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The cosmological constant is not a constant

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Abstract. Our universe's composition was established by 100 s after the big bang and remained constant for the next 13.8 billion years. Atomic/subatomic matter constituted 4.9%, dark matter 27%, and dark energy 68% of our university's total energy/mass. Since the cosmological constant was proportional to dark energy density, as our universe expanded both dark energy density and the cosmological constant decreased with time. 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.

1 Introduction

The cosmological constant is not a constant is based on an Integrated Theory of Everything (TOE). The foundations of an Integrated TOE are twenty independent existing theories. The premise of an Integrated TOE is without sacrificing their integrities; these twenty independent existing theories are replaced by twenty interrelated amplified theories. Amplifications of five of the twenty independent existing theories (string theory, Higgs forces, Super Universe, stellar black holes, and the cosmological constant problem) are required to define the cosmological constant is not a constant.

2 String theory

An Integrated TOE via string theory unites all known physical phenomena from the near infinitely small Planck cube scale (quantum mechanics) to the near infinitely large Super Universe or multiverse scale (Einstein's general relativity). Each of 129 fundamental matter/force particles resides in a Planck cube as a string. Any object in the Super Universe can be 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. The above summarized string theory from Colella's a new cosmology theory: an integrated theory of everything [1].

3 Higgs forces

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. Spontaneous symmetry breaking was bidirectional. The super force could condense into a matter particle and its associated Higgs force or a matter particle and its associated Higgs force could evaporate to the super force. Our universe's and the Super Universe's eight permanent matter particles were 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). Each of these eight permanent matter particles had an associated supersymmetric Higgs force. The sum of the eight Higgs force energies of these eight permanent matter particles was dark energy. The above summarized Colella's an intimate relationship between Higgs forces, dark matter, and dark energy [2].

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4 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 (see Cosmological constant problem section). 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 other gumballs with different radii were parallel universes. 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. For example the Super Universe: contained 129 matter/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.

5 Stellar black holes

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 as follows. A stellar black hole contains a singularity having minimum area and volume, whereas the same stellar black hole has maximum entropy implying maximum event horizon area as defined by Bekenstein [3] or maximum volume as defined by Colella [4].

Stellar black hole theory was 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, a black hole (energy) had super force energy, a Planck cube singularity with minimal volume, 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 the approximate 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 [5].

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 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 [6], 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 our universe's "big bang" (white hole).

In the Super Universe, the fifth type or a super super supermassive quark star (matter) at the proper but undefined solar mass threshold, instantaneously evaporated, deflated, and collapsed to the sixth type or its associated super super supermassive black hole (energy) and created a precursor universe. The above summarized stellar black holes from Colella's a new cosmology theory: an integrated theory of everything [1].

6 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. 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. Proof of the Super Universe's parallel universes was via two advanced optical and gravitational observatory techniques.

Our universe was nested in our precursor universe which was nested in the Super Universe. Fig. 1 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's composition was established by 100 s after the big bang and consisted of atomic/subatomic matter 4.9%, dark matter 27%, and dark energy 68% as described by Colella in [2]. Furthermore, from the end of matter creation at t = 100 s to the present time at 13.8 billion years, those percentages did not change. Atomic/subatomic matter was converted to energy only by big bang, stellar, and supernova nucleosynthesis. Total particle (e.g. up quark) energy/mass consisted of three energy types: rest mass, kinetic (translational and rotational), and potential (gravitational, electromagnetic, and nuclear binding). An up quark's rest mass was converted without changing total atomic/subatomic energy/mass. For example, only 1% of a proton's energy/mass was rest mass whereas 99% was nuclear binding energy. This 1% would be even less if the proton's kinetic and potential energies were included. In addition, up quark rest mass was converted to kinetic energy of products and radiation which was absorbed by surrounding matter particles. Following rest mass conversion, total atomic/subatomic energy/mass remained constant at 4.9%.

The cosmological constant lambda (Λ) was proportional to vacuum or dark energy density (ρ_Λ), or $\Lambda = (8\pi G/3c^2)\, \rho_\Lambda$, where G was the gravitational constant and c the speed of light [7]. Since the cosmological constant was proportional to dark energy density, as our universe expanded both dark energy density and the cosmological constant decreased with time.

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 a cube with a 300 million ly side according to Kirshner [8] or a 490 million ly side according to Anderson's baryon acoustic oscillation spectroscopic survey [9]. Since dark energy was intimately related to matter according to Colella [2], 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 %.

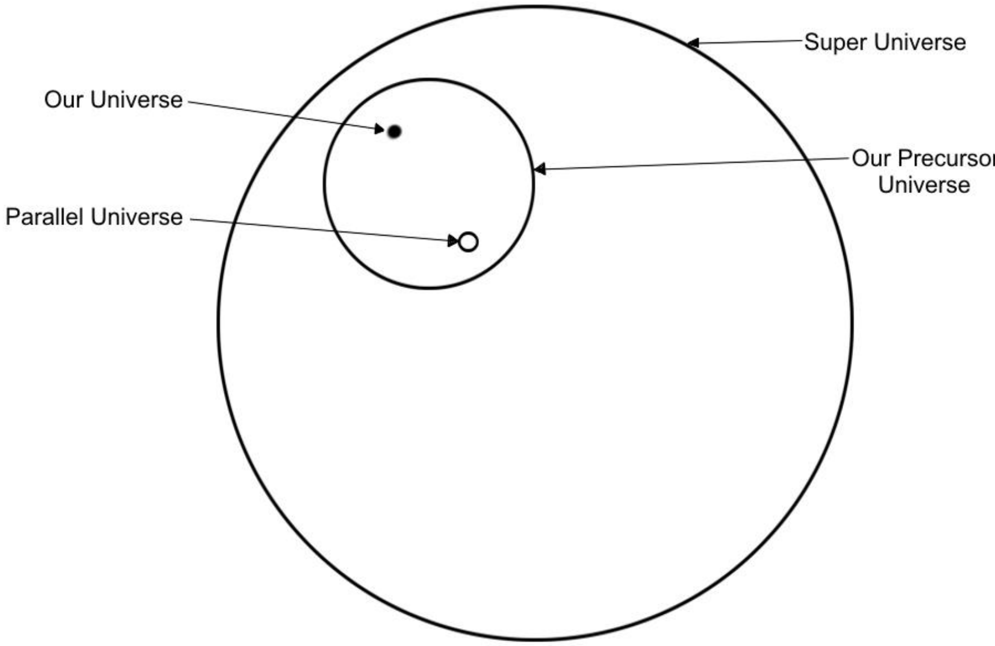

Fig. 1. Three nested universes at t = 0.

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 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 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) which created 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 [10]. According to Steinhardt, this problem existed because the Super Universe was older than expected because of precursor cyclical universes [11]. 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 approximately the volume of the super supermassive quark star (matter) which created our universe divided by the total precursor universe's volume.

Fig. 2 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

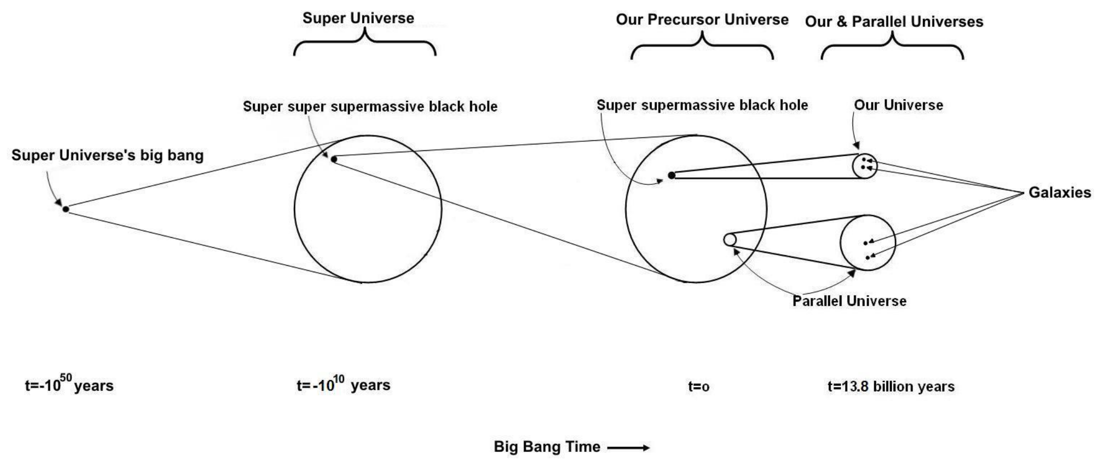

Fig. 2. Super Universe and nested universes.

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. 2 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. 2 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 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 $R_{su} = (10^{40})$ (46.5×10^9 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. 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. 2. 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's (energy) created our precursor universe and at $t = 0$, a super supermassive quark star (matter). Third, the latter's associated super supermassive black hole's (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. 2. For example, at $t = -10^{10}$ years, a second super super supermassive black hole's (energy) created a second parallel precursor universe and subsequently, a super supermassive quark star (matter). The latter's associated super supermassive black hole's (energy) created a parallel universe in the second parallel precursor universe.

To provide a variety of super supermassive quark star (matter)/black hole (energy) collapse sizes, the latter was assumed to be a function of two thresholds, energy/mass and energy/mass density. For creation of our universe, the energy/mass threshold was 10^{54} kilograms and the associated undefined energy/mass density was ρ_{ou} where ou signifies our universe. If only one collapse threshold existed (e.g. energy/mass) all universes would be identical in size. Similarly, a super super supermassive quark star (matter) was assumed to have an energy/mass collapse threshold much greater than 10^{54} kilograms and an energy/mass density collapse threshold much greater than ρ_{ou}. Thus, there were a variety of super supermassive quark stars (matter)/black holes (energy) sizes in precursor universes to create a variety of universe sizes. There were also a variety of super super supermassive quark stars (matter)/black holes (energy) sizes in the Super Universe to create a variety of precursor universe sizes.

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. 3. Implicit in fig. 3 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 doughnut super force singularity surrounded by a spherical "perfect" vacuum bubble as described by Colella [12]. As shown in fig. 3, our universe decelerated for its first eight billion years and accelerated during the next 6 billion years. Currently, a "perfect" vacuum spherical shell exists between the outer boundary of our spherical universe (46.5 billion ly radius) and the inner undefined spherical boundary of our precursor universe. As our universe accelerates, the spherical shell thickness approaches zero. Our universe's acceleration will stop when our universe's outer boundary merges with our precursor universe's inner boundary. The expansion rate of galaxies within our universe will become identical to the linear Hubble 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. 1 and fig. 2 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 where "n" is currently undefined. For a "straw man" Super Universe model, "n" was arbitrarily selected as 4.

Fig. 4 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. 4.

Visual amplification of fig. 4 is required as follows. First, the figure is shown in two instead of three dimensions and not to scale since the Super Universe's volume is 10^{120} larger than our universe. Second, empty spaces do not exist,

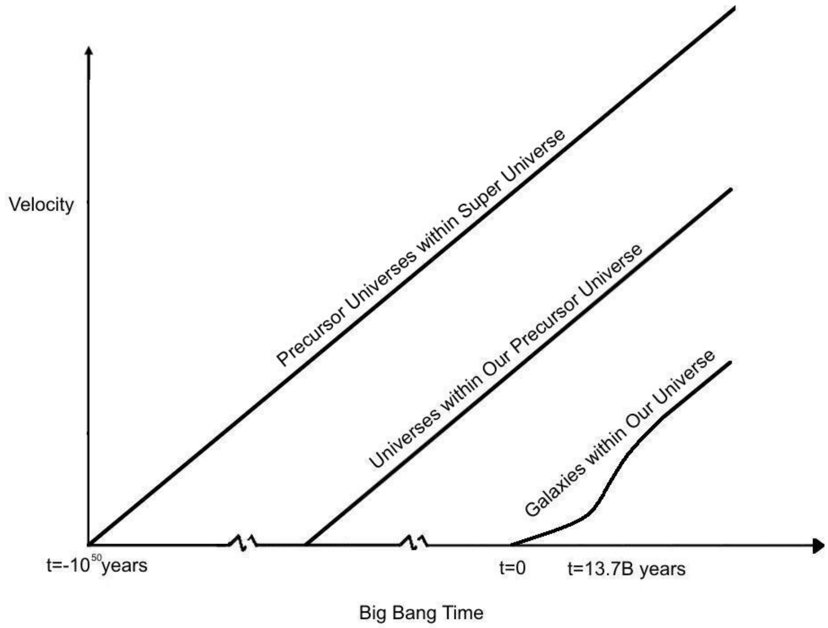

Fig. 3. Hubble's law.

for example, between the six children precursor universes (PU_1 to PU_6) because galaxy matter is uniformly distributed on a large scale in the Super Universe. Empty spaces should be filled with smaller precursor universes.

6.1 Proof of parallel universes

Proof of the Super Universe's parallel universes was 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 their doughnut singularity origin. Similarly, galaxies of any parallel universe are expanding from their doughnut singularity origin. According to Colella [12], 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 spherical shell "perfect" vacuum thickness) and the spherical Super Universe's boundary (radius of 10^{50} ly). Across the spherical shell "perfect" vacuum is the closest galaxy of the closest parallel universe to our Milky Way galaxy. This closest galaxy is moving at a constant velocity toward our Milky Way galaxy whereas our Milky Way galaxy is accelerating toward it. Since the two galaxies are closing towards each other, a search of blue shift galaxies is required. The blue shifted 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 spherical shell "perfect" vacuum thickness. The closer our Milky Way galaxy is to our universe's radius and the smaller the "perfect" vacuum 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 shifted galaxy.

The second advanced technique is a gravitational observatory. An estimated big bang gravitational energy waveform is shown in fig. 5. The x axis represents big bang time in seconds plus or minus t = 0 and the y axis represents gravitational energy. This waveform was derived from the quark star/black hole to big bang (white hole) transition described by Colella in [1].

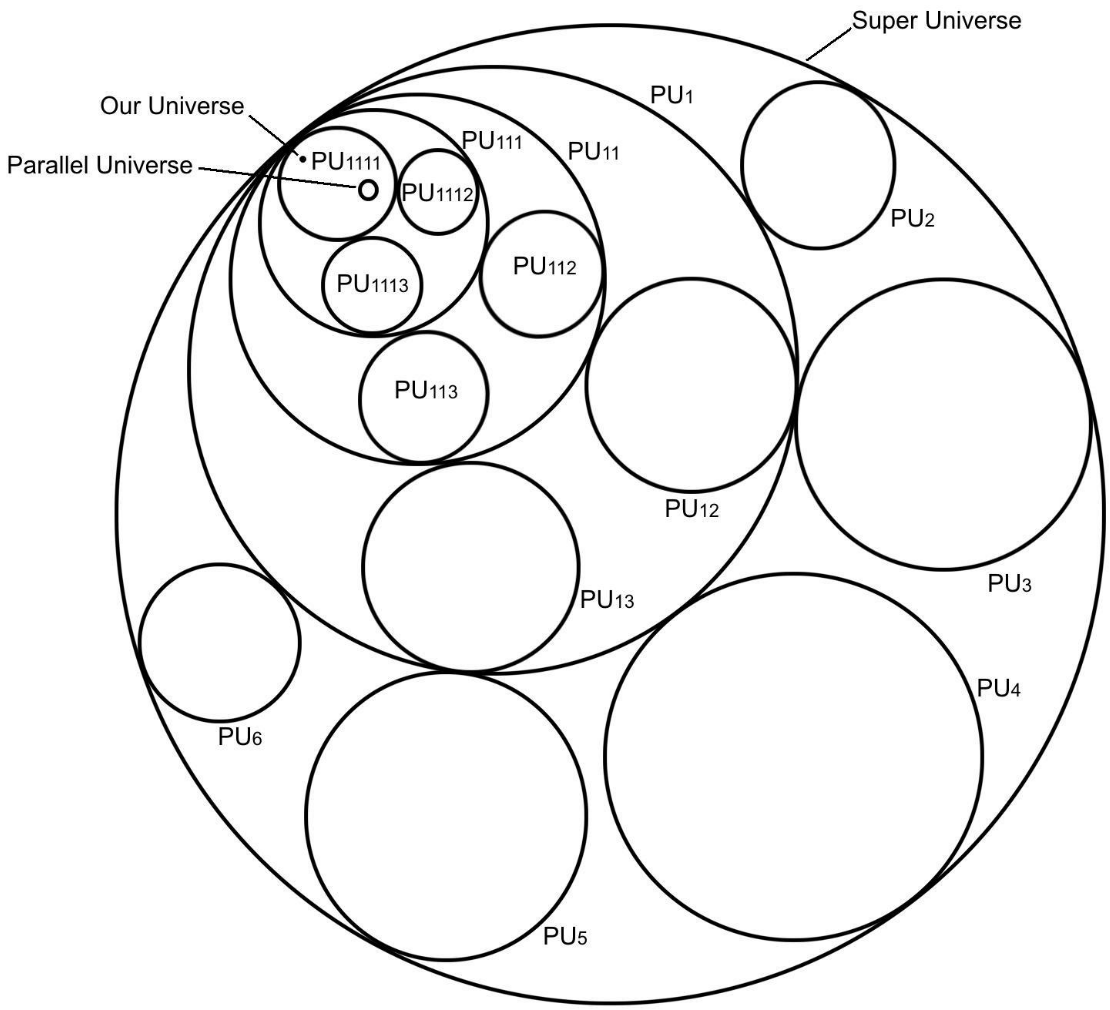

Fig. 4 Four nested children precursor universes at t = 0.

The estimated big bang gravitational energy waveform consists of a pulse and decaying step function, both having identical maximum amplitudes. Fig. 5 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} seconds), the heaviest matter particles were in the most compact 8 m radius sphere and gravitational energy was a maximum as described in particle creation/inflation by Colella [2]. 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.

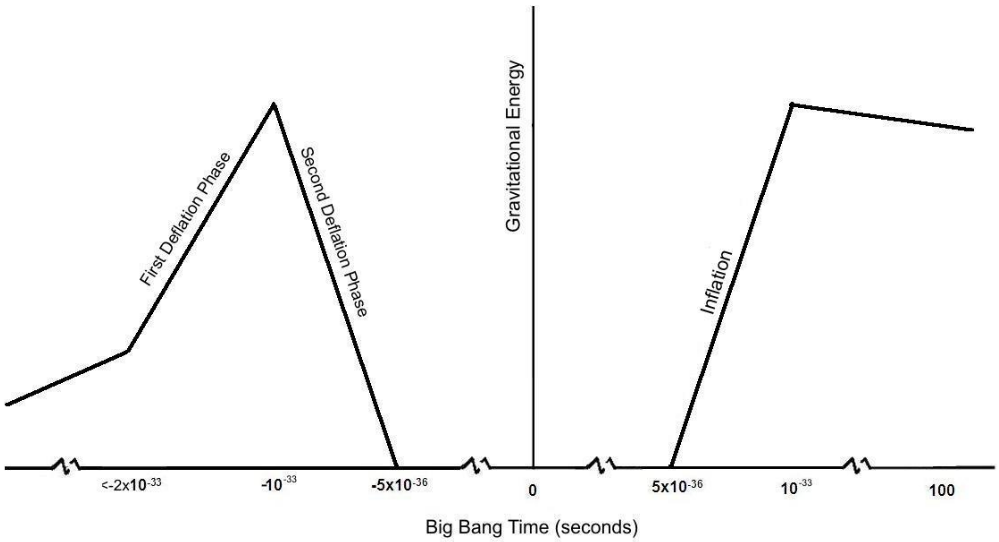

Fig. 5. Estimated big bang gravitational energy waveform.

Prior to the deflation start time 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 near zero temperature (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 near zero temperature 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. 5 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.

7 Conclusions

Our universe's composition was established by 100 s after the big bang and remained constant for the next 13.8 billion years. Atomic/subatomic matter constituted 4.9%, dark matter 27%, and dark energy 68% of our university's total energy/mass. Since the cosmological constant was proportional to dark energy density, as our universe expanded both dark energy density and the cosmological constant decreased with time. 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.

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