years. The James Webb telescope will detect Population III stars and galaxies several hundred million years older. An advanced telescope is required to detect the closest galaxy in the closest parallel universe of our precursor universe, that is, a galaxy with an age greater than 13.7 billion years. This integrates the cosmological constant problem with Super Universe, dark energy, stellar black holes, black hole entropy, and arrow of time theories, (see Table IV).

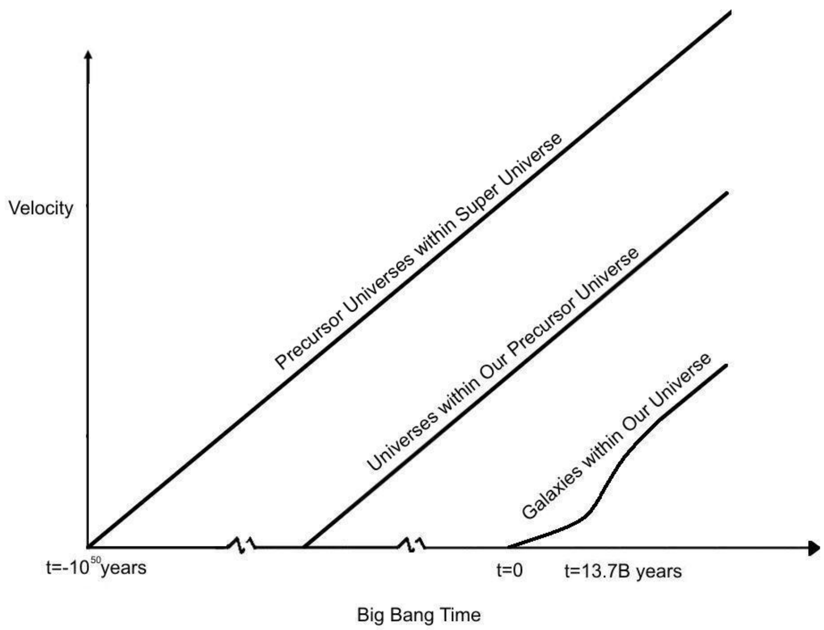

FIG. 10. Hubble's law.

Black hole information paradox

Any universe object's intrinsic information consists of the contents and positions of all the object's contiguous Planck cubes. Intrinsic information is lost in a super supermassive quark star (matter)/black hole (energy) formation and none is emitted as Hawking radiation.

In 1975, Hawking stated Hawking radiation contained no information swallowed by a black hole. In 2004, his position reversed and Hawking radiation contained information. This is the black hole information paradox.

The "No Hair" theorem states a stellar black hole 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 positions (x_u, y_u, z_u, t of Fig. 1) 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. An encyclopedia and a pile of manure having the encyclopedia's identical dimensions and number of Planck cubes have comparable but different intrinsic information. In contrast, the encyclopedia has significant extrinsic information (e.g. its written words) whereas the identical pile of manure has none.

Each up quark, down quark, and electron resides within a specific Planck cube of the encyclopedia's ink, paper, binding, etc. molecules. Encyclopedia intrinsic information is lost in four star stages during decomposition of its molecules to atoms, to protons/neutrons and electrons, to quarks, and to super force energy. In a white dwarf star, molecules decompose to atoms. In a neutron star, atoms decompose to neutrons, protons, and electrons. In a super supermassive quark star (matter), protons and neutrons decompose to up and down quarks. In a super supermassive black hole (energy), up and down quarks decompose (evaporate) to super force particles. Intrinsic or structural information is lost in a super supermassive quark star (matter)/black hole (energy) formation and none is emitted as Hawking radiation.

This integrates black hole information paradox with stellar black holes and particle creation theories (see Table IV).

Baryogenesis

Charge, parity, and time (CPT) violation was the theory which best explained baryogenesis. There were three CPT violation arguments which supported each other and conclusions of previous sections. CPT, unitarity, and entropy preservation were violated in the highly curved space-times of both our precursor universe's super supermassive black hole (energy) and its big bang white hole (energy) counterpart.

Baryogenesis is **t**he asymmetric production of baryons and anti-baryons in the early universe expressed as the baryon to photon ratio $\eta = 6.1 \times 10^{-10}$ [60]. There are 42 identified baryogenesis theories of which six are prominent; electroweak, GUT, quantum gravity, leptogenesis, Affleck-Dine, and CPT violation [61]. Electroweak occurs insufficiently in the Standard Model and is considered unlikely without supersymmetry. Inflationary scenarios disfavor GUT and quantum gravity theories. Leptogenesis and Affleck-Dine are viable but not well understood [62].

The sixth baryogenesis theory is CPT violation which has three mutually supportive arguments. The first argument is the CPT theorem is invalid at the Planck scale [63].

According to 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. In the second argument, highly curved space-times such as a super supermassive black hole (energy) singularity violate CPT because of apparent violations of unitarity caused by incoming matter information disappearance [64]. From the black hole information paradox section's conclusion, incoming matter information is lost in a super supermassive black hole (energy) formation.

The third argument is a quantum mechanics axiom states the evolution of a system, or the transformation from one state to another, must be unitary. Entropy is preserved in unitary dynamics [65]. In a super supermassive quark star (matter) to black hole (energy) collapse, energy/mass quanta in Planck cubes collapse to a super force singularity (no quanta). Thus, quantum mechanics is invalid and unitarity and entropy preservation are violated. From the arrow of time section's conclusion, in a super supermassive quark star (matter) to black hole (energy) collapse, entropy switches from maximum to minimum so entropy is not preserved.

CPT, unitarity, and entropy preservation were violated in the highly curved space-times of both our precursor universe's super supermassive black hole (energy) and its big bang white hole (energy) counterpart. Each matter particle's transformation to a super force particle and each super force to matter particle transformation violated CPT, which provided sufficient CPT violations to produce our universe's baryon to photon ratio of 6.1×10^{-10}.

This integrates baryogenesis with black hole information paradox, arrow of time, stellar black holes, and black hole entropy theories (see Table IV).

Quantum Gravity Theory

Quantum gravity, string theory, and an Integrated TOE unify all known physical phenomena from the infinitely small or Planck cube scale (quantum mechanics) to the infinitely large or Super Universe scale (Einstein's General Relativity). Quantum gravity theories include string theory.

Quantum gravity is an evolving theory that unifies quantum mechanics at the infinitely small Planck cube scale to Einstein's General Relativity at the infinitely large Super Universe scale. All matter and force particles exist as strings 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 mechanics. Extremely massive and dense bodies such as collapsed stars of the infinitely large Super Universe are governed by Einstein's law of General Relativity. Collapsed stars include; white dwarfs, neutron stars, supermassive quark stars (matter), super supermassive quark stars (matter)/black holes (energy), and super super supermassive quark stars (matter)/black holes (energy).

String theory defined all fundamental matter and force particle as strings in Planck cubes. Any object in the Super Universe can be represented by a volume of contiguous Planck cubes containing fundamental matter or force particle strings. Super force string singularities at the center of Planck cubes existed at the start of the Super Universe, all precursor universes, and all universes including our universe. Thus, string theory unified quantum mechanics of the infinitely small at the Planck cube scale (e.g. fundamental matter and force particles) with Einstein's General Relativity of the infinitely large at the Super Universe scale (e.g. the super super super supermassive black hole (energy) or doughnut shaped super force singularity which created the Super Universe).

Quantum gravity, string theory, and an Integrated TOE unified all known physical phenomena from the infinitely small or Planck cube scale (quantum mechanics) to the infinitely large or Super Universe scale (Einstein's General Relativity). This integrated quantum gravity with all other nineteen theories in an Integrated Theory of Everything (see Table IV).

Conclusions

An Integrated TOE unified all known physical phenomena from the infinitely small or Planck cube scale to the infinitely large or Super Universe scale. Each matter and force particle existed within the universe's fundamental building block, the Planck cube. Any universe object was representable by a volume of contiguous Planck cubes. The Planck cube was the quantum or unit of matter particle, force particle, and space. An Integrated TOE unified 16 Standard Model particles, 16 supersymmetric particles, 32 anti-particles, their 64 associated supersymmetric Higgs particles, and the super force or mother particle for 129 particles.

Each of 129 fundamental matter and force particles was represented by its unique string or associated Calabi-Yau membrane in a Planck cube. A string or associated Calabi-Yau membrane's energy/mass was primarily a function of its diameter and secondarily its hills and valley's amplitude displacement and frequency. The big bang's near zero diameter singularity of superimposed super force strings consisted of our universe's near infinite energy. Any object in the Super Universe could be represented by a volume of contiguous Planck cubes containing fundamental matter or force particle strings. Super force string singularities at the center of Planck cubes existed at the start of the Super Universe, all precursor universes, and all universes including our universe.

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

The big bang created our universe's 128 particles from the super force having energy of 10^{54} kilograms. Matter creation was time synchronous with both the inflationary period start time and the one to seven Planck cubes energy to matter expansion. By t = 100 seconds, all super force energy had condensed into eight permanent matter particles and their eight associated Higgs force energies.

The process of generating 17 matter particles and their 17 associated Higgs forces was spontaneous symmetry breaking or the Higgs mechanism. The sum of eight permanent Higgs forces' energies associated with eight permanent matter particles: atomic matter (up quark, down quark, electron); dark matter (zino, photino); and neutrino matter (tau-neutrino, muon-neutrino, electron-neutrino) constituted dark or vacuum energy.

The 32 standard and supersymmetric matter and force particles and their 32 anti-particles were supersymmetric with 64 associated Higgs particles and the latter were supersymmetric with themselves. There were three types of spontaneous symmetry breaking functions for three types of matter particles: 17 standard and supersymmetric matter particles, 3 Standard Model Higgsinos, and 12 supersymmetric Higgsinos.

Intermediate force particles were W/Z bosons for Standard Model particles and supersymmetric W/Z_{ss} bosons for supersymmetric particles. Decays were a series of evaporations of matter particles and their associated Higgs forces to the super force and condensations from the super force to less massive matter particles and their associated Higgs forces. The neutral heavy lepton was a constituent of dark matter.

Dark matter consisted of zinos and photinos. Dark matter agglomeration formed the framework of galaxies.

There were four sequential universe expansions. Entropy increase of the super force and its derivatives drove the expansion within our universe's first Planck cube. X bosons' (inflatons) latent heat drove the inflationary period's exponential expansion. Dark energy drove both the uniform and non-uniform distribution of matter expansions. String theory's seventh extra dimension was the product of our universe's non-uniform distribution of matter expansion rate and the graviton's intergalactic propagation time.

By the end of matter creation or t = 100 seconds, our universe consisted of baryonic matter (4.6 %), cold dark matter (22.8%), and dark energy (72.6%), and these percentages remained constant for 13.7 billion years. The cosmological constant was proportional to vacuum or dark energy density. Dark energy density was the sum of eight permanent Higgs force densities.

Messenger particles were amplified with embedded clock/computers as their operational mechanisms. The graviton/photon clock/computer calculated Newton's gravitational or Coulomb's force and provided it to the receiving particle. The gluon clock/computer calculated the strong force and provided it to the receiving quark. The relative strengths of gravitational and electromagnetic/weak forces were due to propagation factor dilution between gravitational force activation and electromagnetic/weak force creation/activation.

A stellar black hole was a quark star (matter) or black hole (energy) both of which were "black." Six types of 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). Our precursor universe's super supermassive quark star (matter)/black hole (energy) created our universe's "big bang" (white hole) via conservation of energy/mass.

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 $(l_p)^3$.

In our universe and our precursor universe, entropy increased with time. Our universe was created by a doughnut shaped super force singularity of a super supermassive black hole (energy), surrounded by a spherical “perfect” vacuum. Our precursor universe’s maximum entropy super supermassive quark star (matter) evaporated, deflated, and collapsed to the minimum entropy black hole (energy), “resurrecting” life.

An Integrated TOE satisfied Conservation of Energy/Mass, Einstein’s Theory of General Relativity, and the Second Law of Thermodynamics for our precursor universe’s super supermassive quark star (matter)/black hole (energy) transition to the big bang.

The estimated big bang gravitational waveform consisted of a pulse and decaying step function, both having equal maximum amplitudes. This waveform should be detectable at the big bang’s location and time by an advanced extraordinarily high frequency gravitational observatory.

Our universe was nested in our precursor universe which was nested in the Super Universe. The cosmological constant problem existed because the Super Universe’s volume was 10^{120} larger than our universe’s volume. Hubble’s law existed for precursor universes within the Super Universe, universes within precursor universes, and galaxies within universes.

Any universe object’s intrinsic information consisted of the contents and positions of all the object’s contiguous Planck cubes. Intrinsic information was lost in a super supermassive quark star (matter)/black hole (energy) formation and none was emitted as Hawking radiation.

Charge, parity, and time violation was the theory which best explained baryogenesis. There were three CPT violation arguments which supported each other and conclusions of previous sections. CPT, unitarity, and entropy preservation were violated in the highly curved space-times of both our precursor universe’s super supermassive black hole (energy) and its big bang white hole (energy) counterpart.

Quantum gravity, string theory, and an Integrated TOE unified all known physical phenomena from the infinitely small or Planck cube scale (quantum mechanics) to the infinitely large or Super Universe scale (Einstein’s General Relativity). Quantum gravity theories included string theory.

Twenty independent existing theories were replaced by an Integrated TOE consisting of twenty interrelated amplified theories. Table IV Primary interrelationships between twenty amplified theories summarized the interrelationships of an Integrated TOE.

Table IV. Primary interrelationships between twenty amplified theories.

	String	Particle creation	Inflation	Spontaneous symmetry breaking	Higgs forces/supersymmetric Higgs particles	Superpartner and quark 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
String	x	x												x						x
Particle creation	x	x	x	x	x			x	x	x		x		x				x	x	x
Inflation		x	x	x	x			x	x	x									x	x
Spontaneous symmetry breaking		x	x	x	x	x	x	x		x									x	x
Higgs forces/ supersymmetric Higgs particles		x	x	x	x			x	x	x	x								x	x
Superpartner and quark decays				x		x														x
Neutrino oscillations				x			x	x												x
Dark matter		x	x	x	x		x	x		x									x	x
Universe expansions		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
Relative strengths of forces		x							x			x								x
Super Universe										x			x	x	x	x	x			x
Stellar black holes	x	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
Cosmological constant problem										x			x	x	x	x	x			x
Black hole information paradox		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

[1] The Planck cube quantum was selected for two reasons, Planck units and string theory. Planck units consist of the following 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 three of the five constants; gravitational constant, reduced Planck constant, and the speed of light in a vacuum. In string theory, the Planck length is the size of matter and force particle strings.

[2] In the future, the universal rectangular coordinate system should originate at the "Super Universe's" big bang.

[3] B. Greene, *The Elegant Universe* (Vintage Books, New York, 2000), p. 144. Greene specifies only amplitude displacement and wavelength (frequency). He also describes Calabi-Yau membranes as beach balls, doughnuts, and multidoughnuts, and conifold transitions as the procedure whereby membranes transition into each other, pp. 327-329. Energy (E) is inversely proportional to diameter (d), for example, $E = 1/d^n$, where n is an exponent.

[4] G. W. Hinshaw, http://map.gsfc.nasa.gov/universe/uni_matter.html. (2010). Click on Our Universe (Matter/Energy). Mass = (Universe volume) (density) = $[4\pi(4.4 \times 10^{26} \text{ meters})^3/3]$ $[9.9 \times 10^{-27}$ kilograms/meters$^3] = 3.5 \times 10^{54}$ kilograms. Near infinite is defined as finite but extremely large.

[5] The relationship between quantum numbers and particle location should be analyzed. For example, the relationship between the four quantum numbers of an electron in an atom and the electron's location should be extended to "free" fundamental particles such as electrons and up quarks in a quark-gluon plasma.

[6] The W/Z bosons (p_{15}) are actually transient matter particles with associated Higgs force particles (h_{15}) instead of force particles (bosons) with associated Higgsino matter particles.

[7] M. Rees, Ed., *Universe*. (DK Publishing, New York, 2005), pp. 46-49.

[8] The W/Z bosons were represented by one p_{15} instead of three (W^+, W^-, and Z^0 or p_{15a}, p_{15b}, and p_{15c}) particles.

[9] A. H. Guth, *The Inflationary Universe* (Perseus Publishing, New York, 1997), p. 185 Fig. 10.6. Fig. 3 initialized the inflationary period start radius at $.8 \times 10^{-35}$ meters with an exponential inflation factor of 10^{36}. Guth's comparable values were 10^{-50} meters and 10^{49}. Liddle and Lyth specify an exponential inflation factor greater than 10^{26}. (*Cosmological Inflation and Large-scale Structure*, p 46)

[10] The end of matter creation was assumed to be the end of the lightest anti-matter particle or the anti-electron-neutrino. Anti-electron-neutrinos existed after 100 seconds. However, since the end time of anti-electron-neutrinos was unknown, the end of matter creation was approximated to be 100 seconds or the end of anti-electrons.

[11] W/Z bosons are transient matter particles which cause an asymmetrical number of matter particles (i.e. 17 instead of 16).

[12] Twelve superpartners were assumed to exist at $< 10^{-36}$ seconds because they were the latent heat source during inflation.

[13] A. H. Guth, *The Inflationary Universe* (Perseus Publishing, New York, 1997), p. 209 Fig. 12.1, pp. 140-3.

[14] During baryogenesis, the ball initially at its peak position $h_{11} = h_{11bar} = 0$, Z =2, moves down the spontaneous symmetry breaking function equidistant between the X and Y axes. Super force particles condense into a particle p_{11}, its associated Higgs force h_{11}, an anti-particle p_{11bar}, and its associated Higgs force h_{11bar}. The four particles then annihilate and evaporate back to super force energy as the ball returns to its initial peak position (bidirectional spontaneous symmetry breaking). During the second cycle, the ball moves down the spontaneous symmetry breaking function closer to the X axis and then back to its original position. After n condensation/evaporation cycles in the false vacuum state, the ball eventually moves to the Fig. 4 ball position ($h_{11} = -2$, $h_{11bar} = 0$, Z =1.5) or the true vacuum state where the super force condenses totally to the permanent up quark p_{11} and its associated Higgs force h_{11}.

[15] The Higgs force is energy and not a point particle such as an up quark. Therefore, the Large Hadron Collider should search for Higgs force energy not Higgs force point particles having cross sections.

[16] A second type of bidirectional spontaneous symmetry breaking is subsequently described for the collapse of a super supermassive quark star (matter) to a super supermassive black hole (energy) where permanent matter particles and their associated Higgs forces evaporate back to super force particles.
[17] B. Povh, K. Rith, C. Scholz, and F. Zetsche, *Particles and Nuclei* (Springer-Verlag Berlin, Heidelburg, 2008), p. 2.
[18] However, density calculations if used must be modified.
[19] Although 17 types of super force particles are described in this article, there are actually 64 types of super force particles which experience spontaneous symmetry breaking and condense into 32 matter and force particles, 32 anti-matter and force particles, and their 64 associated Higgs particles. However, baryogenesis eliminates half of these, so there are just 32 super force types which condense into 17 standard (13) and supersymmetric (4) matter particles and their 17 associated Higgs forces and 15 Higgsinos and their 15 standard (3) and supersymmetric (12) associated forces.
[20] Since the stable LSPs (zinos and photinos) formed by 10^{-12} seconds or an approximate temperature of 10^{15} K, supersymmetric W/Z_{ss} bosons do not exist after that time or temperature. Therefore, there can be no indirect detection of dark matter (zinos and photinos) via annihilation products in our universe's galaxies which are at lower temperatures than 10^{15} K.
[21] G. Kane, Sci. Am. **293**, 40-48 (July 2005).
[22] B. Kayser, http://www.pd.infn.it/~laveder/unbound/scuole/2009/DBD-09/B_Kayser-DBDmeeting-oct-2009.pdf. (2009). The NHL is referred to as a large right-handed Majorana.
[23] M. Y. Khlopov, http://www.roma1.infn.it/people/bini/seminars/khlopov.ppt. (2006).
[24] D. B. Cline, Sci. Am. **288**, 53 (March 2003). As described in the Supersymmetric Higgs particles section, 15 Higgsinos were produced during spontaneous symmetry breaking. An undefined subset of these including h_1, h_2, and h_{16} associated with the graviton p_1, gluon p_2, and photon p_{16}, should eventually be included as dark matter components.
[25] M. Turner's estimate (private communication).
[26] G. W. Hinshaw, http://arxiv.org/pdf/0803.0732v2.pdf (2008).
[27] E. J. Chaisson, https://www.cfa.harvard.edu/~ejchaisson/cosmic_evolution/docs/text/text_part_5.html (2012).
[28] Galaxies were created approximately 200 million years after the start of our universe when population III stars formed, collapsed, and created prototype galaxies.
[29] 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.
[30] A second reason for a constant total baryonic energy/mass was rest mass was converted to kinetic energy and radiation during nucleosynthesis. For example, stellar nucleosynthesis for stars heavier than our sun occurred via the CNO (carbon-nitrogen-oxygen) cycle. In this cycle, 4 protons fused and produced an alpha particle, 2 positrons, 2 electron neutrinos, 3 gamma rays, and 26.8 MeV of energy. The energy appeared as kinetic energy of the products. Also, the 3 gamma rays were eventually absorbed by matter particles and converted into kinetic energy. Thus, the total baryonic energy/mass remained constant at 4.6%.
[31] S. M. Carroll, http://preposterousuniverse.com/writings/encyc/. (2000).
[32] A. Zichichi, http://cerncourier.com/cws/article/cern/38704. (2009).
[33] The handedness characteristic, discrimination among multiple fermion forces, and messenger particle repetition rates should be analyzed and incorporated into an updated messenger particle theory.
[34] M.A. Thomson, http://www.hep.phy.cam.ac.uk/~thomson/lectures/partIIparticles/pp2004_qcd.pdf. (2004).
[35] C. P. Poole, *The Physics Handbook*, (John Wiley, New York, 1998), p. 365 Fig. 25-1. Electromagnetic and weak force strengths are equal under 10^{-18} meters.
[36] Smaller types of black holes (e.g. micro) were not analyzed.
[37] C. Miller (private communication). The discrepancy between the initial star mass (8 solar) and the final mass (1.38 solar or Chandrasekhar limit) is due to winds.

[38] D. Leahy, R. Ouyed, http://arxiv.org/PS_cache/arxiv/pdf/0708/0708.1787v4.pdf. (2008).The quark star (matter) formed following a quark-nova's confinement energy release. The delayed secondary explosion followed a neutron star's primary supernova explosion.
[39] D. Savage, http://hubblesite.org/newscenter/archive/releases/1997/01/text/. (1997).
[40] C. Carilli, Science **323**, 323 (2009). Galaxy to central black hole mass ratio was 30:1 in the early universe and 700:1 now.
[41] R. Irion, Science **295**, 66 (2002).
[42] If a supermassive quark star (matter) accreted all star/matter in its vicinity it could appear as a void.
[43] A. Kurkela, P. Romatschke, A. Vuorinen, http://arxiv.org/PS_cache/arxiv/pdf/0912/0912.1856v2.pdf. (2010).
[44] J. D. Bekenstein, http://arxiv.org/PS_cache/quant-ph/pdf/0311/0311049v1.pdf. (2003).
[45] A. Dabholkar, Current Science **89**, 2059 (2005).
[46] A. Hamilton, http://casa.colorado.edu/~ajsh/schww.html (2001). A white hole is the reverse of a black hole. A black hole swallows matter and energy whereas a white hole expels it.
[47] B. Greene, *The Fabric of the Cosmos* (Vintage Books, New York, 2005), p. 173.
[48] K. Griest, http://physics.ucsd.edu/students/courses/winter2010/physics161/p161.3mar10.pdf. (2010).
[49] Permanent matter particles (e.g. up quark) are represented by step functions having finite rise times and centered at each matter particle's condensation time. A transient matter particle (e.g. top quark) is represented by, for example, a Gaussian function centered at its condensation time and with a finite standard deviation.
[50] At $t = 10^{-33}$ seconds or the quark era start, our universe consisted of a hot quark-gluon plasma.
[51] The super supermassive quark star (matter) was a sphere consisting of a near zero temperature quark-gluon plasma with eight permanent matter particles: atomic matter (down quark, up quark, and electron); neutrino matter (tau-neutrino, muon-neutrino, and electron-neutrino) and dark matter (photino, zino).
The super supermassive black hole (energy) was a rotating, charged, doughnut shaped super force singularity at the center of a Planck cube. This singularity was also known as a Kerr-Newman black hole.
[52] The term "Ultimate Free Lunch" is attributed to Dr. Alan Guth based on a paper by Edward Tryon, *"Is the Universe a Vacuum Fluctuation,"* Nature **246**, 396-7 (1973). See A. H. Guth, *The Inflationary Universe* (Perseus Publishing, New York, 1997), chapters 1 and 17.
[53] The radius of the extremely large super supermassive quark star (matter) which created our universe was much less than 10^{26} meters, or $<< 10^{26}$ meters, and estimated as follows. The Schwarzschild radius which defined the event horizon for a non-rotating quark star was 4×10^{26} meters for our universe's mass, or $R_s = (2G/c^2)(m) = (1.48 \times 10^{-27}$ m/kg$)(.274 \times 10^{54}$ kg$) = 4 \times 10^{26}$ m, where R_s is the Schwarzschild radius, G is the gravitational constant, c is the velocity of light, and m is mass. This was the upper radius limit. Since the super supermassive quark star's (matter) equation of state and its cold quark-gluon plasma density were unknown, the lower radius limit was estimated as follows. The theoretical lower radius limit occurred when all matter particles of the super supermassive quark star (matter) were in contiguous Planck cubes. If each matter particle existed in a Planck cube and there were 10^{81} matter particles, the super supermassive quark star's (matter) volume was $V = (1.6 \times 10^{-35}$ m$)^3$/ (matter particle) (10^{81} matter particles) $= 4 \times 10^{-24}$ m^3 or a radius of approximately 10^{-8} meters. The estimated super supermassive quark star's (matter) radius was between the upper (4×10^{26} meters) and lower (10^{-8} meters) radius limits or approximately $<< 10^{26}$ meters.
The start of deflation or matter evaporation in Fig. 6 and Fig. 7, was estimated at less than twice the inflation time ($< -2 \times 10^{-33}$ seconds) as follows. During the inflation time of approximately 10^{-33} seconds, our universe expanded in size from a radius of $.8 \times 10^{-35}$ meters to a radius of 8 meters for an exponential inflation factor of 10^{36}. To achieve a radius of 4×10^{26} meters from a radius of 8 meters requires an additional exponential inflation factor of $4 \times 10^{26}/8 \sim 10^{26}$ which is less than 10^{36}. Therefore, assuming identical exponential inflation/deflation rates and the upper limit radius of 4×10^{26} meters, less than twice the inflation time or $< 2 \times 10^{-33}$ seconds would be required for our precursor universe's super supermassive quark star (matter) to deflate from 4×10^{26} meters to $.8 \times 10^{-35}$ meters.

[54] S. M. Carroll, http://www.livingreviews.org/lrr-2001-1. (2008).
[55] P. J. Steinhardt and N. Turok, *Endless Universe: Beyond the Big Bang* (Doubleday, New York, 2007), p 249.
[56] Eventually the big bang time scale where our universe's big bang occurred at t = 0, should be replaced by the start of the Super Universe where t = 0 occurred 10^{50} years ago.
[57] Fig. 8 shows one precursor universe between the Super Universe and our universe. However, there could be from 0 to n precursor universes. For n = 0, the Super Universe was our precursor universe. In general, there were n nested precursor universes.
To provide a variety of sizes for a quark star (matter) to its associated black hole (energy) collapse, collapse size was assumed to be a function of two thresholds, energy/mass and energy/mass density. For creation of our universe, the energy/mass threshold was 10^{54} kilograms and the associated energy/mass density was ρ_{ou} (where ou signifies our universe) and currently undefined. If only one collapse threshold existed (e.g. energy/mass), any super supermassive quark star (matter) greater than 10^{54} kilograms would collapse to its associated super supermassive black hole (energy) before it grew any larger. A super super supermassive quark star (matter) was assumed to have an energy/mass collapse threshold much greater than 10^{54} kilograms and an energy/mass density collapse threshold different than ρ_{ou}. There were thus many combinations of energy/mass and energy/mass density thresholds for creation of a variety of super supermassive quark stars (matter)/black holes (energy) sizes in precursor universes and super super supermassive quark stars (matter)/black holes (energy) sizes in the Super Universe.
[58] Matter is currently uniformly distributed on a large scale in our universe where large scale is defined as a cube with a side equal to approximately 300 million light years. See R. P. Kirshner, *The Extravagant Universe: Exploding Stars, Dark Energy and the Accelerating Cosmos*, (Princeton University Press, Princeton, 2002), p. 71.
[59] The simplest Hubble's law of equal and constant expansion was assumed in Fig. 10 for the three categories; precursor universes within the Super Universe, universes within our precursor universe, and galaxies within our universe.
[60] J. M. Cline, http://arxiv.org/PS_cache/hep-ph/pdf/0609/0609145v3.pdf. (2006). Big bang nucleosynthesis determined η and the Wilkinson Microwave Anisotropy Probe measured it accurately.
[61] M. Shaposhnikov, http://www.physicsforums.com/archive/index.php/t-53648.html. (2004).
[62] N. Bao, P. Saraswat, http://www.astro.caltech.edu/~golwala/ph135c/14SaraswatBaoBaryogenesis.pdf. (2007).
[63] T. D. Lee, *Selected Papers, 1985-1996* (Gordon and Breach, Amsterdam, 1998), p 776, p 787.
[64] N. E. Mavromatos, http://arxiv.org/PS_cache/hep-ph/pdf/0504/0504143v1.pdf. (2005).
[65] F. Hulpke et al., Foundations of Physics **36**, 479, 494 (2006).
[66] I am grateful to all my formal and informal educators.