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Charge, parity, and time violation caused baryogenesis

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Abstract. There were three charge, parity, and time (CPT) violation arguments which supported each other and this article's conclusions. First, the CPT theorem was invalid at the Planck scale. Second, highly curved space-times violated CPT because of apparent violations of unitarity caused by incoming matter information disappearance. Third, a quantum mechanics axiom stated the transformation from one state to another respected unitarity and entropy preservation. If quantum mechanics was invalid, both unitarity and entropy preservation were not respected.

1 Introduction

CPT violation caused baryogenesis 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 seven of the twenty independent existing theories (particle creation, Higgs forces, spontaneous symmetry breaking, stellar black holes, black hole entropy, black hole information paradox, and baryogenesis) are required to define CPT violation caused baryogenesis [1].

2 Particle creation

Our universe's 128 matter/force particles were created from the super force 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} degrees K as shown in the Big Bang time line of Rees [2].

The 128 matter/force particles consisted of 16 Standard Model (SM) matter/force particles, their 16 superpartners, their 32 anti-particles, and their 64 associated supersymmetric Higgs particles. Each of the 128 matter/force particles and the super force particle existed as a unique string in a Planck cube in accordance with the essentials of superstring theory by Greene [3]. Table 1 shows the 32 SM/supersymmetric matter/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/force particles has one of 32 anti-particles and each of those 64 has an associated supersymmetric Higgs particle (see Higgs forces section). 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. The W/Z bosons were reclassified as transient matter particles (see Higgs forces section). By the end of matter creation at t = 100 s, all nine transient matter particles had decayed to eight permanent matter particles. The above was summarized from Colella's an intimate relationship between Higgs forces, dark matter, and dark energy [4].

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Standard Model	Matter	Force	Supersymmetric	Matter	Force
graviton		x	gravitino	x	
gluon		x	gluino	x	
top quark	x		top squark		x
bottom quark	x		bottom squark		x
tau	x		stau		x
charm quark	x		charm squark		x
strange quark	x		strange squark		x
muon	x		smuon		x
tau-neutrino	x		tau-sneutrino		x
down quark	x		down squark		x
up quark	x		up squark		x
electron	x		selectron		x
muon-neutrino	x		muon-sneutrino		x
electron-neutrino	x		electron-sneutrino		x
W/Z bosons		x	wino/zinos	x	
photon		x	photino	x	

Table 1 Standard Model/supersymmetric matter and force particles.

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 could not 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 eight permanent matter particles were the: 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 these eight permanent matter particles had an associated supersymmetric Higgs force. The sum of eight Higgs force energies of these eight permanent matter particles was dark energy. The above was summarized from Colella's an intimate relationship between Higgs forces, dark matter, and dark energy [4].

4 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} to 10^{10} degrees 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 heaviest matter particle (gravitino) at the earliest matter creation time and highest temperature and for the lightest matter particle (electron-neutrino) 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. 1 as amplified from Guth's figure of energy density of Higgs fields for the new inflationary theory [5]. The Z axis represented super force energy density, 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. 1 position.

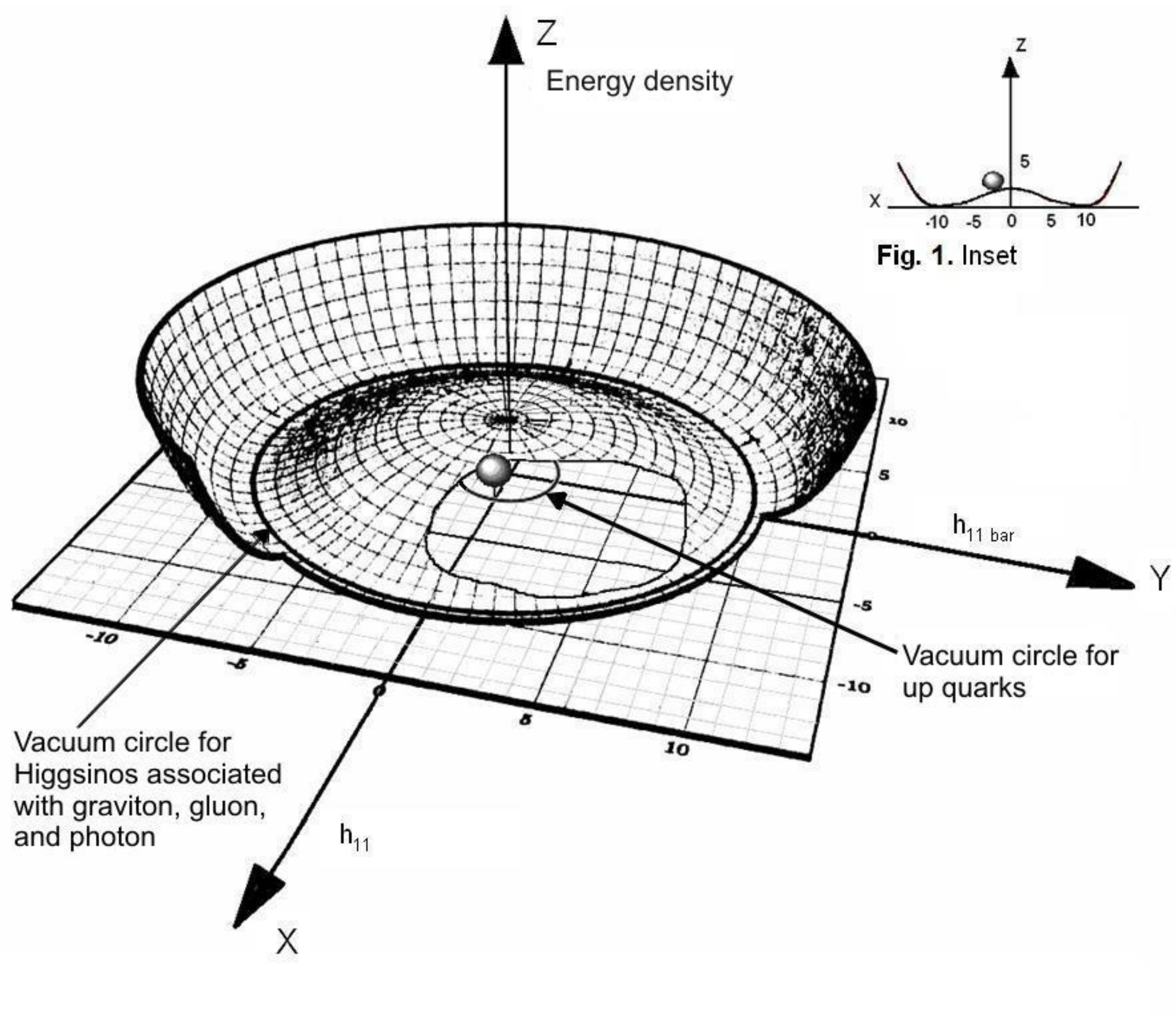

Fig. 1. Up quark spontaneous symmetry breaking.

During baryogenesis, the ball initially at its peak position $h_{11} = h_{11bar} = 0$, z = 2 (fig. 1 inset), 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. 1 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 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. 1 three dimensional spontaneous symmetry breaking had compressed to zero, resulting in the two dimensional fig. 1 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 had condensed and matter particle (e.g. up quark) baryogenesis had not occurred. When the ball was in the fig. 1 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. 1 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. 1 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. 1 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. 1 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 slowly decreased as our universe expanded. The sum of eight Higgs force energies was dark energy.

During matter creation (5×10^{-36} to 100 seconds), 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/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 with 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, or the lowest energy/temperature density state.

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 [6]. Vacuum or dark energy density: was uniformly distributed in our universe; was the sum of eight permanent Higgs force energy densities; and decreased with time along with the cosmological constant as our universe expanded.

5 Stellar black holes

Stellar black hole theory was amplified to include a quark star (matter) and black hole (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 definition 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 or maximum volume as defined by Colella (See Black hole entropy). For resolution of this inconsistency, 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 doughnut 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 final 1.38 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 [7].

The third of six types of stellar black holes, 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 [8], 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 stellar black hole type or its associated super supermassive black hole (energy) which created our universe's "big bang" (white hole). The above summarizes stellar black holes according to Colella [9].

6 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 [10]. 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 strings can arrange themselves. A quark star (matter) contains N matter particle strings each in a Planck cube and a total of M Planck cubes containing matter particle or Higgs force strings. N and M are large and N<< M. According to Dabholkar, the total number of ways of distributing N matter particle strings each with a volume $(l_p)^3$ within a quark star (matter) of volume $V = (4\pi r^3/3)$ is [11]:

$S = k \log \Omega$ 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

7 Black hole information paradox

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 misinterpretation 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. Extrinsic information can consist, for example, 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 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 description illustrated particle creation and decomposition symmetry. 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. Prior to recombination at 380,000 years, protons and helium nuclei combined 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.

Particle decomposition was the symmetric reverse of particle creation. In a white dwarf star, molecules decomposed to atoms. In a neutron star, atoms decomposed to neutrons, protons, and electrons. In a super supermassive quark star (matter), protons and neutrons decomposed to up and down quarks. In a super supermassive black hole (energy), up and down quarks decomposed or evaporated to super force particles.

8 Baryogenesis

CPT violation caused baryogenesis. There were three CPT violation arguments which supported each other and this article's conclusions.

Baryogenesis is **t**he 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 [12]. There are 44 identified baryogenesis theories of which six are prominent; electroweak, Grand Unified Theory (GUT), quantum gravity, leptogenesis, Affleck-Dine, and CPT violation [13]. Electroweak occurs insufficiently in the Standard Model and is considered unlikely without supersymmetry. Inflationary scenarios disfavor GUT and quantum gravity theories. Leptogenesis and Affleck-Dine are viable but not well understood [14]. 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 [15]. 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 string doughnut singularity at the center of a Planck cube as described in detail by Colella [9]. 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 [16] 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 [17] was a quantum mechanics axiom stated the transformation from one state to another respected unitarity and entropy preservation. According to Colella [9], 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. Each matter particle's transformation to a super force particle and each super force particle's transformation to a matter particle violated CPT, which provided sufficient CPT violations to produce our universe's baryon to photon ratio of 6.1×10^{-10}.

9 Conclusions

Baryogenesis for each of 17 matter particles consisted of n bidirectional condensation/evaporation cycles from and to the super force to the true vacuum state where the super force condensed totally to matter particles and their associated Higgs forces. CPT violation caused baryogenesis. There were three CPT violation arguments which supported each other and this article's conclusions. First, the CPT theorem was invalid at the Planck scale. Second, highly curved space-times violated CPT because of apparent violations of unitarity caused by incoming matter information disappearance. Third, a quantum mechanics axiom stated the transformation from one state to another respected unitarity and entropy preservation. If quantum mechanics was invalid, both unitarity and entropy preservation were not respected.

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