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A Two-Step Integrated Theory of Everything

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Two opposing Theory of Everything (TOE) visions are, a Two-Step Integrated TOE consisting of a fundamental physics step followed by a mathematics step, and the prevailing Stephen Hawking's single mathematics step. The essence of the Two-Step Integrated TOE's fundamental physics step is the intimate relationships between 20 existing theories. Currently, these 20 theories are independent of each other because physicists in one theory worked independently of physicists in the 19 other theories. Intimate relationships between 7 of the 20 theories (e.g., string, particle creation, inflation, Higgs forces, spontaneous symmetry breaking, dark energy, and dark matter) follow.

A Two-Step Integrated TOE requires two steps because of unknown answers to physics questions upon which the second mathematics step is dependent but cannot answer by itself. These questions include: what are Higgs forces, dark energy, and dark matter? Furthermore, Hawking's single mathematics step TOE has had near zero results after a century of attempts.

The essence of a Two-Step Integrated TOE's fundamental physics step is the intimate relationships between 20 existing theories. Currently, these 20 theories are independent of each other because physicists in one theory (e.g., Higgs forces) worked independently of physicists in the 19 other theories. The premise of a Two-Step Integrated TOE's fundamental physics step is without sacrificing their integrities, these 20 independent existing theories are replaced by 20 interrelated amplified theories. Amplifications provide interface requirements between the 20 theories. Intimate relationships between 7 of the 20 theories (e.g., string, particle creation, inflation, Higgs forces, spontaneous symmetry breaking, dark energy, and dark matter) follow, including answers to what are Higgs forces, dark energy, and dark matter?

Our universe's 128 matter and force particle types were created from the super force and manifested themselves primarily during matter creation. The latter occurred from the beginning of inflation at $t = 5 \times 10^{-36}$ s to $t = 100$ s and at extremely high temperatures between 10^{27} and 10^{10} K. By $t = 100$ s and 10^{10} K, only 22 permanent matter/force particle types remained. Atomic/subatomic matter or six permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, and tau-neutrino) constituted 5% of our universe's energy/mass. Dark matter or the zino, photino, and three permanent Higgsino types constituted 26%. Dark energy or eight Higgs forces associated with eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino) constituted 69%. Three Standard Model (SM) force particles (graviton, gluon, and photon) existed but accounted for 0%. These percentages remained constant for 13.8 billion years, that is, there was no quintessence.

Each of 129 fundamental matter and force particle types is defined by its unique closed string in a Planck cube (1). Table I shows 32 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).

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

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

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}	stop squark		x
p_4	bottom quark	x		p_{20}	sbottom squark		x
p_5	tau	x		p_{21}	stau		x
p_6	charm quark	x		p_{22}	scharm squark		x
p_7	strange quark	x		p_{23}	sstrange squark		x
p_8	muon	x		p_{24}	smuon		x
p_9	tau-neutrino	x		p_{25}	stau-sneutrino		x
p_{10}	down quark	x		p_{26}	sdown squark		x
p_{11}	up quark	x		p_{27}	sup squark		x
p_{12}	electron	x		p_{28}	selectron		x
p_{13}	muon-neutrino	x		p_{29}	smuon-sneutrino		x
p_{14}	electron-neutrino	x		p_{30}	selectron-sneutrino		x
p_{15}	W/Z's		x	p_{31}	wino/zinos	x	
p_{16}	photon		x	p_{32}	photino	x	

A doughnut physical singularity existed at the center of a Planck cube at the start of our universe. The big bang's singularity consisted of superimposed super force or mother particle closed 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 using a measured Hubble constant (2). This singularity was created in our precursor universe by the evaporation, deflation, and gravitational collapse of a super supermassive quark star (matter) to its associated super supermassive black hole (energy) or Kerr-Newman black hole (3).

Our universe's 128 matter and force particle types were created from the super force and manifested themselves primarily during matter creation. This occurred from the beginning of inflation at t = 5 x 10^{-36} s to t = 100 s and at extremely high temperatures between 10^{27} and 10^{10} K as shown in Fig. 1 Big bang time line of Rees (4). For simplicity, Fig. 1 excluded 32 anti-particles and their 32 associated Higgs particles. The X axis was shown both as time in seconds and temperature in Kelvins because of the intimate relationship between matter creation time and the matter particle's energy/mass or temperature (e.g., W^- at 10^{-12} s, 80 GeV, and 10^{15} K). Upper case letters were exclusively used because particle creation involved total particle energy/mass (e.g., total up quark energy/mass was P_{11}). Total energy/mass consisted of three energy types: rest mass, kinetic (translational and rotational), and potential (gravitational, electromagnetic, nuclear binding).

At t = 0 our universe consisted of a doughnut physical singularity at a Planck cube center which expanded to a spherical singularity via a conifold transition (5) by t = 5 x 10^{-36} s. Our universe expanded from a spherical physical singularity smaller than a Planck cube at the start of inflation to an 8 m radius sphere consisting of a hot quark-gluon plasma with a temperature of approximately 10^{25} K at the end of inflation or 10^{-33} s. Currently, our spherical universe has a radius of 46.5 billion ly.

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 energy/matter expansion. Since individual super force and matter particles existed as closed strings in Planck cubes, they could not exist when our universe was smaller than a Planck cube or when our universe's radius was smaller than .8 x 10^{-35} m, see Fig. 2. The one to seven Planck cubes energy to

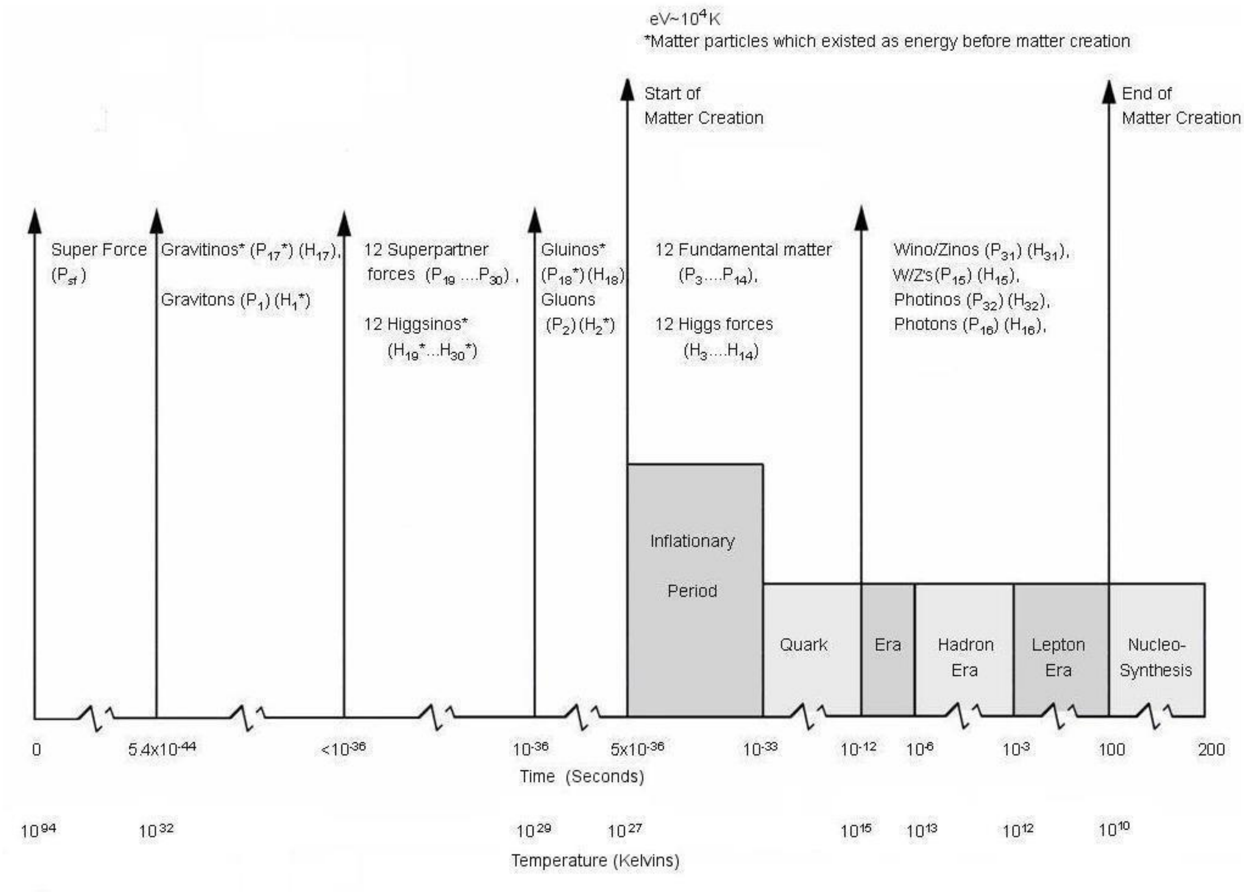

Fig. 1. Big bang.

energy/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 physical singularity of superimposed super force particles part of which condensed into either six individual super force or matter particles in the six contiguous Planck cubes. The first Planck cube shell was then pushed out and a second super force or matter particle Planck cube shell condensed between the center Planck cube and the first shell. This process continued until enough shells with enough Planck cubes existed to accommodate our universe's individual super force or matter particles. Fig. 2 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}) (6). Liddle and Lyth specified an exponential inflation factor of 10^{26} (7). Thus this article's exponential inflation factor of 10^{36} was between Guth's 10^{53} and Liddle and Lyth's 10^{26}. Future B-mode polarization measurements and analyses should define inflation and the correct exponential inflation factor from the above three estimates.

In Fig. 1 at t = 5.4 x 10^{-44} s, four fundamental forces were unified. Gravitons, their gravitino superpartners, and their two associated Higgs particles (H_1*, H_{17}) condensed from the super force. At t = 10^{-36} s, three forces were unified. Gluons, their gluino superpartners, and their two associated Higgs particles condensed from the super force. At t = 10^{-12} s, two forces were unified. Photons, their photino superpartners, and their two associated Higgs particles condensed from the super force. W/Z's, their Wino/Zino superpartners, and their two associated Higgs particles condensed from the super force. At t < 10^{-36} s, 12 superpartner forces and their 12 associated Higgsinos (X bosons or inflatons) condensed from the super force. X bosons were the latent energy which expanded our universe during the inflationary period (8). X bosons were to the inflation period as Higgs forces (dark energy) were to our universe's expansion from the end of inflation to the present.

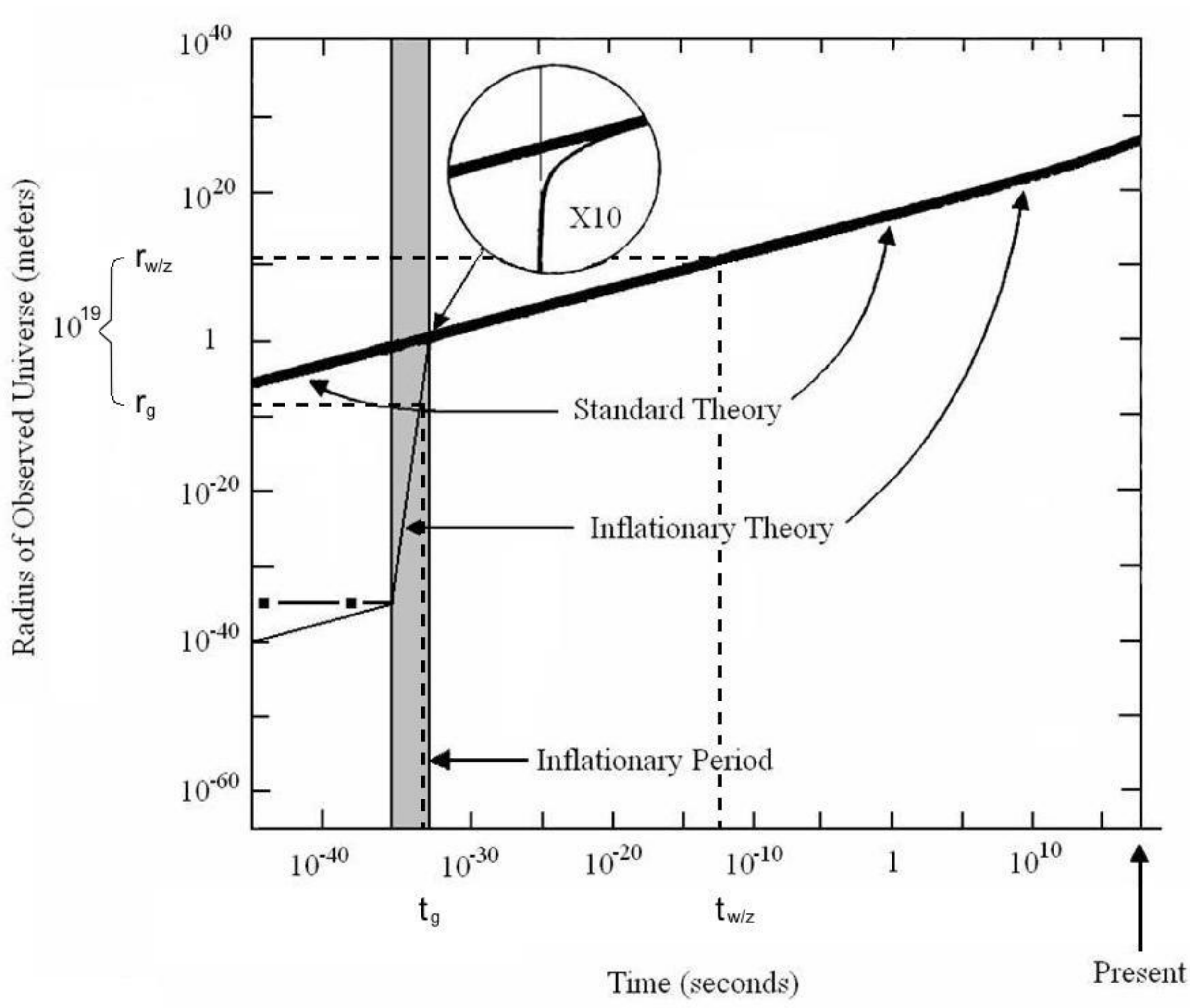

Fig. 2. Size of universe in the standard and inflationary theories.

Key requirement amplifications to Higgs force theory follow and included 64 associated supersymmetric Higgs particles, one for each of 16 SM matter and force particles, their 16 superpartners, and their 32 anti-particles. There were a total of 129 particle types in our universe, 128 matter and force particles plus the super force or mother particle. The 64 supersymmetric Higgs particles defined a "Super supersymmetry." If a standard or supersymmetric particle was a matter particle (e.g., up quark), its associated Higgs particle was a Higgs force. If a standard or supersymmetric particle was a force particle (e.g., sup squark), its associated Higgs particle was a Higgsino.

Matter creation was a super force particle's condensation to a matter particle/Higgs force. The latter two were one and inseparable and modeled as an undersized porcupine (e.g., up quark Planck cube closed string) with overgrown spines (e.g., a three dimensional radial Higgs force quantized into Higgs force Planck cube closed strings). Extremely high temperatures between 10^{27} and 10^{10} K in our early universe caused spontaneous symmetry breaking. The Higgs force was a product not the cause of spontaneous symmetry breaking. The super force condensed into 17 matter particles/Higgs forces at 17 different temperatures. There were nine transient matter particles (top quark, bottom quark, charm quark, strange quark, tau, muon, gravitino, gluino, and W/Z's) and eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino). The zino and photino were dark matter particles. Spontaneous symmetry breaking was similar to the three bidirectional phases of H_2O cooling from steam, to water, to ice as temperature decreased from 212^o to 32^o F. Similarly the super force, down quark/Higgs force, up quark/Higgs force, three W/Z's/Higgs forces etc., were the same but manifested themselves differently as temperature decreased from 10^{27} to 10^{10} K. There was an intimate relationship between matter creation time and the matter particle's energy/mass or temperature (e.g., 17 SM/supersymmetric particles and three permanent Higgsino types). The earlier the matter creation time, the greater was the matter particle's energy/mass. Ice also evaporated or melted to water which then evaporated to steam as temperature increased from 32º to 212º F. Similarly, particle creation was bidirectional as temperature increased, for example, the up quark/Higgs force and down quark/Higgs force evaporated back to the super force.

By 100 seconds after the big bang, nine transient matter particles/Higgs forces decayed via evaporation/condensation cycles to and from the super force to eight permanent matter particles/Higgs forces. The latter included the: up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, photino and their eight Higgs forces.

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

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

Particle decay was the evaporation of a heavy matter particle/Higgs force to the super force and the condensation of the super force to lighter and permanent matter particles/Higgs forces. In the Beta minus decay with Higgs force amplification, the down quark/Higgs force evaporated to a super force particle. Division of energy not matter occurred as one portion of the super force condensed to the up quark/Higgs force, and a second portion to the W^- particle/Higgs force. The three W/Z's (W^+, W^-, and Z^0) were transient matter particles because, for example, within 10^{-25} s of its creation, the W^- transient matter particle/Higgs force evaporated back to a super force particle. The super force then condensed into an electron/Higgs force and an anti-electron-neutrino/Higgs force. Since the W/Z's were reclassified as transient matter particles, this produced the asymmetrical number 17 instead of 16 matter particles, that is, 9 transient and 8 permanent matter particles.

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

The up quark spontaneous symmetry breaking function is shown in Fig. 3 from Guth's amplified energy density of Higgs fields for the new inflationary theory (9). The Z axis represented super force energy density allocated to up quarks/Higgs forces, the X axis a Higgs force (h_{11}) associated with an up quark, and the Y axis a Higgs force (h_{11bar}) associated with an anti-up quark. 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 up quarks/Higgs forces had condensed. When the ball was in the Fig. 3 position, super force energy density had condensed to up quarks/Higgs forces. The z coordinate of the Fig. 3 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. 3 ball position was the super force energy density condensed to up quarks. During the hadron era, the ball moved from its peak position to the Fig. 3 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.

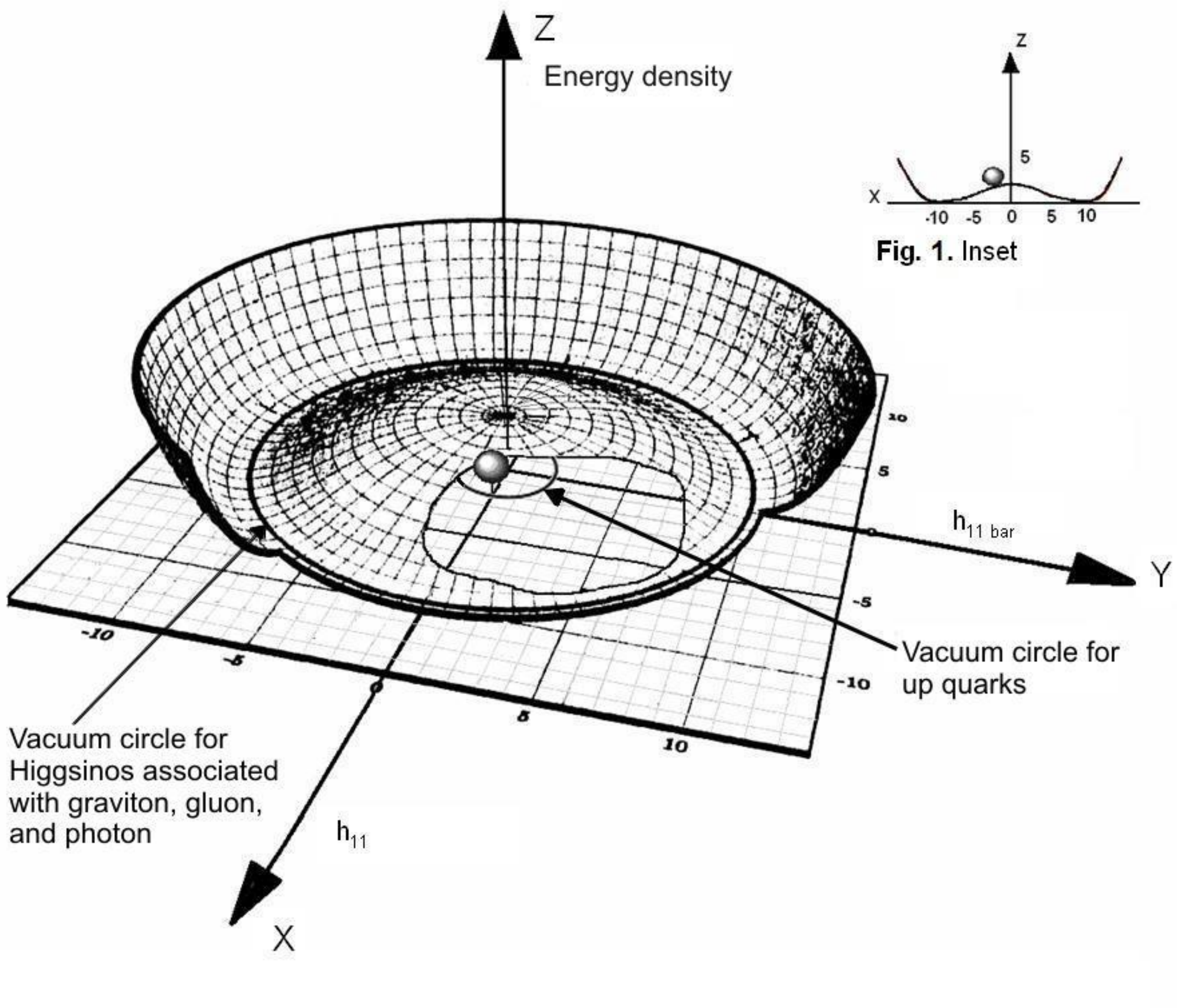

Fig. 3. Up quark spontaneous symmetry breaking function.

By 100 s, all nine transient matter particles/Higgs forces had evaporated to the super force and condensed to eight permanent matter particles/Higgs forces, a process described as “decay.” Each of the eight permanent matter particles spontaneous symmetry breaking functions had the same generic up quark Mexican hat shape of Fig. 3, but each had a different peak super force energy density (peak z coordinate) and Higgs force (ball x coordinate).

Three permanent Higgsinos types associated with three SM force particles (graviton, gluon, and photon), also experienced spontaneous symmetry breaking as follows. The ball position in the Higgsino version of Fig. 3 started at the peak position and came down the spontaneous symmetry breaking function along the X/Z axes until it intersected the vacuum circle for Higgsinos associated with the graviton, gluon, and photon. All a super force particle’s energy condensed to a Higgsino and none to its associated zero energy force particle (graviton, gluon, or photon). Of the total 15 Higgsino types, the remaining 12 Higgsinos associated with 12 superpartner forces (X bosons or inflatons) did not experience spontaneous symmetry breaking because their energy expanded our universe during inflation prior to their conversion to matter.

The 22 permanent matter and force particle types of the total 128 complied with conservation of energy/mass accountability at t = 100 s. Atomic/subatomic matter or six permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, and tau-neutrino) constituted 5% of our universe's energy/mass. Dark matter or the zino, photino, and three permanent Higgsino types constituted 26%. Dark energy or eight Higgs forces associated with eight permanent matter particles (up quark, down quark, electron, electron-neutrino, muon-neutrino, tau-neutrino, zino, and photino) constituted 69% (10). Three permanent SM force particles (graviton, gluon, and photon) had zero energy. Those percentages remained constant during our universe's life time of 13.8 billion years, that is, there was no quintessence.

The essence of the Two-Step Integrated TOE's fundamental physics step was the intimate relationships between 20 existing theories. Intimate relationships between 7 of the 20 theories (e.g., string, particle creation, inflation, Higgs forces, spontaneous symmetry breaking, dark energy, and dark matter) were provided including answers to what are Higgs forces, dark energy, and dark matter?

Integration of all 20 independent existing theories is defined as follows. The 13 additional independent existing theories: superpartner and SM decays, neutrino oscillations, universe expansions, 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 are summarized in Table 5. The two parts of the Two-Step Integrated TOE's second mathematics step are, an amplified E8 Lie algebra for particles and an amplified N-body simulation for cosmology, see (11) for all of the above.

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