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An Integrated Theory of Everything – Revision A

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Abstract. Via a single string theory solution, an Integrated Theory of Everything (TOE) unified all known physical phenomena from the Planck cube to the Super Universe (multiverse). Each of 129 fundamental matter and force particles was defined by its unique closed string in a Planck cube. Any object in the Super Universe was defined by a volume of contiguous Planck cubes containing fundamental matter or force particle strings. Super force string doughnut singularities existed at the center of Planck cubes at the start of the Super Universe, all precursor universes, and all universes including our universe. String theory's six extra dimensions were the dynamic point particle position and velocity coordinates in a Planck cube. Two reasons for replacing inadequate existing matter and force particle symbols were explicit Higgs particle representation and elimination of ambiguities. Our universe's 128 matter and force particles were created from the super force. Matter creation was time synchronous with both inflation start time and the one to seven Planck cubes energy to matter expansion. Higgs particles were God particles because they constituted approximately 82% of our universe's total energy/mass. The sum of eight Higgs force energies associated with eight permanent matter particles was dark energy. Spontaneous symmetry breaking occurred for 17 matter particles and had two time sequential phases. Decays were a series of evaporations/condensations of matter particles and their associated Higgs forces to and from the super force. Neutrinos oscillated between three flavors via the seesaw model using a neutral heavy lepton. Dark matter consisted of zinos, photinos, and three permanent Higgsinos. There were four types of sequential universe expansions. The product of the non-uniform distribution of matter expansion rate and the graviton's intergalactic propagation time was string theory's seventh extra dimension. By the end of matter creation, our universe consisted of atomic/subatomic matter (4.9 %), cold dark matter (27%), and dark energy (68%), and those percentages remained constant for 13.8 billion years (Lamda cold dark matter ΛCDM cosmological model). Messenger particles contained embedded clocks/computers. The relative strengths of gravitational and electromagnetic forces were due to gravitational propagation factor dilution. All 128 matter and force particles were required for conservation of energy/mass accountability. The single vacuum Super Universe consisted of nested parallel precursor and nested parallel universes. Stellar black holes included quark stars (matter) and black holes (energy). The Friedmann metric had three scenarios. The proposed entropy formula for a quark star (matter) was proportional to the quark star's volume and inversely proportional to a Planck cube's volume. In our precursor universe, a super supermassive quark star (matter) instantaneously evaporated, deflated, and collapsed to its associated super supermassive black hole's (energy) which created our universe. The prevailing cosmology theory "The Ultimate Free Lunch" satisfied only the third of three laws of physics and should be replaced by "An Integrated TOE" which satisfied all three. 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. Proof of the Super Universe's parallel universes was via two advanced optical and gravitational observatory techniques. Intrinsic or structural 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 caused baryogenesis. String theory and an Integrated TOE were identical to quantum gravity theory. Two steps were required for an Integrated TOE mathematical solution, a fundamental physics step and a two part mathematics step. Conclusions: For an Integrated TOE, twenty independent existing theories were replaced by twenty interrelated amplified theories and summarized in Table 5; six Integrated TOE advanced validation techniques and independent analyses/validations by physicists were proposed.

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1 Introduction

The foundations of an Integrated TOE are the following twenty independent existing theories; string, particle creation, inflation, Higgs forces, spontaneous symmetry breaking, 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, 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 and summarized in Table 5, Primary interrelationships between twenty interrelated amplified theories.

2 String theory

Via a single string theory solution, an Integrated TOE unifies all known physical phenomena from the near infinitely small Planck cube scale (quantum mechanics) to the near infinitely large Super Universe (multiverse) scale (Einstein's General Relativity). Each of 129 fundamental matter and force particles is defined by its unique closed string in a Planck cube. Any object in the Super Universe is defined by a volume of contiguous Planck cubes containing fundamental matter or force particle strings. Super force string doughnut singularities existed at the center of Planck cubes at the start of the Super Universe, all precursor universes, and all universes including our universe [1].

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

Each of 129 fundamental matter and force particles is defined by its unique closed string in a Planck cube. Table 1 shows 32 Standard Model (SM)/supersymmetric matter and force particles. There are 12 SM matter particles and 4 SM force particles. There are 4 supersymmetric matter particles and 12 supersymmetric force particles. Each of these 32 matter and force particles has one of 32 anti-particles and each of those 64 has an associated supersymmetric Higgs particle (see Higgs forces section). Each of the 128 SM/supersymmetric particles and the super force particle can be equivalently represented by: a dynamic point particle, its unique closed 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. String theory was amplified so that a zero brane dynamic point particle generates particle positions over time for both a one brane vibrating string and a two brane Calabi-Yau membrane [1]. According to Greene, two basic Calabi-Yau membrane types are beach balls and doughnuts. Conifold transitions are the transformations of the two membrane types into each other. The Planck cube sized beach ball membrane contains periodic surface hills and valleys where particle energy/mass is proportional to their amplitude displacement and frequency [2]. A string can be visualized as a thin sticky rubber 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.

Any object in the Super Universe is defined by a volume of contiguous Planck cubes containing fundamental matter or force particle strings. Planck cubes are visualized as near infinitely small, cubic, Lego blocks. A proton is represented by a 10^{-15} m radius spherical volume of contiguous Planck cubes containing up quark, down quark, and force particle strings. An atom is represented by a volume of contiguous Planck cubes containing protons, neutrons, electrons and force particle strings. By extension, any object in the Super Universe (e.g. molecule, encyclopedia, star, galaxy, or the entire Super Universe) is represented by a volume of contiguous Planck cubes containing fundamental matter or force particle strings.

A Calabi-Yau membrane's potential energy/mass was represented by three springs aligned along the Planck cube's x, y, z axes and connected together at the Planck cube's center. A Calabi-Yau membrane's energy/mass was primarily a function inversely proportional to its radius and secondarily directly proportional to its surface hills and valley's amplitude displacement and frequency. A particle's energy/mass was amplified from two string parameters according to Greene [2] to three via addition of the radius parameter. Radius defined the particle's basic energy/mass whereas the amplitude displacement and frequency parameters modulated it. A Calabi-Yau membrane just touching a Planck cube's sides with zero amplitude displacement and frequency defined zero tension or

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}	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} (64 types)

129	total	

Table 1. Standard Model/supersymmetric matter and force particle.

energy/mass. A range of amplitude displacements and frequencies about this zero energy/mass defined 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) [3].

Super force string doughnut singularities existed at the center of Planck cubes at the start of the Super Universe, all precursor universes, and all universes including our universe. The big bang's near zero radius doughnut singularity consisted of superimposed super force strings containing our universe's near infinite energy of approximately 10^{54} kg (10^{24} $M_\odot$, 10^{90} eV, or 10^{94} K) as calculated from critical density and a measured Hubble constant [4]. A doughnut singularity's potential energy was also represented by three springs connected together at the Planck cube's center. Energy was a function inversely proportional to the singularity's radius so that the smaller the singularity's radius, the greater was its potential energy. The radius of the Super Universe's doughnut singularity was much smaller than our universe's doughnut singularity because the energy/mass of the Super Universe was much larger than the energy/mass of our universe. According to Colella, the Super Universe's energy/mass was 10^{120} times the energy/mass of our universe or (10^{120}) $(10^{54}$ kg$)$ = 10^{174} kg [1].

Our universe's super force doughnut singularity had energy (mass), charge, and spin. This doughnut singularity was created in our precursor universe by the evaporation, deflation, and collapse of a super supermassive quark star (matter) to its associated super supermassive black hole (energy) or Kerr-Newman black hole (see Arrow of time section).

Via conservation laws of energy/mass, charge, and angular momentum [5], the energy/mass, charge, and spin of the doughnut singularity was distributed to the energy/masses, charges, and spins of fundamental particles, atoms, stars, and galaxies in our universe. The energy/mass, charge, and spin of each particle in our universe was directly related to the energy/mass, charge, and spin of the doughnut singularity. Entanglement was the relationship between the energy/mass, charge, and spin of a particle in our universe with the energy/masses, charges, and spins of other particles in the first particle's vicinity.

Pauli's exclusion principle states no two matter particles have identical quantum numbers, which was assumed equivalent to occupying the same Planck cube. In contrast, Pauli's exclusion principle permits force particles to exist within the same Planck cube such as super force strings in the singularity. The relationship between quantum numbers and particle location must be amplified. For example, the relationship between the four quantum numbers of an electron in an atom and the electron's location must be amplified to include "free" fundamental particles such as electrons and up quarks in a quark-gluon plasma.

The Super Universe is the composite of every object in it. At the present time t = 13.8 billion years, the Super Universe consists of 10^{305} contiguous Planck cubes. That is our universe's 10^{185} Planck cubes multiplied by the relative size of the Super Universe to our universe (10^{120}) or (10^{185}) (10^{120}) = 10^{305}. There is only one Super Universe string solution at time t, not 10^{500} solutions described by Susskind [6].

This integrated string with particle creation, Super Universe, and stellar black holes theories (see Table 5).

2.1 Universal rectangular coordinate system

String theory's six extra dimensions are the dynamic point particle position and velocity coordinates in a Planck cube. The inertially stabilized X_u, Y_u, Z_u universal rectangular coordinate system of fig. 1 originates at our universe's big bang at $x_u = 0$, $y_u = 0$, $z_u = 0$, $t = 0$, (see space-time coordinates in Einstein's General Relativity section). 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 Planck cube's X_p, Y_p, and Z_p axes aligned with the X_u, Y_u, Z_u axes. Any point within the Planck cube is identified by x_p, y_p, z_p coordinates measured from the cube's center with velocity components v_{xp}, v_{yp}, and v_{zp}. At t = 0, our universe consisted of a super force doughnut singularity centered in a Planck cube at $x_u = 0$, $y_u = 0$, and $z_u = 0$.

2.2 Proposed standard/supersymmetric particle symbols

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

Table I shows proposed symbols with SM particles on the left and supersymmetric particles on the right. The subscript xx explicitly identifies a specific matter or force particle (e.g. the subscript 11 identifies the up quark p_{11}). Adding sixteen to the SM 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 anti-up quark p_{11bar} replaces a u with a bar over it, and the photon p_{16} replaces γ.

The first reason for replacing existing symbols is explicit Higgs particle symbols are required. In the proposed symbols, there is a Higgs particle for each matter and force particles. Since there are 16 SM 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 eight 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 as described in the following six examples.

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

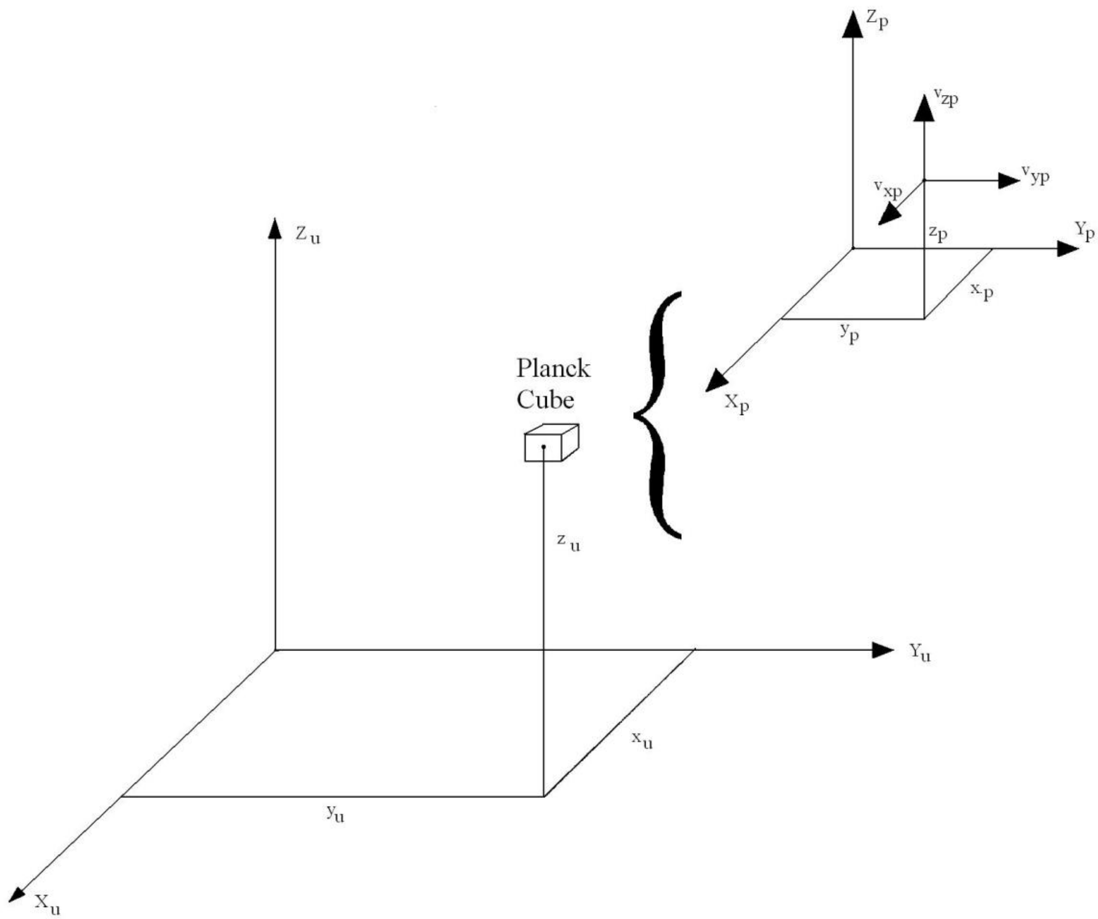


Fig. 1. Universal rectangular coordinate system.

A second example is the photon p_{16} which is categorized into two types; p_{16a} for electromagnetic radiation and p_{16b} for force carrier. Electromagnetic radiation is further subdivided into gamma ray p_{16a1}, X rays p_{16a2}, etc. for each electromagnetic radiation type. The photon symbol γ illustrates ambiguities of existing symbols because all electromagnetic and the specific gamma ray radiation are defined by γ. In addition, a force carrier photon is not defined in existing symbols and annihilation of matter and anti-matter particles produces super force particles (p_{sf}) not electromagnetic radiation (γ) as described in the spontaneous symmetry breaking section.

A third example is the W/Z bosons (p_{15}) are actually transient matter particles with associated Higgs forces (h_{15}) instead of force particles (bosons) (see Higgs forces section). The three W/Z transient matter particles are explicitly represented as W^+ (p_{15a}), W^- (p_{15b}) and Z^0 (p_{15c}).

A fourth example is there are 64 super force types of which seventeen condense into seventeen different matter particles. The 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 up quark matter particle. There is only one super force in existing symbols.

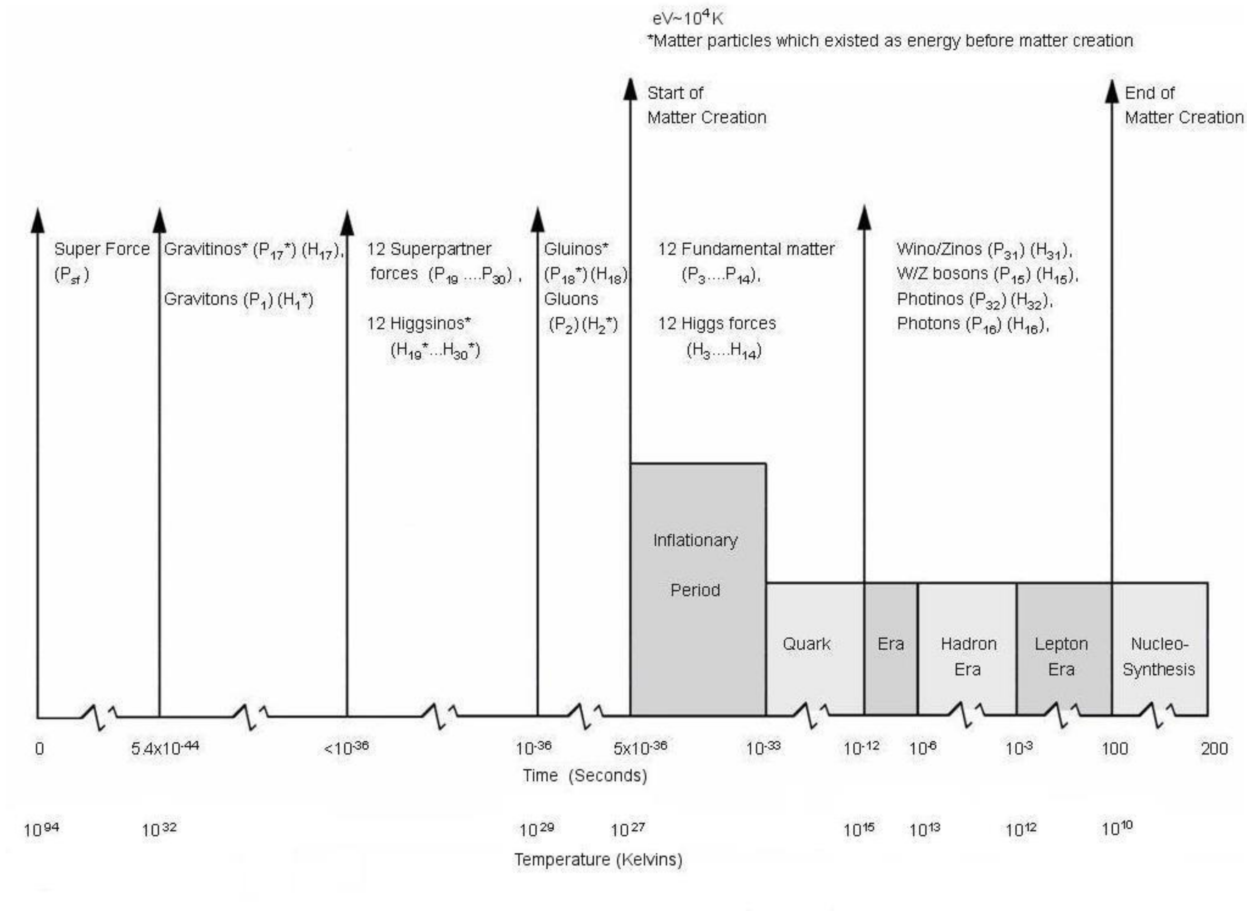


Fig. 2. Big bang.

A fifth example is proposed total particle energy/mass is represented by an upper case letter symbol, for example, total up quark energy/mass is P_{11}. The big bang time line of fig. 2 uses total energy/mass for 32 matter and force particles. Total particle energy/mass is not available in existing symbols.

A sixth example is there are 64 super force energy densities which are identified for example by P_{sfdp11} where the subscripts (sfd) signify super force energy density and the following subscripts (e.g. p11) signify the condensed up quark matter particle (see Spontaneous symmetry breaking section). Only one super force energy density is available in existing symbols.

3 Particle creation

Our universe's 128 matter and force particles were created from the super force and manifested primarily between the beginning of inflation at t = 5 x 10^{-36} s to the end of the lepton era at t = 100 s and at extremely high temperatures between 10^{27} and 10^{10} K as shown in fig. 2 Big Bang time line from Rees [7]. The X axis was shown both as time in seconds and temperature in Kelvins because of the intimate relationship between matter creation time and matter energy/mass. Energy/mass in electron volts was related to temperature via eV ~ 10^4 K. Matter creation was time synchronous with both inflation start time and the one to seven Planck cubes energy to matter expansion. By t = 100 s, all super force energy had condensed into eight permanent matter particles and their eight associated Higgs force energies.

Fig. 2 shows creation of our universe's 128 particles from the super force P_{sf} having energy of 10^{54} kilograms. Upper case letters are exclusively used because particle creation involves total 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}. 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} s or Planck time and gluinos* (P_{18}*) /gluons (P_2) at t = 10^{-36} s or Grand Unified Theory (GUT) time and their Higgs particles. The asterisk (*) signifies matter particles which existed as energy before condensation to matter particles. Twelve superpartner force energies (P_{19}….P_{30}) and their 12 associated Higgsino energies (H_{19}*….H_{30}*) were created at < 10^{-36} s and were X bosons or inflatons. Twelve fundamental matter (P_3….P_{14}) and their Higgs forces (H_3….H_{14}) condensed during matter creation. Wino/zinos, W/Z bosons, photinos, and photons condensed at t = 10^{-12} s.

4 Inflation

Matter creation theory was amplified to be time synchronous with both inflation start time (5 x 10^{-36} s) and the one to seven Planck cubes energy to matter expansion. Since matter particles existed in Planck cubes, matter could not exist when our universe was smaller than a Planck cube or when our universe's radius was smaller than .8 x 10^{-35} m, see fig. 3. 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 a spherical singularity (conifold transition from doughnut to beach ball) of superimposed super force particles which condensed into six matter particles in the six contiguous Planck cubes. The first matter shell was then pushed out, and a second matter particle Planck cube shell condensed between the center Planck cube and the first matter shell. This process continued until enough shells with enough Planck cubes existed to accommodate all our universe's matter particles and their associated Higgs forces. The size of our universe expanded from the size of a sphere smaller than a Planck cube at the start of inflation to a sphere with a radius of 8 m and a hot quark-gluon plasma with a temperature of approximately 10^{25} K at the end of inflation. Fig. 3 had an inflationary period start radius of approximately .8 x 10^{-35} m with an exponential inflation factor of 10^{36} (8/.8 x 10^{-35}). Guth's comparable values were 10^{-52} m and 10^{53} (8/.8 x 10^{-52}) [8]. Liddle and Lyth specified an exponential inflation factor approximately 10^{26} [9]. Thus this article's exponential inflation factor of 10^{36} was between Guth's 10^{53} and Liddle and Lyth's approximately 10^{26}.

Eight of the created matter particles were permanent and included six atomic/subatomic matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, and tau-neutrino) and two dark matter particles (zino and photino). Nine of the created matter particles were transient and included the top quark, bottom quark, charm quark, strange quark, tau, muon, gravitino, gluino, and W/Z bosons. By the end of matter creation at t = 100 s, all nine transient matter particles had decayed to eight permanent matter particles.

Following the start of matter creation, gravitinos* (P_{17}*), gluinos* (P_{18}*), and 12 fundamental matter (6 quarks and 6 leptons) particles (P_3….P_{14}) energy/masses condensed to matter particles. At t = 10^{-12} s, W/Z bosons (P_{15}), winos/zinos (P_{31}) and photino (P_{32}) energy/masses condensed to matter particles.

Particle/anti-particle pairs condensed from super force particles and evaporated back to them. As our universe expanded and cooled this baryogenesis process was predominantly from energy to matter rather than to anti-matter (see Spontaneous symmetry breaking 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 s), our universe consisted of a time varying particle soup. The end of matter creation was defined as 100 s because by: 10^{-3} s, up and down quarks formed protons and neutrons; 1 s, neutrinos decoupled from matter; 100 s, only electrons remained following electron anti-electron annihilations. The end of matter creation was the end of the lightest anti-matter particle or the anti-electron-neutrino. Anti-electron-neutrinos existed after 100 s. However, since the end time of anti-electron-neutrinos was undefined, the end of matter creation was approximated as 100 s or the end of anti-electrons. By t = 100 s, all super force energy had condensed into eight permanent matter particles and their eight associated Higgs force energies. Also at t = 100 s, nucleosynthesis began.

This integrates inflation with particle creation, Higgs forces, spontaneous symmetry breaking, and baryogenesis theories, (see Table 5).

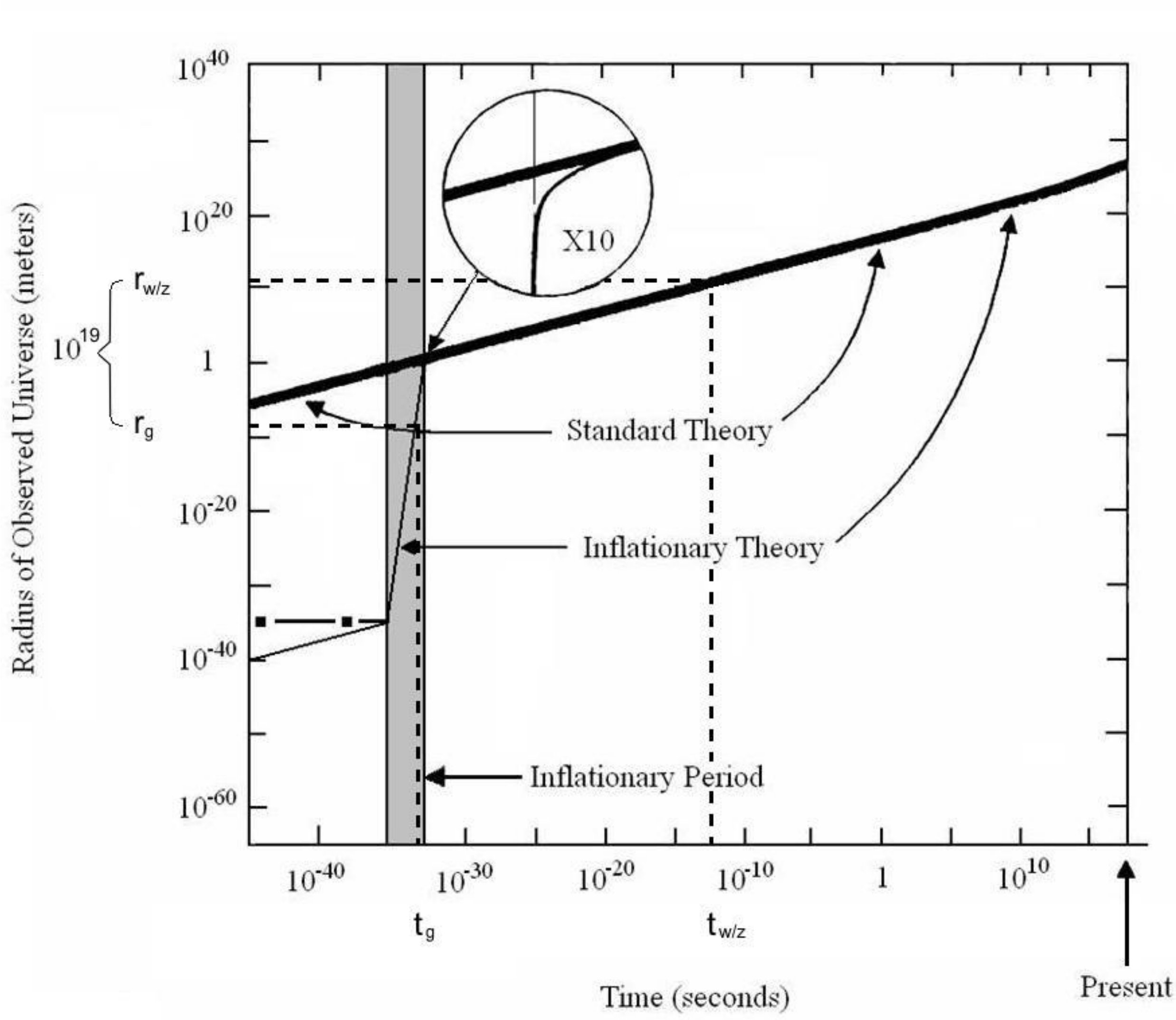


Fig. 3. Size of universe in the standard and inflationary theories.

5 Higgs forces

"New Physics" or amplifications of Higgs force theory was key to an Integrated TOE and included:

1. Higgs particles were God particles because they constituted approximately 82% of our universe's total energy/mass
2. The sum of eight Higgs force energies associated with eight permanent matter particles was dark energy
3. Sixty four associated supersymmetric Higgs particles existed
4. Extremely high temperatures in our early universe caused spontaneous symmetry breaking, not the Higgs force
5. The Higgs force was a residual super force which contained the mass, charges, and spin of the associated matter particle
6. Matter particles and their associated Higgs forces were one and inseparable
7. Mass was given to a matter particle by its associated Higgs force and gravitational force messenger particles
8. Spontaneous symmetry breaking was bidirectional

Higgs particles were God particles because they constituted approximately 82% of our universe's total energy/mass. The sum of eight Higgs force energies associated with eight permanent matter particles was dark energy (see Spontaneous symmetry breaking section) and 68% of our universe's energy/mass [10]. Dark matter consisted of zinos, photinos, and three permanent Higgsinos (see Conservation of energy/mass accountability section). Assuming permanent Higgsinos were half of dark matter's energy/mass (27%), permanent Higgsinos were 13.5% of our universe's energy/mass. Higgs forces plus three permanent Higgsinos constituted 68% + 13.5% ~ 82% of our universe's energy/mass. Therefore, if our universe and God were one, Higgs particles were God particles.

Sixty four associated supersymmetric Higgs particles existed, one for each of 16 SM matter and force particles, their 16 superpartners, and their 32 anti-particles. The 64 supersymmetric Higgs particles defined a "Super supersymmetry." If a standard or supersymmetric particle was a matter particle (*e.g.* an up quark or gravitino), its associated Higgs particle was a Higgs force particle. If a standard or supersymmetric particle was a force particle (*e.g.* an up squark or a graviton), its associated Higgs particle was a Higgsino matter particle.

Extremely high temperatures in our early universe caused spontaneous symmetry breaking, not the Higgs force. The super force condensed into 17 matter and 17 associated Higgs forces at 17 different temperatures. The Higgs force was a product not the cause of spontaneous symmetry breaking. Spontaneous symmetry breaking was similar to the three phase H_2O cooling from steam, to water, to ice at different temperatures. Similarly the super force, the up quark and its associated Higgs force, the down quark and its associated Higgs force, the electron and its associated Higgs force, the three W/Z bosons and their three associated Higgs forces etc., were the same but manifested themselves differently at extremely high but different temperatures (10^{27} to 10^{10} K) in our early universe. There was an intimate relationship between matter creation time and its energy/mass. The earlier the matter creation time, the greater was its energy/mass in Kelvins or electron volts.

The Higgs force was a residual super force which contained the mass, charges, and spin of the associated matter particle. When a matter particle (e.g. up quark) condensed from the super force, the residual super force was the Higgs force associated with the up quark (see Spontaneous symmetry breaking section).

Matter particles and their associated supersymmetric Higgs forces were one and inseparable and modeled as an underweight porcupine with overgrown spines. A matter particle cannot exist without its associated Higgs force or vice versa. A matter particle (*e.g.* an up quark closed string in a Planck cube) was modeled as an underweight porcupine and the three dimensional Higgs force field as overgrown spines. The latter was quantized into Planck cubes containing Higgs force strings which surrounded the associated matter particle and extended to infinity as shown in fig. 5.

Mass was given to a matter particle by its associated Higgs force and gravitational force messenger particles. Gravitational force messenger particles were amplified to include embedded clocks/computers. The embedded clock/computer calculated Newton's gravitational force and provided it to the receiving particle as described in the messenger particles section.

Spontaneous symmetry breaking was bidirectional. The super force condensed into a matter particle and its associated Higgs force or a matter particle and its associated Higgs force evaporated to the super force. In Beta minus decay, the down quark decayed to an up quark and a W^- boson. The W^- boson then decayed to an electron and an anti-electron-neutrino. The Beta minus decay equation was at best ambiguous or at worst incorrect. Fundamental particles such as the down quark or W^- boson cannot be split because fundamental particles are indivisible.

Particle decay was the evaporation of a heavy matter particle and its Higgs force to the super force and the condensation of the super force to lighter and stable matter particles and their Higgs forces. In the Beta minus decay with Higgs force amplification, the down quark p_{10} and its associated Higgs force h_{10}

evaporated to a super force particle p_{sfp10}. Division of energy not matter occurred as one portion of the super force condensed into the up quark p_{11} and its associated Higgs force h_{11}, and a second portion condensed into the W^- particle p_{15b} and its associated Higgs force h_{15b}. The three W/Z bosons (W^-, W^+, and Z^0) were transient matter particles not bosons because, for example, within 10^{-25} s of its creation, the W^- transient matter particle and its associated Higgs force evaporated back to a super force particle p_{sfp15b} having energy ($p_{15b} + h_{15b}$). The super force 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}. Since the W/Z bosons were reclassified as transient matter particles, this produced the asymmetrical number 17 instead of 16 matter particles, that is, 9 transient and 8 permanent matter particles.

Bidirectional spontaneous symmetry breaking was key to particle decay as described above. Bidirectional spontaneous symmetry breaking was also key to the evaporation in our precursor universe of a super supermassive quark star (matter) to a super supermassive black hole (energy) as described in the arrow of time section and baryogenesis as described in the spontaneous symmetry breaking section.

This integrated Higgs forces with particle creation, spontaneous symmetry breaking, superpartner and quark decays, dark matter, dark energy, messenger particles, arrow of time, and baryogensis theories, (see Table 5).

6 Spontaneous symmetry breaking

Spontaneous symmetry breaking occurred for 17 matter particles (9 transient and 8 permanent) during matter creation in our early universe between 5 x 10^{-36} to 100 s and at specific temperatures between 10^{27} and 10^{10} K. Spontaneous symmetry breaking had two time sequential phases:

1. Baryogenesis for each of 17 matter particles followed by
2. Decay of nine transient matter particles to eight permanent matter particles.

Baryogenesis for each of 17 matter particles occurred for the assumed heaviest matter particle (gravitino) at the earliest matter creation time and highest temperature and for the lightest electron-neutrino matter particle at the latest time and lowest temperature. Baryogenesis for each of 17 matter particles consisted of n bidirectional condensation/evaporation cycles of four particles from and to the super force. For the up quark the four particles were the: up quark, up quark Higgs force, anti-up quark, and anti-up quark Higgs force. The up quark spontaneous symmetry breaking function is shown in fig. 4 as amplified from Guth's figure of energy density of Higgs fields for the new inflationary theory [8]. The Z axis represented super force energy density allocated to the up quark (P_{sfdp11}), the X axis represented a Higgs force (h_{11}) associated with an up quark, and the Y axis represented a Higgs force (h_{11bar}) associated with an anti-up quark. Up quark baryogenesis occurred prior to 10^{-3} s as the ball moved from its peak position to the fig. 4 position. During baryogenesis, the ball initially at its peak position $h_{11} = h_{11bar} = 0$, z = 2, moved down the spontaneous symmetry breaking function equidistant between the X and Y axes. Two super force particles condensed into an up quark matter particle, its associated Higgs force, an anti-up quark matter particle, and its associated Higgs force. The four particles then annihilated and evaporated back to super force particles as the ball returned to its peak position. Bidirectional spontaneous symmetry breaking was illustrated by the condensation and evaporation of these four particles. During the second condensation/evaporation cycle, the ball moved down the spontaneous symmetry breaking function closer to the X axis than the Y axis and then back to its peak position. After n of these condensation/evaporation cycles in the false vacuum state, the ball eventually moved to the fig. 4 ball position ($h_{11} = -2$, $h_{11bar} = 0$, z = 1.5) or the true vacuum state. In the true vacuum state, the super force condensed totally to the up

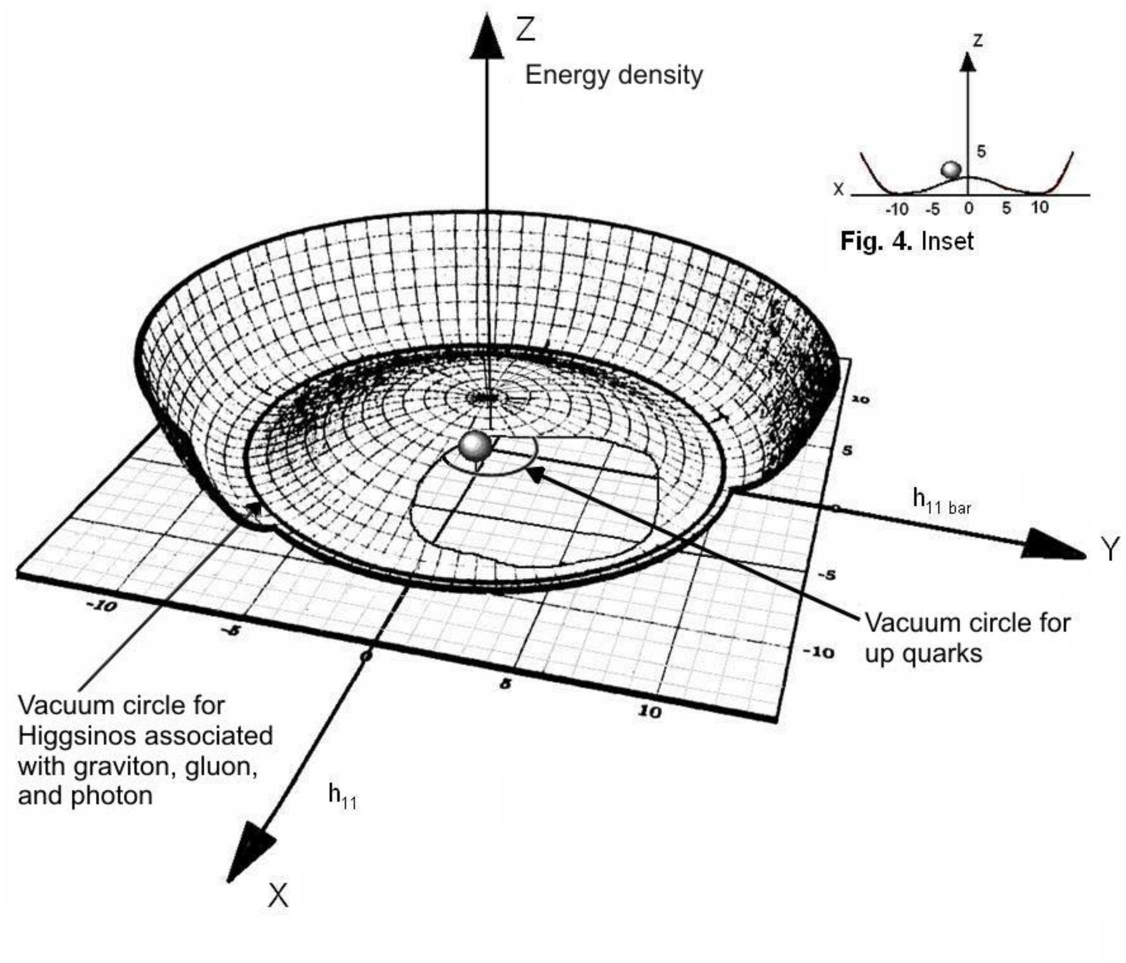


Fig. 4. Up quark spontaneous symmetry breaking function.

quark and its associated Higgs force and none to the anti-up quark and its associated Higgs force. By the end of up quark baryogenesis, the Y axis of the fig. 4 three dimensional spontaneous symmetry breaking had compressed to zero, resulting in the two dimensional fig. 4 inset.

Baryogenesis described above as n bidirectional condensation/evaporation cycles from and to the super force (e.g. matter particle, matter particle Higgs force, anti-matter particle, and anti-matter particle Higgs force) is significantly different than the prevailing two particle annihilation description (e.g. electron/selectron) to high energy photons or gamma rays.

Decay of nine transient matter particles to eight permanent matter particles or the second time sequential spontaneous symmetry breaking phase, was as follows. There were two key ball positions. When the ball was in its peak position ($x = 0$, $y = 0$, $z = 2$) none of the super force energy density allocated to the up quark had condensed and matter particle (e.g. up quark) baryogenesis had not occurred. When the ball was in the fig. 4 position, matter particle (e.g. up quark) baryogenesis had occurred and all super force energy density had condensed to up quark matter particles and their associated Higgs forces. The z coordinate of the fig. 4 ball position was the super force energy density condensed to up quark Higgs forces. The z coordinate of the peak ball position minus the z coordinate of the fig. 4 ball position was the super force energy density condensed to up quark matter particles. It took less than 10^{-3} s or by the end of the hadron era for the ball to move from its peak position to the fig. 4 position. It took 13.8 billion years for the ball to move vertically down to its current position just above the vacuum circle for up quarks. As the ball moved vertically down, the up quark's Higgs force (ball's x coordinate) remained constant whereas the up quark Higgs forces' energy density (ball's z coordinate) slowly decreased as our universe expanded.

There were 17 spontaneous symmetry breaking functions associated with nine transient matter particles (top quark, bottom quark, charm quark, strange quark, tau, muon, gravitino, gluino, and W/Z bosons) and eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino). The permanent zino and photino matter particles were dark matter. Each of the 17 spontaneous symmetry breaking functions had the same generic up quark fig. 4 Mexican hat shape but each had a different peak super force energy density (peak z coordinate) and Higgs force (ball x coordinate). By 100 s, baryogenesis had been completed for all matter particles. All nine transient matter particles and their Higgs forces had evaporated to the super force and condensed to eight permanent matter particles and their Higgs forces, a process described as "decay." By 100 s, only eight permanent matter particles and their eight associated Higgs forces remained. The sum of eight Higgs force energy densities was dark energy density which decreased with time as our universe expanded. The sum of eight Higgs force energies was dark energy.

During matter creation (5×10^{-36} to 100 s), there were two time sequential false vacuum phases. First during baryogenesis for each of 17 matter particles, particle/anti-particle pairs condensed from and evaporated to the super force. As our universe expanded and cooled and after n of these condensation/evaporation cycles, this baryogenesis process was predominantly from energy to matter rather than to anti-matter. Particles/anti-particles were the intermediate, transient, or false vacuum state prior to the permanent matter and Higgs force or true vacuum state.

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

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. 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 and inflation eliminated them (see Spontaneous symmetry breaking for Higgsinos section). Thus, super force (P_{sf}) energy equaled 32 SM/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 $t = 5.4 \times 10^{-44}$ s, 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 $t = 10^{-36}$ s, 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 $t < 10^{-36}$ s, twelve super force energy pairs [($P_{19} + H_{19}^*$) …. ($P_{30} + H_{30}^*$)] were created as X bosons or inflatons. During our universe's matter creation period (5 x 10^{-36} to 100 s), 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} s, 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}).

As shown in fig. 2, Planck time or 5.4 x 10^{-44} s is the unification time of the gravitational, strong, electromagnetic and W/Z forces. The Planck mass associated with Planck time is 2.2 x 10^{-8} kg (1.22 x 10^{28} eV or 1.22 x 10^{32} K). At 5.4 x 10^{-44} s, the gravitational force or graviton separated from the super force. Specifically, gravitons and their associated Higgsinos* and gravitinos* and their associated Higgs forces condensed from the super force. At 10^{-36} s or GUT time with an energy of 10^{25} eV or 10^{29} K, the strong force or gluon separated from the super force. Specifically, gluons and their associated Higgsinos* and gluinos* and their associated Higgs forces condensed from the super force. At 10^{-12} s or 10^{11} eV or 10^{15} K, the electromagnetic force or photon and the weak force or W/Z bosons separated from the super force. Specifically, photons and their associated Higgsinos, photinos and their associated Higgs forces, W/Z bosons and their associated Higgs forces, and wino/zinos and their associated Higgs forces condensed from the super force.

Two conditions are required for matter condensation, our universe must be larger than a Planck cube and the specific matter condensation temperature must exist. The one to seven Planck cube energy to matter expansion began at the start of inflation when the size of our universe became larger than a Planck cube. During inflation, it was assumed the gravitino or heaviest supersymmetric matter particle and its Higgs force existed first as a super force particle (p_{sfp17}) or ($p_{17} + h_{17}$). At the gravitino condensation temperature, p_{sfp17} condensed to the gravitino p_{17} and its associated supersymmetric Higgs force h_{17} (see Relative strengths of forces/Hierarchy problem section).

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 revealed quarks and leptons to be smaller than 10^{-18} meters [11]. If higher resolution scattering reveals matter particles are larger than a Planck cube, the Planck cube must be replaced by an augmented Planck cube.

6.1 Spontaneous symmetry breaking for Higgsinos

Spontaneous symmetry breaking occurs for two of three types of matter particles, 17 standard and supersymmetric matter particles and 3 SM Higgsinos.

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 permanent Higgsinos (h_1, h_2, and h_{16}) associated with three SM force particles (graviton p_1, gluon p_2, and photon p_{16}), experience spontaneous symmetry breaking as follows. The ball in the Higgsino version of 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 its 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}) did not experience spontaneous symmetry breaking because their energy was expended prior to matter creation. The 12 squarks and sleptons, their 12 associated Higgsinos, and their 24 anti-particles were X bosons or inflatons. X bosons were the latent energy which expanded our universe during the inflationary period [12]. X bosons were to the inflation period as Higgs forces (dark energy) were to our universe's expansion following inflation. X bosons were also the intermediate force particles (W/Z_{ss} bosons) for supersymmetric (ss) particles as described in the next section.

This integrated spontaneous symmetry breaking with particle creation, inflation, Higgs forces, superpartner and quark decays, dark matter, universe expansions, dark energy, and baryogenesis theories, (see Table 5).

7 Superpartner and quark decays

Decays are series of evaporations/condensations of matter particles and their associated Higgs forces to and from the super force. Intermediate force particles are W/Z bosons for SM particles and supersymmetric W/Z_{ss} bosons for supersymmetric particles. 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 gauge mediated 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 SM particles and supersymmetric W/Z_{ss} bosons (X bosons) for supersymmetric particles. For example, in a Beta minus decay, the W^- boson decayed to an electron and an anti-electron-neutrino. Similarly, the supersymmetric W/Z_{ss} boson decayed to a quark and lepton.

Superpartners decayed into lower energy/mass superpartners. The decay chain ended with zinos and photinos of the stable Lightest Supersymmetric Particles (LSP) and SM particles [13]. Stable LSPs assumed to be zinos, photinos, and three permanent Higgsinos were formed by 10^{-12} s or 10^{15} K (see Conservation of energy/mass accountability section).

Heavy quarks decayed into lower energy/mass quarks and W bosons defined by the Cabibbo-Kobayashi-Maskawa (CKM) matrix. Quark decays were described in the Higgs forces section.

This integrated superpartner and quark decays with particle creation, Higgs forces, spontaneous symmetry breaking, and universe expansions theories, (see Table 5).

8 Neutrino oscillations

Neutrinos oscillated between three flavors via the seesaw model using a neutral heavy lepton (NHL). The three neutrino flavors were: electron-neutrino, muon-neutrino, and tau-neutrino. According to the seesaw model, neutrino mass was $(m_D)^2/M_{NHL}$, where m_D was the SM Dirac mass (i.e. p_{14}, p_{13}, p_9) and M_{NHL} was the neutral heavy lepton mass also referred to as a large right-handed Majorana [14]. The neutral heavy lepton appeared in some SM extensions and was assumed to be the stable fourth family neutrino, either a zino p_{31} or photino p_{32}, and a constituent of dark matter [15].

This integrated neutrino oscillations with particle creation, spontaneous symmetry breaking, and dark matter theories, (see Table 5).

9 Dark matter

Dark matter consisted of zinos, photinos, and three permanent Higgsinos. Dark matter agglomeration formed the framework of galaxies.

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

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. Dark matter agglomeration formed the framework of galaxies and its start time was 30,000 years [17]. 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 [18].

This integrated dark matter with particle creation, inflation, and universe expansions theories (see Table 5).

10 Universe expansions

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

During the first expansion, our universe's size expanded from a doughnut singularity at $t = 0$, to a spherical singularity (*i.e.* conifold transition) with a radius of less than $.8 \times 10^{-35}$ 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/sleptons, their 12 associated Higgsinos, and their 24 anti-particles) were the latent heat energy source during inflation (see Conservation of energy/mass accountability section). During the one to seven Planck cube expansion, matter particles and their Higgs forces were created (i.e. condensed or froze).

Our universe's expansion occurred from 10^{-33} s 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.

10.1 String theory's seventh extra dimension

The product of the non-uniform distribution of matter expansion rate and the graviton's intergalactic propagation time is string theory's seventh extra dimension. 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) multiplied by the graviton's intergalactic propagation time (t_i). The matter expansion rate (e_r) is itself a function of time because our universe decelerated during its first 8 billion years and accelerated during the last 6 billion years. The product (e_rt_i) is string theory's seventh extra dimension which dilutes the intergalactic gravitational force because of our universe's non-uniform distribution of matter expansion.

This integrated universe expansions with string theory, particle creation, inflation, Higgs forces, and spontaneous symmetry breaking theories, (see Table 5).

11 Dark energy

By the end of matter creation or t = 100 s, our universe consisted of atomic/subatomic matter (4.9 %), cold dark matter (27%), and dark energy (68%), and those percentages remained constant for 13.8 billion years (ΛCDM cosmological model). The cosmological constant was proportional to vacuum or dark energy density. Dark energy density was the sum of eight permanent Higgs force energy densities.

By t = 100 s, only eight permanent matter particles and their Higgs forces remained. Following t = 100 s, 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. Permanent dark matter particles could not change following $t = 10^{-12}$ s because of insufficient temperatures in our universe. Thus by the end of matter creation, our universe consisted of atomic/subatomic matter (4.9 %), cold dark matter (27%), and dark energy (68%), and these percentages remained constant for 13.8 billion years.

At t = 200 s or the start of the opaque era, our universe consisted of uniformly distributed matter particles (e.g. electrons, protons, helium nuclei, electron-neutrinos, muon-neutrinos, tau-neutrinos, zinos, photinos, and 3 permanent Higgsinos) and their Higgs forces in the space between matter particles (true vacuum). Our universe's uniform 10^8 K temperature caused radiation emission/absorption between electrons, protons, and helium nuclei. At 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 13.8 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 [19]. Dark energy density: was uniformly distributed in our universe; was the sum of eight permanent Higgs force energy densities, or $\rho_{\Lambda} = H_{11d}, H_{10d}, H_{12d}, H_{31d}, H_{32d}, H_{9d}, H_{13d}, H_{14d}$; and decreased with time along with the cosmological constant as our universe expanded. Our universe was defined by the widely accepted ΛCDM cosmological model.

This integrated dark energy with particle creation, inflation, dark matter, and universe expansions theories, (see Table 5).

12 Messenger particles

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

Particles are insufficient to constitute matter, glues are also required. Strong force glue (gluon) is required for nuclei. Electromagnetic force glue (photon) is required for atoms/molecules. Gravitational force glue (graviton) is required for multi-mass systems [20].

12.1 Gravitational/electromagnetic

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

Fig. 5 shows an up quark particle p_{11} surrounded by quantized Higgs force particles h_{11} in two instead of three dimensions. The up quark and its associated supersymmetric Higgs force are one and inseparable and modeled as an underweight porcupine with overgrown spines. Both the underweight porcupine (up quark) and its associated Higgs force (overgrown spines) have been quantized into Planck cube closed strings. Radial Higgs force strength is reduced by the propagation factor $1/R^2$ where R is the distance between the up quark p_{11} in the center Planck cube and a quantized Higgs force h_{11} in another Planck cube.

Newton's gravitational force ($F = Gm_1m_2/r^2$) and Coulomb's force ($F = Cq_1q_2/r^2$) equations have the same form, where m_1 and m_2 are two masses, q_1 and q_2 are two charges, r is the 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 (see h_{11} contents of fig. 5) associated with the transmitting particle (e.g. p_{11}). The Higgs force particle contents includes mass, charges, and spin of both the particle p_{11} and its associated Higgs force h_{11}, and messenger particle p_1, p_2, p_{15}, p_{16} templates. For example, the p_1 template contains Newton's gravitational force equation parameter formats: G, m_1, m_2, t_r, t_t, and c. The graviton or photon extracts G or C in the graviton p_1 or 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 is extracted from the Higgs force particle associated with the receiving particle (e.g. p_{10}). The graviton/photon clock/computer calculates Newton's gravitational or Coulomb's force and provides it to the receiving particle. The gravitational or electromagnetic forces transmitted between transmitting and receiving particles consist of a continuous series of graviton or photon messenger particles.

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

This integrates messenger particles and Higgs forces theories, (see Table 5).

12.2 Strong

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

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

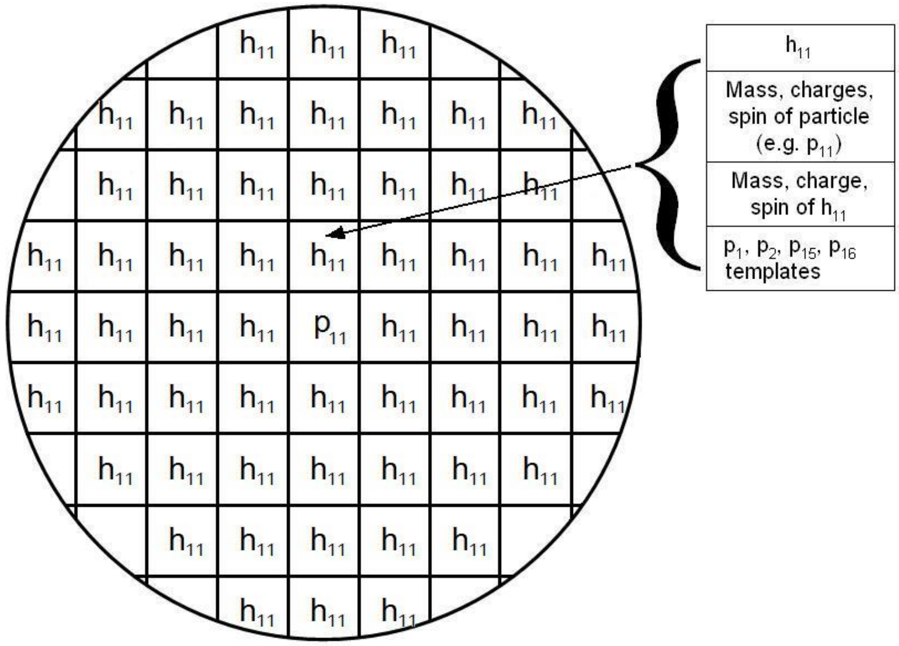


Fig. 5. Up quark with quantized Higgs force particles.

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 [21].

13 Relative strengths of forces/Hierarchy problem

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

Column two of Table 2 shows computed relative strengths of gravitational and electromagnetic force between a proton and electron as 10^{-39} [22]. The gravitational force was activated at time (t_g) when our universe's radius was (r_g). The electromagnetic/weak force creation/activation time ($t_{w/z}$) was 10^{-12} s when our universe's radius was ($r_{w/z}$). At the gravitational force activation time (t_g) all force strengths were equal. From fig. 2, the gravitational force or graviton was created at 5.4 x 10^{-44} s but activated at (t_g) during condensation of the heaviest supersymmetric matter particle assumed to be the gravitino. At electromagnetic/weak force creation/activation time ($t_{w/z}$) or 10^{-12} s, the gravitational force had already been diluted by 10^{-39} or equivalently a range dilution of approximately 10^{-19}. Since energy/masses of the supersymmetric particles were 100 to 1500 GeV according to Snowmass [3] and W/Z weak force particles were 80 to 90 GeV, their relative energy/masses and activation times were too close for the required range reduction factor.

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

Table 2. Relative strengths of forces.

From fig. 3, the electromagnetic/weak force creation/activation time ($t_{w/z}$) was 10^{-12} s which corresponded via the right and top dashed lines to our universe's radius ($r_{w/z}$) of 10^{11} m. The gravitational force activation time (t_g) is the time required to produce a 10^{-19} range reduction factor ($r_g/r_{w/z}$). From fig. 3, the bottom and left dashed lines related our universe's radius (r_g) or 10^{-8} m to the gravitational force activation time (t_g) of 5 x 10^{-34} s. From fig. 2, t_g corresponded to a gravitino energy/mass of approximately 10^{25} K or 10^{21} eV.

This integrated relative strengths of forces with particle creation, inflation, and universe expansions theories, (see Table 5)

14 Conservation of energy/mass accountability

All 128 matter and force particles were required for conservation of energy/mass accountability. Accountability of our universe's total 10^{54} kg of energy by the end of particle creation at t = 100 s was as follows. Eight permanent SM/supersymmetric anti-particles (anti-up quark, anti-down quark, anti-electron, anti-electron-neutrino, anti-muon-neutrino, anti-tau-neutrino, anti-zino, and anti-photino); their eight associated Higgs forces; three SM anti-forces (anti-graviton, anti-gluon, and anti-photon); and their three associated Higgsinos accounted for 0% of our universe's energy/mass. Baryogenesis via charge, parity, and time (CPT) violation annihilated these 22 particles and was completed by t = 100 s (see Spontaneous symmetry breaking and Baryogenesis sections).

Nine transient matter particles (top quark, bottom quark, charm quark, strange quark, tau, muon, gravitino, gluino, and W/Z bosons), their nine associated Higgs forces, their nine anti-particles, and their nine associated Higgs forces for a total of 36 particles accounted for 0%. Baryogenesis eliminated nine anti-particles and their nine associated Higgs forces. By 100 s, nine transient matter particles and their nine associated Higgs forces evaporated and condensed (decayed) to eight permanent matter particles and their Higgs forces.

X bosons or inflatons accounted for 0% because all their energy expanded our universe during inflation. X bosons or inflatons consisted of 12 transient force particles (six squarks and six sleptons), their 12 associated Higgsinos, 12 anti-force particles, and their 12 associated Higgsinos for a total of 48 particles.

Twenty two permanent particles remained. Three SM force messenger particles (graviton, gluon, and photon) existed but accounted for 0%. Even though in transit photons contained radiation energies at t = 100 s, these photons were assumed to contain zero energy. Transmitted radiation energies were allocated to transmitting particles until the radiation was received and then allocated to receiving particles.

Three types of matter and force particles with energy/masses remained at t = 100 s, atomic/subatomic matter, dark matter, and dark energy. Atomic/subatomic matter or six permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, and tau-neutrino) constituted 4.9% of our universe's energy/mass. Dark matter or the zino, photino, and three permanent Higgsinos constituted 27%

of our universe's energy/mass. Dark energy or eight Higgs forces associated with eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino) constituted 68% of our universe's energy/mass.

15 Super Universe

The Super Universe or multiverse consisted of nested parallel precursor universes. Precursor universes consisted of nested parallel universes. Our universe was nested in our precursor universe which was nested in the Super Universe as shown in fig. 8. The Super Universe was modelled as a near infinitely large gumball machine. Our universe with a radius of 46.5 billion ly was one of the gumballs and parallel universes were other gumballs with different radii. A subset of the gumballs which included our universe was our precursor universe. The entire gumball machine was the Super Universe of parallel universes.

Universal laws of physics and structure were assumed across the Super Universe. The Super Universe: had a single vacuum; was homogeneous and isotropic on a large scale; contained 129 matter and force particles; had eight permanent matter particles and their eight associated supersymmetric Higgs forces (dark energy); obeyed conservation of energy/mass; and had a constant dark energy to total energy/mass percentage (68%) just like our universe.

This integrated the Super Universe with dark energy and stellar black holes theories, (see Table 5).

16 Stellar black holes

Stellar black holes include quark stars (matter) and black holes (energy).

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

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

Stellar gravitational collapse occurs when internal energy is insufficient to resist the star's own gravity and is stopped by Pauli's exclusion principle degeneracy pressure. If the star's mass is less than 8 solar masses, it stops contracting and becomes a white dwarf supported by electron degeneracy pressure. The discrepancy between the initial 8 solar masses and approximately 1.39 solar masses or Chandrasekhar limit is due to solar winds. If the star is between 8 and 20 solar masses, it gravitationally collapses to a neutron star supported by neutron degeneracy pressure with a supernova explosion. If the star is between 20 and 100 solar masses, it gravitationally collapses to a quark star (matter) supported by quark degeneracy pressure with a quark-nova explosion. According to Leahy and Ouyed, the quark star (matter) forms with a quark-nova's nuclear binding energy release. The delayed secondary explosion follows a neutron star's primary supernova explosion [23].

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

The first type or a supermassive quark star (matter) contains 10^6 to 10^{10} solar masses [24]. They may be "fossil quasars" with masses proportional to their host galaxies' masses. According to Carilli, galaxy to central black hole mass ratio was 30:1 in our early universe and 700:1 now [25]. Population III stars containing hydrogen, helium, and lithium first formed approximately 200 million years after the start of our universe. These first generation stars contained up to 100 times more gas than the sun, had short lives, and created over 100 billion neutron stars or quark stars (matter) and their supernova or quark-nova remnants [26]. Over the next 13.6 billion years, by accretion of stars/matter and merger with galaxies, approximately 100 billion supermassive quark stars (matter) and their 100 billion galaxies formed in our universe. That is, over the last 13.6 billion years, approximately 10^6 to 10^{10} solar masses were swallowed by these supermassive quark stars (matter).

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

The third type or a super supermassive quark star (matter) contains 10^{10} to 10^{24} solar masses. In our precursor universe, the super supermassive quark star (matter) which consisted of a cold quark-gluon plasma [27], increased in size via accretion of stars/matter and merger with galaxies. At the 10^{24} solar mass threshold or our universe's energy/mass, quark degeneracy pressure was insufficient to stop further gravitational collapse. The super supermassive quark star (matter) instantaneously evaporated, deflated, and collapsed to the fourth type or its associated super supermassive black hole (energy) which created a bubble of zero-point energy and our universe's "big bang" (white hole). A zero-point energy bubble is completely empty (i.e. a perfect vacuum) whereas a true vacuum contains dark energy or Higgs forces. (see Arrow of time section).

In the Super Universe, the fifth type or a super super supermassive quark star (matter) contained >> 10^{24} solar masses and instantaneously evaporated, deflated, and collapsed to the sixth type or its associated super super supermassive black hole (energy) and created a precursor universe. Table 3 summarized the relationships between stellar black hole types and precursor universes, universes, and galaxies.

This integrated stellar black holes with particle creation, dark energy, Super Universe, and black hole entropy theories, (see Table 5).

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

Table 3. Relationships between stellar black hole types and precursor universes, universes, and galaxies.

16.1 Einstein's General Relativity

The Friedmann, Lemaitre, Robertson, and Walker (FLRW) metric is the accepted solution to Einstein's General Relativity equations. The three terms in Friedmann's equation are [28]:

$\ddot{a}/a = - 4\pi G\rho/3 - 4\pi Gp/c^2 + \Lambda/3$

where a is the scale factor, G is the gravitational constant, ρ is mass density, p is pressure, Λ is the cosmological constant, and c is the velocity of light. Since the radiation pressure force ended at 380,000 years, the second term ($- 4\pi Gp/c^2$) can be ignored after that time and the remaining terms describe two opposing forces which shape universes. The first term ($- 4\pi G\rho/3$) is the gravity/matter force and the third term ($\Lambda/3$) is the anti-gravity/dark energy force ($\Lambda = 8\pi G\rho_{\Lambda}$) where ρ_Λ is dark energy density.

The FLRW metric has three scenarios [29]. In the first scenario, matter and dark energy are in close balance. From a singularity, a universe expands at a decelerating rate until it reaches an inflection point and then expands at an accelerating rate. This is our universe's scenario where the inflection point is eight billion years after our universe's start. This scenario applies to most Super Universe parallel universes because it is balanced and stable.

In the second scenario, matter overwhelms dark energy. From a singularity, a universe expands at a decelerating rate until it reaches a maximum radius and then contracts to another singularity (big crunch). This is our precursor universe's scenario where the super supermassive quark star (matter) evaporated, deflated, and collapsed to a super supermassive black hole (energy), creating our universe's "big bang" (white hole). This scenario applies to a small percentage of parallel universes because of the Second Law of Thermodynamics (see Arrow of time section).

In the third scenario, dark energy overwhelms matter. From a nonzero radius, a universe expands at an ever increasing acceleration rate. This is the least understood scenario and applies to a small percentage of parallel universes because it is an unstable scenario.

Because of three star factor products only a small portion of our universe's volume (10^{-52}) contained stellar black holes. The three factor products were: stars were concentrated matter surrounded by large volumes of space (10^{-32}); only a small fraction of stars were stellar black holes (10^{-3}); and stellar black holes were compressed stars (10^{-17}). Newton's equations of motion and Cartesian Coordinates were applicable for most of our universe's volume provided expansion of space was included. In those subvolumes containing stellar black holes and on an exception basis, Einstein's equations of General Relativity must be substituted for Newton's equations and space-time coordinates substituted for Cartesian Coordinates.

17 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 [30]. 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 particle closed strings can arrange themselves. A quark star (matter) contains N matter particle closed strings each in a Planck cube and a total of M Planck cubes. N and M are large and N<< M. According to Dabholkar, the total number of ways of distributing N matter particle closed strings each with a volume $(l_p)^3$ within a quark star (matter) of volume $V = (4\pi r^3/3)$ is [31]:

$S = k \log \Omega$ or

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

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

This integrated black hole entropy with particle creation and stellar black holes theories, (see Table 5).

18 Arrow of time

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

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

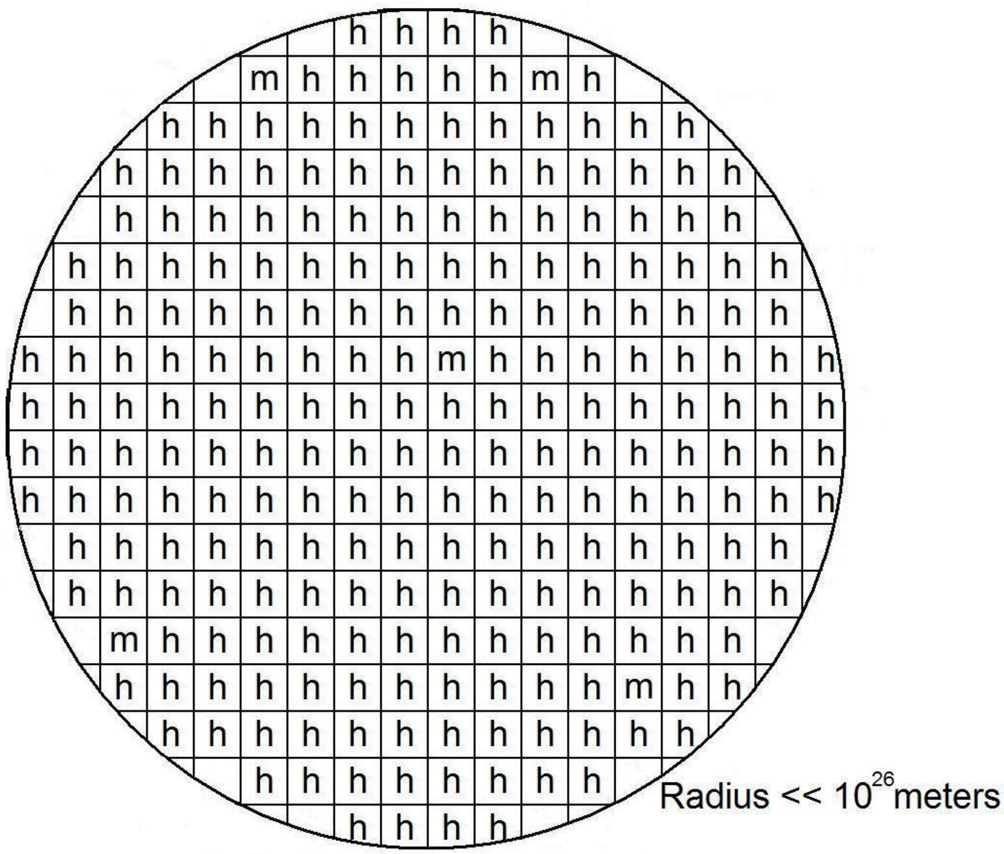
During a specific time interval within a subset volume of our universe, entropy decreased without negating our universe's Second Law of Thermodynamics. A nebula's hydrogen/helium gas, dust, and plasma began ordering itself at our solar system's creation 4.6 billion years ago. Entropy decreased because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

At the 10^{24} solar mass threshold, a super supermassive quark star (matter) instantaneously evaporated, deflated, and collapsed to its associated super supermassive black hole's (energy) doughnut singularity shown in fig. 6. In fig. 6a, a matter particle is shown as an m and a Higgs force as an h in their Planck cubes. The m represents the eight types of permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino) and three permanent Higgsinos. The h represents eight superimposed supersymmetric Higgs forces. Fig. 6a is shown in two, not three dimensions and not to scale since Planck cubes are near infinitely smaller than the super supermassive quark star (matter). At the super supermassive quark star's (matter) center, a single electron-neutrino and its associated Higgs force were subjected to extremely high pressure and temperature. The electron-neutrino and its associated Higgs force evaporated to the super force, incrementally increasing the super supermassive quark star (matter) center's temperature. A chain reaction began which instantaneously evaporated, deflated, and collapsed the super supermassive quark star (matter) to a super supermassive black hole (energy) as shown in fig. 6b. The super supermassive black hole (energy) or super force doughnut singularity was a Kerr-Newman black hole.

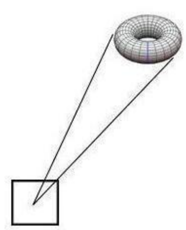
In fig. 6a, the super supermassive quark star (matter) existed until approximately one second before our universe's start. The Hawking temperature of the super supermassive quark star (matter) with mass M was $T=10^{-7}$ (M_Θ /M) K or 10^{-30} K and its life time t was approximately 10^{66} $(M/M_\Theta)^3$ years, where M_Θ was solar mass, and K was degrees Kelvin [32]. Since its equation of state and cold quark-gluon plasma density were unknown, its radius was "roughly" approximated as follows. Its upper radius was its Schwarzschild radius or $r_s = 2Gm/c^2 = (1.48 \times 10^{-27}$ m/kg) $(.32 \times 10^{54}$ kg) ~ 5×10^{26} m, where r_s is the Schwarzschild radius, G is the gravitational constant, c is the velocity of light, and m is our universe's mass [33]. The lower radius was approximated by assuming all matter particles were in contiguous Planck cubes. Since there were 10^{81} matter particles in our universe, the minimum quark star volume was $V = (1.6 \times 10^{-35}\ \mathrm{m})^3/$ (matter particle) (10^{81} matter particles) = 4×10^{-24} m^3, and its radius was approximately 10^{-8} m. The "rough" approximate radius was between the upper (5×10^{26} m) and lower (10^{-8} m) radius and shown in fig. 6a as << 10^{26} m. Conceptually, this << 10^{26} m radius was visualized as a radius of 50,000 ly or the radius of our Milky Way galaxy.

Fig. 7 shows our precursor universe's super supermassive quark star (matter)/black hole (energy) to our universe's big bang (white hole) transition. The x axis represents big bang time in seconds plus or minus from t = 0 and the y axis represents number of super force particles. Fig. 7 shows time symmetry between -10^{-33} and 10^{-33} s in accordance with Einstein's theory of General Relativity. At t = 0, all our universe's energy consisted of super force particles stacked one atop another in a doughnut singularity at the center of a Planck cube. The number of super force particles was a maximum between t = 0 and the start of inflation at $t = 5 \times 10^{-36}$ s. The start of inflation was time synchronous with the one to seven Planck cubes energy to matter expansion as described in the inflation section. During inflation, the size of our universe expanded from a sphere smaller than a Planck cube to a sphere with a radius of 8 m and a hot quark-gluon plasma with a temperature of approximately 10^{25} K. During matter creation between 5×10^{-36} and 100 s and at extremely high temperatures between 10^{27} and 10^{10} K, heavy matter particles and their Higgs forces evaporated to the super force and condensed to lighter matter particles and their Higgs forces. By t = 100 s, only eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino), their eight associated supersymmetric Higgs forces, and three permanent Higgsinos existed.

On the left side of fig. 7, matter evaporation occurred between $< -2 \times 10^{-33}$ and -5×10^{-36} s and was the counterpart of matter creation or condensation between 5×10^{-36} and 100 s. Deflation differed from inflation because its duration was longer and had two phases. During the first deflation phase between $< -2 \times 10^{-33}$ and -10^{-33} s, the super supermassive quark star (matter) or cold quark-gluon plasma at 10^{-30} K,



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



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

Fig. 6. Super supermassive quark star (matter) collapse to a super supermassive black hole (energy).

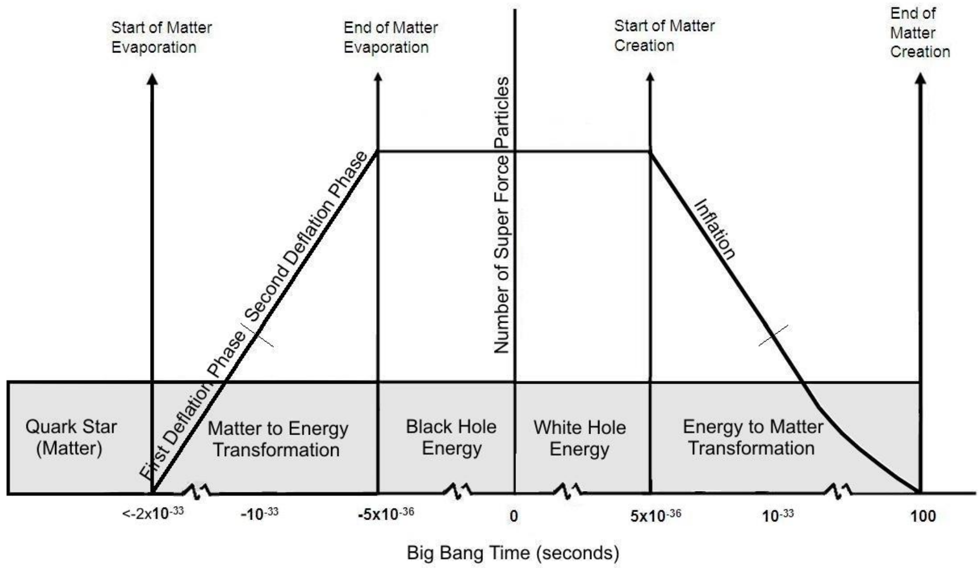


Fig. 7. Quark star/black hole to big bang (white hole) transition.

collapsed to a hot quark-gluon plasma with a radius of 8 m and a temperature of approximately 10^{25} K. During the second deflation phase between -10^{-33} and -5×10^{-36} s, the hot quark-gluon plasma collapsed to a doughnut singularity. The second deflation phase was the time reverse of inflation. That is, at -10^{-33} s, the super supermassive quark star (matter) consisted of a hot quark-gluon plasma with a radius of 8 meters and a temperature of approximately 10^{25} K identical to our universe's hot quark-gluon plasma at 10^{-33} s. At -5×10^{-36} s, the super supermassive black hole (energy) or spherical singularity was identical to our universe's white hole (energy) spherical singularity at 5×10^{-36} s.

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

Figure 7 illustrated general relativity and quantum mechanics applicability. General relativity was applicable for all times in our universe between t = 0 and the present time t = 13.8 billion years. In contrast, quantum mechanics was not applicable between -5×10^{-36} and 5×10^{-36} s. At t = 0 s, our universe was a doughnut singularity smaller than a Planck cube. At -5×10^{-36} s and 5×10^{-36} s, our universe was a spherical singularity smaller than a Planck cube. Between -5×10^{-36} and 5×10^{-36} s, quantum mechanics was not applicable because our universe was smaller than a Planck cube quantum. Quantum mechanics was applicable outside this time interval because our universe consisted of one or more Planck cubes.

For creation of a variety of universe and precursor universe sizes, quark star (matter) collapse size was assumed to be a function of two thresholds, energy/mass and energy/mass density. For our universe's creation, the energy/mass threshold was 10^{24} solar masses and the undefined energy/mass density was $\rho_{qs,}$ If only one collapse threshold existed (e.g. energy/mass), each super supermassive quark star (matter) would collapse at the 10^{24} solar masses threshold to its associated super supermassive black hole (energy) and all created universes would be identically sized. There were many combinations of energy/mass and energy/mass density thresholds of super supermassive quark star (matter) collapses to associated super supermassive black holes (energy) for a variety of created universe sizes. There were also many combinations of energy/mass and energy/mass density thresholds of super super supermassive quark star (matter) collapses to associated super super supermassive black holes (energy) for a variety of created precursor universe sizes.

Following is a thought experiment on creation of a variety of quark star (matter) sizes. A neutron star consisted of eight permanent matter particles: up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino and three permanent Higgsinos. For analysis simplicity, the relatively low energy/mass electron and three neutrino matter particles were ignored. The seven remaining fundamental matter particles (up quark, down quark, zino, photino, and three permanent Higgsinos) were modeled as indivisible ball bearings in Planck cubes. Protons/neutrons were modeled as basketballs. Proton basketballs contained two up quarks and one down quark whereas neutron basketballs contained one up quark and two down quarks. In the first example, the neutron star consisted entirely of proton/neutron basketballs. As the number of basketballs in the neutron star increased, the basketballs compressed until neutron degeneracy pressure was inadequate to prevent further collapse to a quark star (matter) and its quark-nova explosion. In the second example, the neutron star consisted of proton/neutron basketballs with a percentage of zinos, photinos, and three permanent Higgsinos. The presence of indivisible zinos, photinos, and three permanent Higgsinos mitigated neutron star collapse until its mass was larger than the first example. The larger the percentage of zinos, photinos, and three permanent Higgsinos relative to proton/neutron basketballs in a neutron star, the larger was the neutron star, its resultant quark star (matter), and its quark-nova explosion. In the super supermassive quark star (matter) which created our universe, 27% of its energy/mass consisted of dark matter (zinos, photinos, and three permanent Higgsinos.

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

This integrated arrow of time with dark energy, Super Universe, stellar black holes, black hole entropy, and black hole information paradox theories, (see Table 5).

18.1 A new cosmology theory justification

The prevailing cosmology theory "The Ultimate Free Lunch" satisfies only the third of three laws of physics and should be replaced by "An Integrated TOE which satisfies all three [34].

Table 4 compares the Ultimate Free Lunch theory versus an Integrated TOE. Three laws of physics are listed in column one, the Ultimate Free Lunch theory in column two, and an Integrated TOE in column three. The Ultimate Free Lunch theory stated 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 at t = 0. An Integrated TOE satisfied Conservation of Energy/Mass because the energy/mass in our precursor universe's super supermassive quark star (matter)/black hole (energy) was identical to our universe's energy.

Einstein's Theory of General Relativity is time symmetrical about t = 0 and consists of a black hole, a white hole, and an Einstein-Rosen bridge (i.e. a wormhole or singularity) connecting the 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 super force doughnut singularity in a Planck cube.

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

19 Cosmological constant problem

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 [35]. The Super Universe of parallel universes was created by time sequential and concurrent cycles of big bangs through stellar black holes. Hubble's law existed for precursor universes within the Super Universe, universes within our precursor universe, and galaxies within our universe. There were "n" time sequential precursor universes between the Super Universe and our universe. An estimate of sizes and number of precursor universe lineal descendants was provided. Proof of the Super Universe's parallel universes was via two advanced optical and gravitational observatory techniques.

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

Table 4. The Ultimate Free Lunch theory versus an Integrated TOE.

Our universe was nested in our precursor universe which was nested in the Super Universe. Fig. 8 shows three nested universes at t = 0 in two instead of three dimensions and not to scale. Our universe and a parallel universe were nested in our precursor universe. At t = 0, our universe was a doughnut singularity at the center of a Planck cube. The parallel universe was of finite size because it was created before t = 0. Our precursor universe was nested in the Super Universe.

Our universe obeyed the cosmological principle, that is, the distribution of matter was homogeneous and isotropic on a large scale. In addition our universe had a center at its doughnut singularity location and a spherical boundary with a radius of 46.5 billion ly. Large scale was defined as a cube with a 300 million ly side according to Kirshner [36] or a 490 million ly side according to Anderson's baryon acoustic oscillation spectroscopic survey [37]. Since dark energy (i.e. eight Higgs forces) and matter were created simultaneously and were intimately related according to Colella [10], dark energy was also uniformly distributed on a large scale. Any 490 million ly cube in our universe had identical percentages of atomic/subatomic matter 4.9 %, dark matter 27%, and dark energy 68 %.

Since dark energy was a constant 68% of total Super Universe energy/mass, as the Super Universe expanded via eternal inflation, dark energy density decreased with time. Dark energy was uniformly distributed on a large scale throughout the Super Universe, all precursor universes, and all universes including our universe. Matter and dark energy were uniformly distributed on a large but undefined scale in our precursor universe just prior to t = 0. However, matter and dark energy were not uniformly distributed on a small scale. A super supermassive quark star (matter) formed in one of our precursor universe's small scale volumes. At the 10^{24} solar mass threshold, it instantaneously evaporated, deflated, and collapsed to its associated super supermassive black hole (energy) creating a zero-point energy bubble and our universe's "big bang" (white hole).

The cosmological constant problem existed because the Super Universe's volume was 10^{120} larger than our universe. The observed cosmological constant was 10^{-120} of the expected value (2×10^{110} erg/cm^3) and known as the cosmological constant problem [38]. According to Steinhardt, this problem existed because the Super Universe was older than expected because of precursor cyclical universes [39]. Cyclical universes were special cases of nested universes where the collapsed volume was the total precursor universe. Steinhardt's cyclical universes were amplified to nested universes to provide a dark energy reduction coupling factor between our precursor universe and our universe. Because of uniform distribution of dark energy in our precursor universe, the reduction coupling factor was the volume of the super supermassive quark star (matter) which created our universe divided by the total precursor universe's volume.

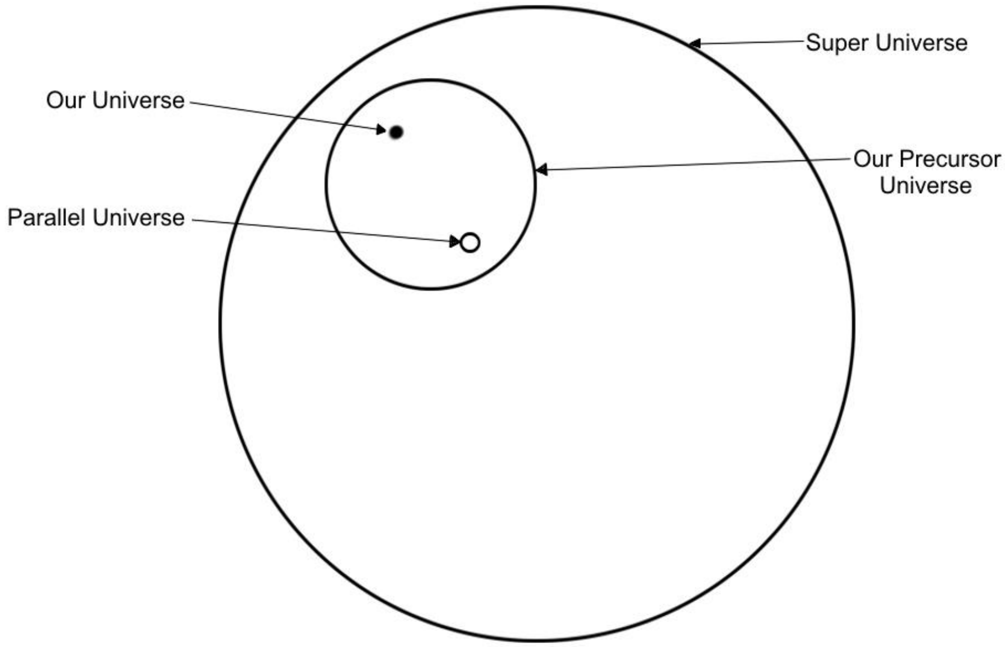


Fig. 8. Three nested universes at t = 0.

Fig. 9 shows three nested universes: the Super Universe, our precursor universe, and our universe at four sequential big bang times in two instead of three dimensions and not to scale. Super force string doughnut singularities at the center of Planck cubes existed at the start of the Super Universe, all precursor universes, and all universes including our universe. The Super Universe's big bang occurred approximately at -10^{50} years. At an arbitrary $t = -10^{10}$ years, a super super supermassive black hole (energy) was created in the Super Universe preceded by its associated super super supermassive quark star (matter). By t = 0, that super super supermassive black hole (energy) expanded into our precursor universe. Within our precursor universe, a super supermassive black hole (energy) was created preceded by its associated super supermassive quark star (matter). The super supermassive black hole (energy) transitioned to our big bang's white hole as described in the stellar black hole section. After 13.8 billion years of expansion, our universe exists. Fig. 9 also shows our precursor universe spawned a parallel universe at a time prior to t = 0. Within our universe and the parallel universe were galaxies. Eventually, the big bang time scale of fig. 9 where our universe's big bang occurred at t = 0, should be replaced by the Super Universe's big bang time scale where t = 0 occurred approximately 10^{50} years ago.

Since the Super Universe's volume was 10^{120} larger than our universe and spherical volumes were proportional to their radii cubed, the ratio of the Super Universe's radius R_{su} to our universe's radius R_{ou} (46.5×10^9 ly) was $(10^{120})^{1/3}$ or 10^{40}. The Super Universe's radius was $R_{su} = (10^{40})(46.5 \times 10^9 \text{ ly})$ or approximately 10^{50} ly. Assuming equal expansion rates or our universe's radius/our universe's age = Super Universe's radius/Super Universe's age, the Super Universe's age was approximately 10^{50} years.

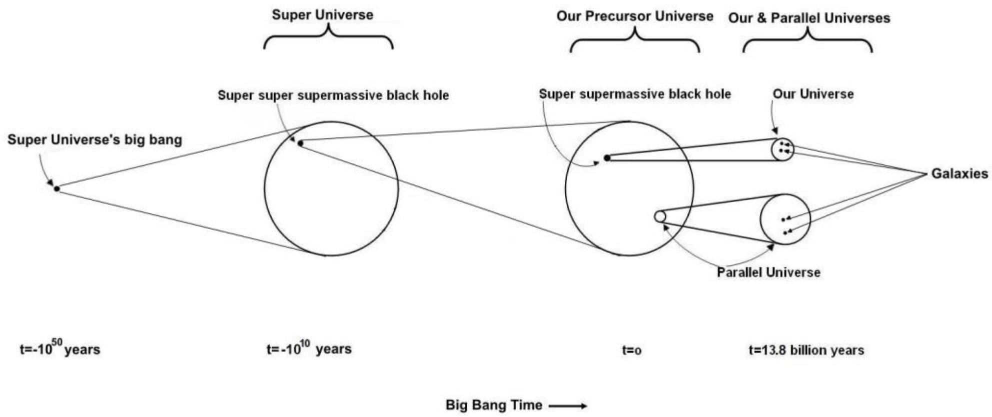


Fig. 9. Super Universe and nested universes.

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

The Super Universe of parallel universes was created by time sequential and concurrent cycles of big bangs through stellar black holes. Three time sequential cycles are explicitly shown in fig. 9. In the first cycle, the Super Universe's big bang created the Super Universe and at t = -10^{10} years, a super super supermassive quark star (matter). Second, the latter's associated super super supermassive black hole (energy) created our precursor universe and at t = 0, a super supermassive quark star (matter). Third, the latter's associated super supermassive black hole (energy) created our universe and by t = 13.8 billion years, supermassive quark stars (matter) at the center of each of our universe's galaxies. The concurrent cycles of big bangs through stellar black holes are implicit in fig. 9. For example, at approximately t = -10^{10} years, a second super super supermassive black hole (energy) created a second parallel precursor universe and subsequently, a super supermassive quark star (matter). The latter's associated super supermassive black hole (energy) created a parallel universe in the second parallel precursor universe.

Hubble's law existed for precursor universes within the Super Universe, universes within our precursor universe, and galaxies within our universe as shown in fig. 10. Implicit in fig. 10 is Hubble's law existed for universes within all precursor universes and galaxies within all universes. At the Super Universe's big bang 10^{50} years ago, all the Super Universe's energy (10^{54} kg)(10^{120}) = 10^{174} kg was in the Super Universe's super force doughnut singularity. Precursor universes within the Super Universe were created by super super supermassive quark stars (matter)/black holes (energy) collapses. There was a linear Hubble's law between the velocity or red shift of precursor universes within the Super Universe and time or distance. Similarly, there was a linear Hubble's law for universes within our precursor universe.

Our universe was created 13.8 billion years ago by a super force doughnut singularity surrounded by a spherical zero-point energy bubble. As shown in fig. 10, our universe decelerated for its first eight billion years and accelerated during the next 6 billion years. Currently, a zero-point energy spherical shell exists between the outer boundary of our spherical universe (46.5 billion ly radius) and the inner undefined

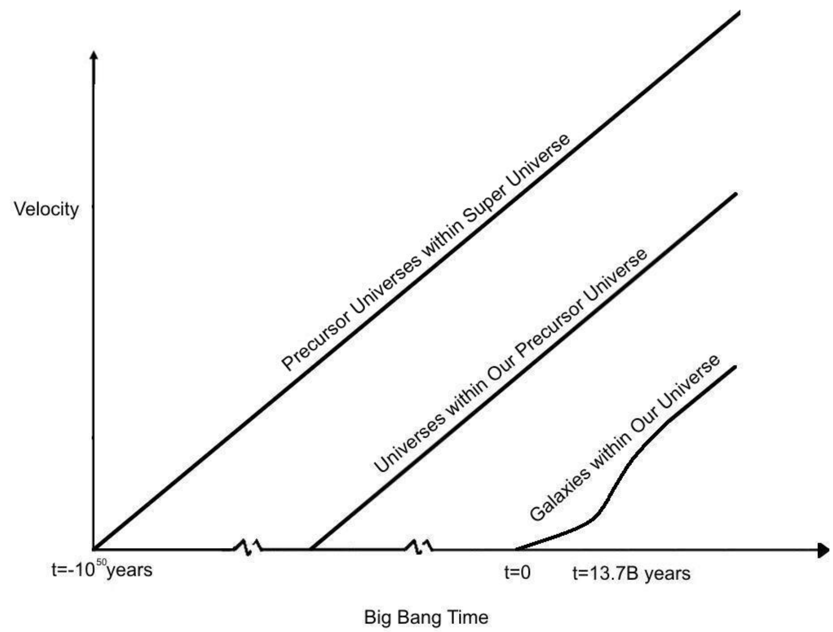


Fig. 10. Hubble's law.

spherical boundary of our precursor universe. As our universe accelerates, the spherical shell thickness approaches zero. Our universe's acceleration will stop when our universe's outer boundary merges with our precursor universe's inner boundary. Then, the expansion rate of galaxies within our universe will become identical to the linear Hubble's law 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 13.8 billion years.

There were "n" time sequential precursor universes between the Super Universe and our universe. Fig. 8 and fig. 9 show a simplified Super Universe with only one nested child precursor universe between the Super Universe and our universe. There were realistically "n" nested child precursor universes and for a "straw man" Super Universe model, "n" was arbitrarily selected as 4.

Fig. 11 shows four nested children precursor universes at t = 0. The Super Universe is the largest circle. Children precursor universes (PU) nested in the Super Universe are PU_1, PU_2, PU_3, PU_4, PU_5, and PU_6. Subscripts identify children, grandchildren, great-grandchildren, and great-great-grandchildren precursor universes. The first subscript identifies children, the second grandchildren, the third great-grandchildren, and the fourth great-great-grandchildren precursor universes. For example, in the first child precursor universe PU_1 are three grandchildren precursor universes PU_{11}, PU_{12}, and PU_{13}. In the first grandchild precursor universe PU_{11} are three great-grandchildren precursor universes PU_{111}, PU_{112}, and PU_{113}. In the first great-grandchild precursor universe PU_{111} are three great-great-grandchildren precursor universes PU_{1111}, PU_{1112}, and PU_{1113}. In the first great-great-grandchild precursor universe P_{1111} are our universe and a parallel universe. A variety of quark stars (matter)/black holes (energy) sizes created a variety of nested precursor universe sizes shown in fig. 11.

Visual amplification of fig. 11 is required as follows. First, the figure is shown in two instead of three dimensions and not to scale since the Super Universe's volume is 10^{120} larger than our universe. Second,

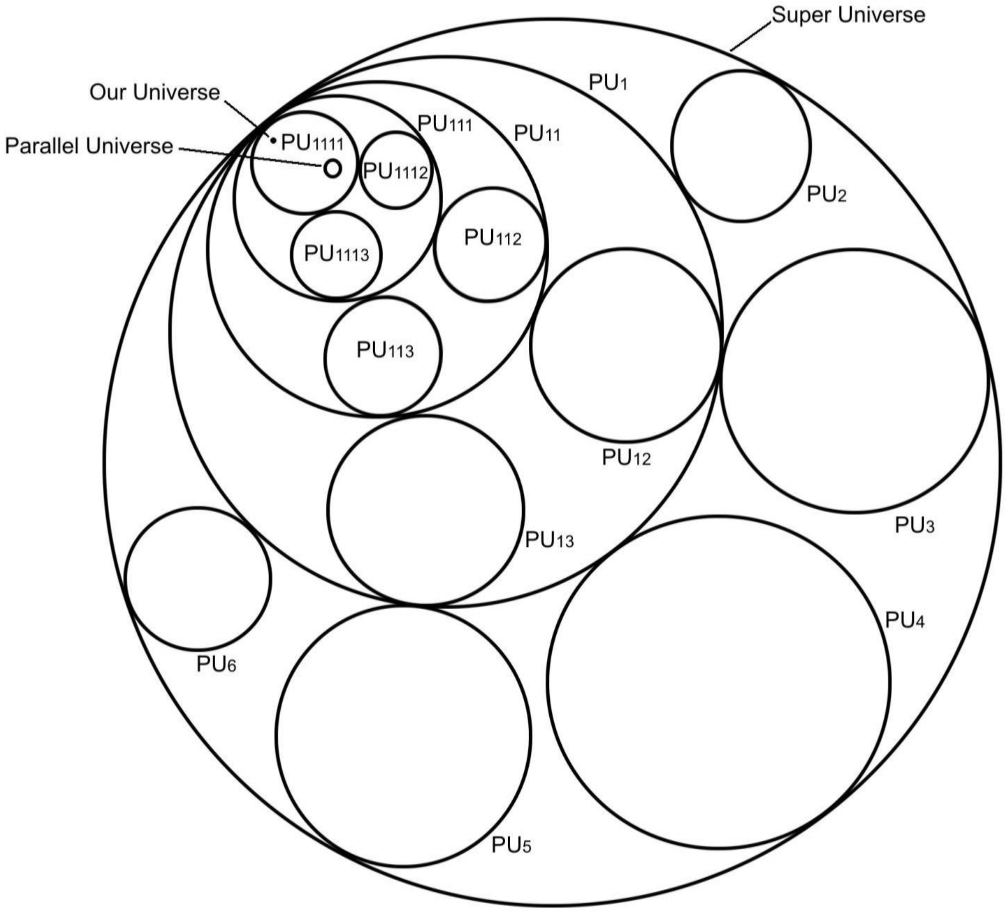


Fig. 11 Four nested children precursor universes at t = 0.

empty spaces do not exist in the Super Universe. For example, between the six children precursor universes (PU_1 to PU_6) matter must be uniformly distributed on a large scale. Empty spaces must be filled with smaller precursor universes.

19.1 Proof of parallel universes

Proof of the Super Universe's parallel universes is via two advanced optical and gravitational observatory techniques. First is the Hubble Ultra Deep Field telescope which can detect galaxies with an age of 13.2 billion years. Galaxies within our universe are expanding from our universe's doughnut singularity origin. Similarly, galaxies of any parallel universe are expanding from their universe's doughnut singularity origin. Galaxies of parallel universes are uniformly distributed in the Super Universe between our universe's boundary (radius of 46.5 billion ly plus an undefined zero-point energy spherical shell thickness) and the spherical Super Universe's boundary (radius of 10^{50} ly). Across the zero-point energy spherical shell is the closest galaxy of the closest parallel universe to our Milky Way galaxy. This closest galaxy is accelerating or moving at a constant velocity toward our Milky Way galaxy assuming its early deceleration phase has completed. Our Milky Way galaxy is accelerating toward the closest galaxy. Since the two galaxies are accelerating towards each other, a search of blue shift galaxies is required. The blue shift galaxy radiation strength is dependent on the galaxy's size and its distance from our Milky Way galaxy. That distance is dependent on the undefined location of our Milky Way galaxy in our universe and the undefined zero-point energy spherical shell thickness. The closer our Milky Way galaxy is to our universe's boundary and the smaller the zero-point energy spherical shell thickness, the greater is the signal from the closest galaxy. Since the direction of the closest galaxy of the closest parallel universe from our Milky Way galaxy is undefined, a number of uniformly distributed angular search directions should detect the blue shift galaxy.

Deceleration of our universe occurred during the first 8 billion years and acceleration during the last 6 billion years as shown in fig. 10. If deceleration/acceleration of our universe is assumed symmetrical, our universe will merge with our precursor universe in approximately 2 billion years. If the Milky Way galaxy is at our universe's boundary, the closest galaxy is only 2 billion ly away.

The second advanced technique is a gravitational observatory. An estimated big bang gravitational energy waveform is shown in fig. 12. The x axis represents big bang time in seconds plus or minus from t = 0 and the y axis represents gravitational energy. This waveform was derived from fig. 7 Quark star/black hole to big bang (white hole) transition.

The estimated big bang gravitational energy waveform consists of a pulse and decaying step function, both having identical maximum amplitudes. Fig. 12 shows time symmetry between -10^{-33} and 10^{-33} s in accordance with Einstein's theory of General Relativity. Our precursor universe's super supermassive quark star (matter) composition at -10^{-33} s was identical to our universe's hot quark-gluon plasma at 10^{-33} s. Between t = 0 and t = 5 x 10^{-36} s, 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 x 10^{-36} to 10^{-33} s), or during the white hole (energy) to hot quark-gluon plasma (matter) transformation. At the start of the hot quark-gluon plasma (10^{-33} s), the heaviest matter particles were in the most compact 8 m radius sphere and gravitational energy was a maximum. As our universe expanded following 10^{-33} s, matter particles moved further apart from each other and gravitational energy decreased. Matter density and gravitational energy were a maximum at 10^{-33} s and at the time symmetrical hot quark-gluon plasma of the super supermassive quark star (matter) at time -10^{-33} s.

Prior to the first deflation phase at < -2 x 10^{-33} s, the super supermassive quark star (matter) added 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} m) super supermassive quark star (matter) at 10^{-30} K (cold quark-gluon plasma). During the first deflation phase between < -2 x 10^{-33} and -10^{-33} s, the super supermassive quark star (matter) at 10^{-30} K evaporated, deflated, and 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 x 10^{-36} s with a decrease in gravitational energy to zero at t = -5 x 10^{-36} s. Between -5 x 10^{-36} and 5 x 10^{-36} s, all our universe's energy (10^{54} kg) 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 (10^{-35} s) of the super supermassive black hole (energy)/white hole (energy).

The estimated big bang gravitational waveform's location was the origin of our universe's big bang. The estimated gravitational energy waveform occurred at the big bang time t = 0, or 13.8 billion years ago. If all our universe's galaxy positions are extrapolated backwards in three dimensional space, they intersect at the origin at t = 0. The estimated gravitational energy waveform should be detectable at the big bang's location and time by an advanced extraordinarily high frequency (> 10^{33} Hertz) Laser Interferometer Gravitational Observatory (LIGO) or Laser Interferometer Space Antenna (LISA). The fundamental time period between peaks of the fig. 12 waveform is 2 x 10^{-33} s. The Fourier series fundamental frequency is f = 1/T = 1/(2 x 10^{-33} s) = .5 x 10^{33} Hz.

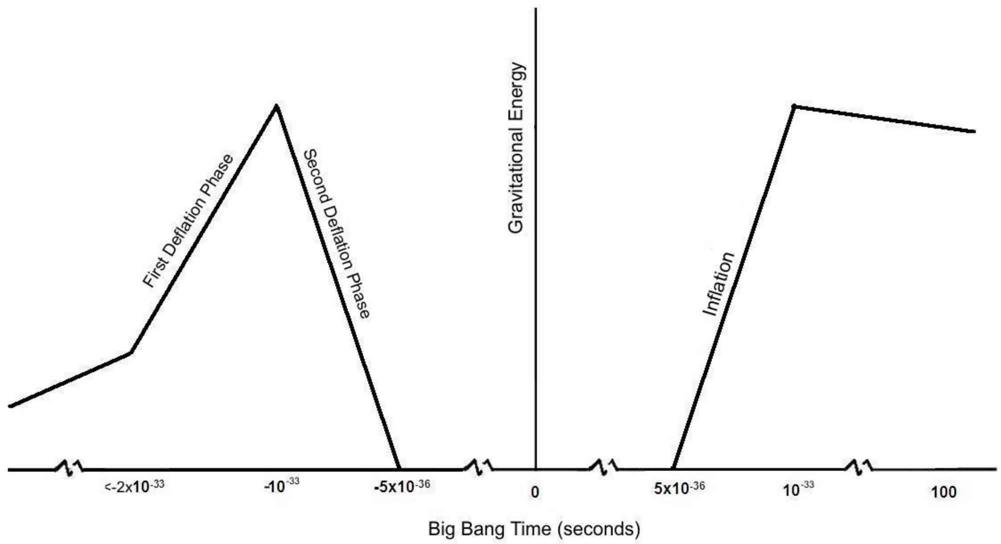


Fig. 12. Estimated big bang gravitational energy waveform.

This integrated the cosmological constant problem with dark matter, dark energy, Super Universe, stellar black holes, black hole entropy, and arrow of time theories, (see Table 5).

20 Black hole information paradox

Intrinsic or structural information was lost in a super supermassive quark star (matter)/black hole (energy) formation and none was emitted as Hawking radiation. In 1975, Hawking correctly stated Hawking radiation contained no information swallowed by a black hole. In 2004, his position reversed and he incorrectly stated Hawking radiation contained information. This was the black hole information paradox caused by misunderstanding of an object's intrinsic and extrinsic information.

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

Each up quark, down quark, and electron resides as a closed string within a specific Planck cube of the encyclopedia's ink, paper, binding, etc. molecules. Encyclopedia intrinsic information is lost in four star collapse stages during decomposition of its molecules to atoms, to protons/neutrons and electrons, to quarks, and to super force particles. In a white dwarf star, molecules decompose to atoms and molecular intrinsic structural information is lost. In a neutron star, atoms decompose to neutrons, protons, and electrons and atomic intrinsic structural information is lost. In a super supermassive quark star (matter), protons and neutrons decompose to up and down quarks and nuclear intrinsic structural information is lost. In a super supermassive black hole (energy), up and down quarks decompose or evaporate to super force particles and fundamental matter intrinsic structural information is lost. Intrinsic or structural information is lost in a super supermassive quark star (matter)/black hole (energy) formation and none is emitted as Hawking radiation. Hawking's 1975 solution is correct, not his 2004 solution.

The above matter decomposition description was intimately related to and the reverse of our universe's matter creation as follows. During and immediately following inflation, particle creation was the condensation of super force particles into eight permanent matter particles and their eight associated supersymmetric Higgs forces. During the hadron era, up quarks and down quarks combined to form protons and neutrons. At 380,000 years, protons and helium nuclei recombined with electrons to form hydrogen and helium atoms. Hydrogen atoms combined to form hydrogen molecules. Starting at 200 million years, molecular hydrogen clouds formed stars. Stellar core and supernova nucleosynthesis created all Periodic Table atoms above hydrogen and helium. These atoms combined to form complex molecules.

This integrated black hole information paradox with particle creation/decomposition, stellar black holes, black hole entropy, and arrow of time theories, (see Table 5).

21 Baryogenesis

Charge, parity, and time (CPT) violation caused baryogenesis [40]. Baryogenesis is the asymmetric production of baryons and anti-baryons in our early universe expressed as the baryon to photon ratio $\eta = 6.1 \times 10^{-10}$. Asymmetric production of quarks and anti-quarks is more appropriate, however, since baryons and anti-baryons were defined before quarks and anti-quarks, the baryogenesis definition is retained. Big bang nucleosynthesis determined η and the Wilkinson Microwave Anisotropy Probe measured it accurately [41]. There are 44 identified baryogenesis theories of which six are prominent: electroweak, GUT, quantum gravity, leptogenesis, Affleck-Dine, and CPT violation [42]. Electroweak occurs insufficiently in the SM and is considered unlikely without supersymmetry. Inflationary scenarios disfavor GUT and quantum gravity theories. Leptogenesis and Affleck-Dine are viable but not well understood [43]. The sixth baryogenesis theory is CPT violation having three arguments which support each other and this article's conclusions.

The first argument according to T. D. Lee stated the CPT theorem was invalid at the Planck scale [44]. In this article, a Planck cube defined the quantum of matter particle, force particle, and space. Our universe originated as a super supermassive black hole (energy) or a super force doughnut singularity at the center of a Planck cube as described in the string theory section. Quantum mechanics was invalid between our universe's origin at $t = 0$ s and the start of inflation at $t = 5 \times 10^{-36}$ s because our universe was smaller than a Planck cube quantum, in agreement with Lee.

The second argument according to N. E. Mavromatos [45] is in the CPT theorem, laws of physics are unchanged by combined CPT operations provided locality, unitarity (sum of all possible outcomes of any event is one), and Lorentz invariance are respected. Highly curved 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. From the black hole information paradox section's conclusion, incoming matter information is lost in the collapse of a super supermassive quark star (matter) to a super supermassive black hole (energy) in agreement with Mavromatos.

The third argument according to F. Hulpke [46] was a quantum mechanics axiom stated the transformation from one state to another respected unitarity and entropy preservation. According to the arrow of time section, the maximum entropy super supermassive quark star (matter) evaporated, deflated, and collapsed to the minimum entropy super supermassive black hole (energy). Entropy was reset to a minimum as the super supermassive black hole (energy) "resurrected" life via creation of super force particles. During the collapse, energy/mass quanta in Planck cubes collapsed to a super force singularity in a volume smaller than a Planck cube quantum. During the collapse, quantum mechanics was invalid and both unitarity and entropy preservation were not respected in agreement with Hulpke.

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 symmetric big bang white hole (energy) counterpart. The evaporation of each matter particle and its Higgs force to a super force particle and the condensation of each super force particle to a matter particle and its Higgs force violated CPT. This provided sufficient CPT violations to produce our universe's baryon to photon ratio of 6.1×10^{-10}.

This integrated baryogenesis with particle creation, inflation, Higgs forces, spontaneous symmetry breaking, dark matter, dark energy, stellar black holes, black hole entropy, arrow of time, and black hole information paradox theories, (see Table 5).

22 Quantum Gravity Theory

String theory and an Integrated TOE as described in this article are identical to quantum gravity theory because they unify all known physical phenomena from the near infinitely small or Planck cube scale (quantum mechanics) to the near infinitely large or Super Universe scale (Einstein's General Relativity).

All matter and force particles exist as closed 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. In contrast, extremely massive collapsed stars are only described by Einstein's law of General Relativity. These include: super supermassive black holes (energy), super super supermassive black holes (energy), and the super super super supermassive black hole (energy).

String theory defined each of 129 fundamental matter and force particles as a closed string in a Planck cube. Any object in the Super Universe is defined by a volume of contiguous Planck cubes containing these fundamental matter or force particle strings. Super force string doughnut singularities existed at the center of Planck cubes at the start of the Super Universe, all precursor universes, and all universes including our universe. Thus, string theory unified quantum mechanics of the near infinitely small or Planck cube scale (e.g. fundamental matter and force particles) with Einstein's General Relativity at the near infinitely large Super Universe scale (e.g. the super super super supermassive black hole (energy) or the super force doughnut singularity which created the Super Universe).

This integrated quantum gravity with all other nineteen theories in an Integrated TOE, (see Table 5).

23 An Integrated TOE mathematics solution

Two steps are required for an Integrated TOE mathematics solution, a fundamental physics step and a two part mathematics step. The two parts of the mathematics step are, an amplified E8 Lie algebra for particles [47] and an amplified N-body simulation for cosmology [48].

An Integrated TOE includes particle creation, Higgs forces, spontaneous symmetry breaking, dark energy, stellar black hole, etc. theories. An Integrated TOE can be resolved via two methodologies, one step or two steps. The one step methodology uses pure mathematics and is intellectually overwhelming. After a century of attempts using this methodology, there are near zero TOE results. In contrast, the two step methodology is intellectually formidable but viable. In the first fundamental physics step and without sacrificing their integrities, twenty independent existing theories are amplified to provide an Integrated TOE as described in this article. This is followed by the second mathematics step. Two steps are essential because there are significant information gaps in the twenty independent existing theories which the single mathematics step methodology cannot resolve. For example, amplified Higgs forces requirements must be inputs to the mathematics step because the latter has no intelligence to define them.

The first part of the second mathematics step is an amplified E8 Lie algebra technique for particles and their interactions described by Lisi. This article's amplified requirements must be added to Lisi's current E8 Lie algebra technique and include: 128 matter and force particle closed strings in Planck cubes; 64 supersymmetric Higgs particles; spontaneous symmetry breaking caused by extremely high temperatures in our early universe; gauge mediated spontaneous symmetry breaking for both SM and supersymmetric particles (no graviweak coupling); mass given to a matter particle by its associated Higgs force, not by W/Z bosons; a cosmological constant proportional to dark energy density or eight Higgs force energy densities; a cosmological constant problem caused by the Super Universe's volume being 10^{120} larger than our universe; and invalid quantum mechanics prior to matter creation.

The second part of the second mathematics step is an amplified N-body numerical simulation for cosmology described by Baldi. A large scale, homogeneous, ΛCDM dark energy model is adequate. Since this article provides the theoretical roots for the universally accepted ΛCDM cosmological model, complex inhomogeneous models (e.g. modified gravity theories) are not required. This article's amplified requirements must be added to current homogeneous N-body simulations and include: Higgs forces created during matter creation; dark energy was 68% of our universe's energy/mass at t = 100 s and remained constant for the next 13.8 billion years (no quintessence); atomic/subatomic, dark matter, and dark energy were uniformly distributed on a large scale; two opposing forces (gravity/matter and anti-gravity/dark energy) shaped our universe following the end of the radiation force at 380,000 years; and dark energy density and the cosmological constant decreased with time as our universe expanded. The amplified N-body simulation will predict positions (e.g. of galaxies) which are then compared with measured galaxy positions. In the current N-body simulation, measured galaxy positions are used to calibrate the model instead of vice versa. The amplified N-body simulation should also eventually include the Super Universe with four nested precursor universes.

Because of its intellectual formidability, an Integrated TOE mathematics solution consisting of: the fundamental physics step provided by this article, the proposed particle mathematics step, and the proposed cosmology mathematics step, remains a work in progress.

24 Conclusions

For an Integrated TOE, twenty independent existing theories were replaced by twenty interrelated amplified theories and summarized in Table 5. An Integrated TOE was modeled as a jigsaw puzzle shown in fig. 13. Five independent existing theories (Higgs forces, string, particle creation, inflation, and dark energy) were shown by five unshaded jigsaw puzzle pieces. The five theories were independent because physicists in each theory worked independently of physicists in other theories. The shaded areas surrounding the five unshaded jigsaw puzzle pieces represented interrelated amplified requirements. For example, the unshaded area of the key Higgs forces jigsaw puzzle piece was amplified by its shaded area to provide compatible interface requirements with the four other jigsaw puzzle pieces (string, particle creation, inflation, and dark energy). After nine years and 200 iterations, the number of independent existing jigsaw puzzle pieces expanded from five to twenty as described in this article. Each of twenty jigsaw puzzle pieces was selectively amplified without sacrificing its integrity (i.e. unshaded areas of independent existing requirements) to provide twenty snuggly fitting interrelated amplified theories. Table 5 Primary interrelationships between twenty interrelated amplified theories summarized an Integrated TOE. Prior to an Integrated TOE, twenty independent existing theories were in the first column and first row and Table 5 was blank.

	String	Particle creation	Inflation	Higgs forces	Spontaneous symmetry breaking	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	x						x
Particle creation	x	x	x	x	x	x	x	x	x	x		x		x	x			x	x	x
Inflation		x	x	x	x			x	x	x		x							x	x
Higgs forces		x	x	x	x	x		x	x	x	x					x			x	x
Spontaneous symmetry breaking		x	x	x	x	x	x	x	x	x									x	x
Superpartner and quark decays		x		x	x	x			x											x
Neutrino oscillations		x			x		x	x												x
Dark matter		x	x	x	x		x	x	x	x							x		x	x
Universe expansions	x	x	x	x	x	x		x	x	x		x								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								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
Arrow of time				x						x			x	x	x	x	x	x	x	x
Cosmological constant problem								x		x			x	x	x	x	x			x
Black hole information paradox		x												x	x	x		x	x	x
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

Table 5. Primary interrelationships between twenty interrelated amplified theories.

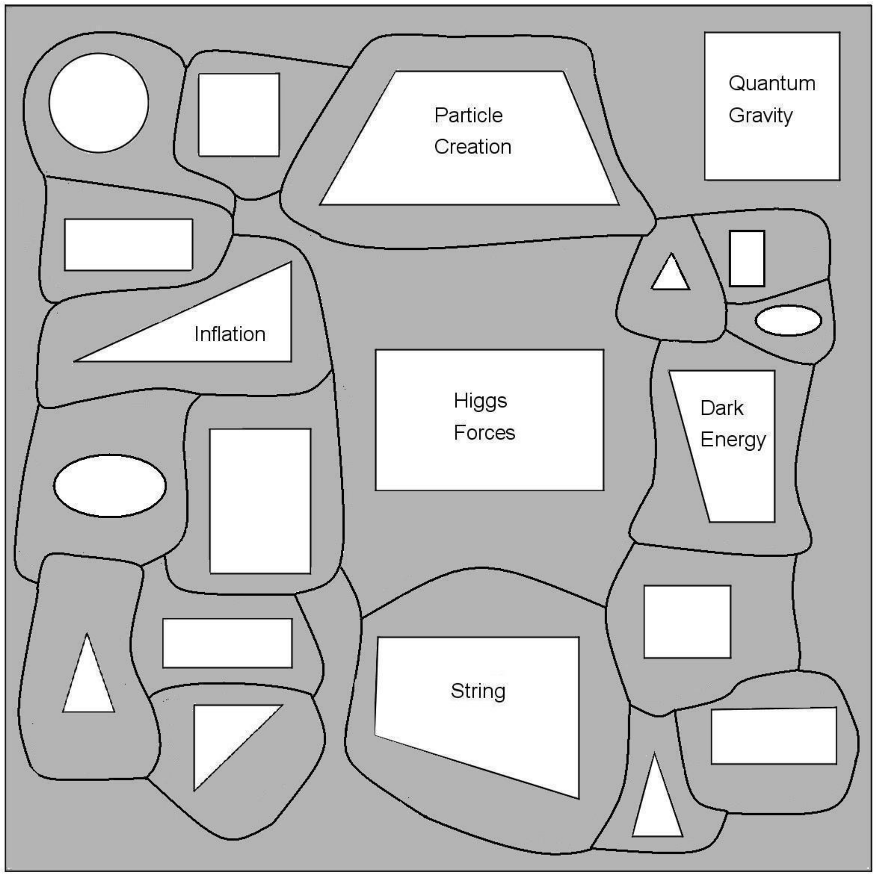


Fig. 13. An Integrated Theory of Everything jigsaw puzzle.

Six Integrated TOE advanced validation techniques are: Large Hadron Collider (LHC) detection of all 32 Higgs particles; detection of hierarchy problem estimate of gravitino energy/mass; amplified N-body numerical simulation; Background Imaging of Cosmic Extragalactic Polarization (BICEP2)/Planck B-mode inflation polarization measurements; optical observatory detection of parallel universes, and gravitational observatory detection of estimated big bang gravitational energy waveform.

The following amplified requirements from the Higgs forces section should be incorporated in the LHC for detection of 32 Higgs particles.

1. Higgs particles were God particles because they constituted approximately 82% of our universe's total energy/mass
2. The sum of eight Higgs force energies associated with eight permanent matter particles was dark energy
3. Sixty four associated supersymmetric Higgs particles existed
4. Extremely high temperatures in our early universe caused spontaneous symmetry breaking, not the Higgs force
5. The Higgs force was a residual super force which contained the mass, charges, and spin of the associated matter particle
6. Matter particles and their associated Higgs forces were one and inseparable

7. Mass was given to a matter particle by its associated Higgs force and gravitational force messenger particles
8. Spontaneous symmetry breaking was bidirectional.

Eight permanent Higgs forces, 9 transient Higgs forces, three permanent Higgsinos, and twelve transient Higgsinos remain to be detected by the LHC.

The gravitino estimated energy/mass of 10^{21} eV described in the relative strengths of forces/Hierarchy problem section should be detected.

In the N-body numerical simulation technique, amplified requirements must be added as described in an Integrated TOE mathematics solution section for galaxy position prediction.

In the BICEP2/Planck B-mode technique, one B-mode polarization type is generated during inflation. This B-mode polarization is being investigated by the BICEP2 experiment at the South Pole and the Planck satellite. According to Mortonson and Seljak, the BICEP2 results are not a definite proof of inflation because the measured B-mode polarization may have been caused by dust polarization contributions [49]. However, future B-mode polarization measurements and analyses should define inflation and the exponential inflation factor. One of three exponential inflation factors described in the inflation section should be validated.

The optical observatory technique described in the proof of parallel universes section should detect the blue shift of the closest galaxy of the closest parallel universe.

The gravitational observatory technique described in the proof of parallel universes section should detect the estimated big bang gravitational energy waveform.

Independent analyses/validations by physicists or the seventh validation technique is also proposed. For example in 1919, Sir Arthur Eddington travelled to the island of Principe off the west coast of Africa to photograph stars near the eclipsed sun. Einstein's equations predicted star deflection of light, Eddington measured the deflection, and confirmed Einstein's theory of General Relativity.

An open, frank, and cooperative discussion is required between physicists working in the twenty interrelated amplified theories. Only then will the integrated mathematics TOE, the final theory, the crowning achievement of science, the ultimate triumph of human reasoning, and knowledge of God's mind be resolved.

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