The Symmetric Physics of the Universe

Paul K. Suh (pksuh@msn.com)
CosmoOne Group, 2 Fairbanks Court
Woodbury, New York 11797

This paper presents a physical theory where, in symmetry to the conventional physics, dark matter and energy become not only observable, but also interacting. The predictions and conclusions resulting from this theory are in agreement with observations, including the most recent findings. Among the features that are explained by the theory are: the nature of the dark matter and energy; why dark matter and energy are unobservable (to humans), why the dark energy is not the constant vacuum energy; how singularities in the black holes and big-bang are circumvented; what mechanisms could have produced the big bang and powered its inflationary expansion; how dark matter and energy evolved concurrently with the observable matter and energy in the big bang; how the totality of matter and energy became skewed toward the dark side (96 %) against the observable side (4 %); how the matter-antimatter asymmetry of the observable Universe has come about; how the seeds of the massive black holes and galaxies were formed primarily in the big-bang; how the energy conservation law in the Universe is achieved; how the Universe's expansion speed switched from deceleration to acceleration around the Universe's age of 8.5 billion years; and the source of the powerful energy bubbles observed in the Milky Way Galaxy.

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1. Introduction

While it is known that non-observable dark matter and energy constitute the 96 percent of the Universe against the 4 percent of observable matter and energy, the all out efforts over the past several decades to explain their makeup and interaction physics have not been fruitful. This is surprising, because the nature is simple and symmetric in essence, and the predominant constituent of the Universe would be manifested in the front-line fundamental principles of the physics at hand.

There are two mutually non-overlapping framework theories of physics: quantum theory and general relativity. The central point here pertains to the very familiar notion of quantum interactions. It is well understood that the Hermitean momentum operator represents the real momentum in the physics of observable matter and energy [1]. There is the mirror image physics that is given by the antiHermitean momentum operator that would represent the momentum in the physics of non-observable matter and energy. The dark matter and energy in fact reveal themselves in one-to-one correspondence with the non-observable (antiHermitean) matter and energy.

There are analogies in the physics of Dirac's negative energy states that led to the realization of the matter/anti-matter symmetry physics. Niels Bohr advocated such expeditions in his principle of complementarity [2]: "The opposite of a profound truth may well be another profound truth."

In this paper, the non-observable dark matter and energy, as the reciprocity of the observable matter and energy, is stipulated in terms of the Hermitean-antiHermitean symmetry [3]. Through this only modification to the fundamental principles of the conventional

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quantum theory, the dark matter and energy become visible and interacting. The consequences are dramatic and far-reaching, elucidating not only the elusive dark matter and energy, but the working mechanism of the Universe, including the genesis of the big-bang [4, 5, 6].

The Hermitean cosmos shall be called the RHS Universe, while the congruent antiHermitean cosmos will be designated as the LHS Universe. The two Universes are related by the "Four Universal Tenets" (see §2), whereupon the dark matter and energy are visible and interacting in the LHS Universe on an equal footing with those visible (to humans) and interacting in the RHS Universe. Quantum principles permits a separation of two interaction domains in terms of a potential barrier with a perfect coefficient of reflection (see §3). The separation of the RHS Universe and LHS Universe by a perpetual "quantum partition" in fact is a direct consequence of the quantum interactions implicit in the Hermitean-antiHermitean symmetry in the Universe (see §6 and Appendix A).

It is telling that the gravitational interaction engages equally with the matter and energy in both Universes in the symmetric interaction structure of the Universe, providing evidence for the existence of the dark matter and energy. And dark matter and energy in the LHS Universe have their specific complementary as well as indispensable roles in the evolving of the Universe.

2. Four Universal Tenets

This work takes stock of the cumulative theoretical and observational evidence in the working dynamics of the Universe to derive "Four Universal Tenets" [4]:

1) Matter and energy in the LHS Universe coexist with matter and energy in the RHS Universe, and occupy the same space.

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2) Matter and energy in each of the LHS and RHS Universes, quantum interacting among themselves in their specific modes, are observable only to themselves.
3) The quantum partition disengages matter and energy in one Universe from matter and energy in the other Universe with respect to quantum interactions, rendering them mutually unobservable. In certain particular circumstances, however, it may subject to a transient breakdown.
4) The gravitation law is independent of the quantum interaction intricacies.

These tenets provide the foundation for the symmetric physics of the Universe, leading to elucidate not only of the properties of the dark matter and energy, but also the governing principles of the Universe. Pending the fully comprehensive physics, the inductive proofs, where contingencies are explored until the predictions agree consistently with the observed data in multitudinous situations, are at times called for.

3. Quantum Partition and the Dual Time.

To simulate the quantum partition that decouples the RHS and the LHS Universes [4, 5, 6] consider the space component of a wave for a particle "R" in Fig. 1,

$$\Psi_t = R_t \exp\left(ip_t x\right) \tag{1}$$

with the momentum (for simplicity in 2 dimensional real space-time [x, t] without loss of generality) in the right half space,

$$p_t = m \, {}^{dx}\!/_{dt} = \left\{2m\left(E - V\right)\right\}^{1/2} = \text{a real quantity} \tag{2}$$

where E > V. The p_t here stands for the Hermitean momentum, and the wave Ψ_t oscillates in the right half space.

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Moving into the left half space, where E < V,

$$p_{t,r\to l} = m\, {dx}/{dt} = i\left\{2m\left|E-V\right|\right\}^{1/2} = \text{an imaginary quantity} \qquad (3A)$$

i.e. an antiHermitean momentum with a vanishing real component,

$$p_{t,r\to l}\rfloor_{real} = 0 \qquad (4A)$$

independent of V. The Hermitean momentum p_t of Eq. (2) in terms of the real time “t” in the right half (E > V) space, converts into the anti-Hermitean momentum $p_{t,\, r\to l}$ of Eq. (3A) in the left half (E < V) space.

Eq. (3A) converts with the transfer of the time,

$$t \to \tau = it \qquad (5A)$$

to,

$$p_{t,r\to l}/i = m dx/d(it) = p_{\tau,r\to l} = m\, dx/d\tau = \left\{2m\left|E-V\right|\right\}^{1/2} \qquad (6A)$$

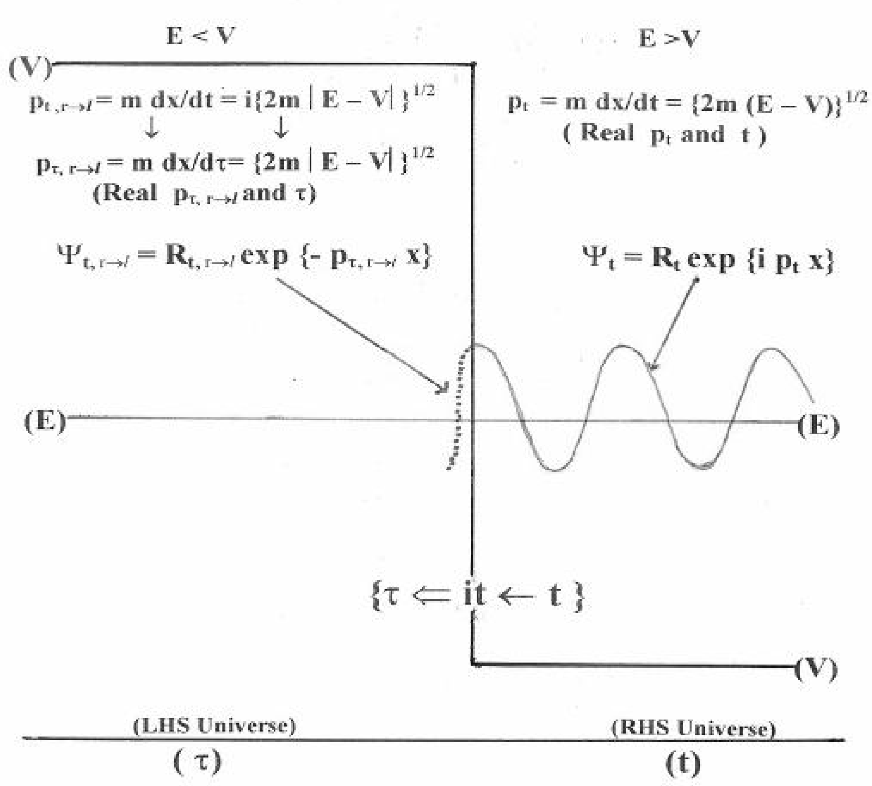

Fig. 1. The simulated potential barrier in the dual-time Universe.

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Because "x" is real, "τ"—an imaginary time in terms of the real time "t" in the right half (E > V) space—behaves as a real time in the left half (E < V) space.With "τ" converting to the real time in the left half (E < V) space, the $p_{t,\, r\to l}$ in Eq. (3A),an imaginary quantity (the anti-Hermitean momentum), also recasts in Eq.(6A) into a real momentum $p_{\tau,\, r\to l}$ (the Hermitian momentum). The process of the wave moving into the potential barrier thus exhibits a dual-time disposition, transforming the incoming wave Ψ_t of Eq. (1) into an exponentially decaying,

$$\Psi_{t,r\to l} = R_{t,r\to l}\exp\left\{-p_{\tau,r\to l}x\right\} \tag{7A}$$

With the measures of {E, V} in Fig. 1 *inverted* between the RHS Universe and LHS Universe, an oscillating wave for the particle "L" in the left half (E > V) space-time [x, τ] with τ representing a real time, is,

$$\Psi_\tau = L_\tau \exp\left\{ip_\tau x\right\} \tag{8}$$

in terms of the (Hermitean) momentum,

$$p_\tau = m\, {dx}/{d\tau} = \left\{2m(E - V)\right\}^{1/2} = \text{a real quantity.} \tag{9}$$

Moving into the right half (E < V) space,

$$p_{\tau,l\to r} = m\, dx / d\tau = i\left\{2m\left|E-V\right|\right\}^{1/2} = \text{an imaginary quantity} \tag{3B}$$

systematizes Eq. (4A) independent of V into

$$p_{\tau,l\to r}\rfloor_{real} = 0 \tag{4B}$$

Eq. (3B) stipulates the inversion in the time transmutation of Eq. (5A) into

$$\tau \to t = i\tau \tag{5B}$$

and the wave Ψ_τ of Eq. (8) exponentially decays across the potential barrier, i.e.,

$$\Psi_{\tau,l\to r} = L_{\tau,l\to r}\exp\left\{-p_{t,l\to r}x\right\} \tag{7B}$$

with (real) Hermitean momentum $p_{t,l\to r}$ in

$$p_{\tau,l\to r}/i = m\,dx/d(i\tau) = p_{t,l\to r} = m\,dx/dt = \left\{2m\left|E-V\right|\right\}^{1/2} \tag{6B}$$

The simulation of complete decoupling of the RHS Universe and LHS Universe can be accomplished with $V \to \infty$, whereupon the exponentially decaying functions $\Psi_{t,\,r\to l}$ of Eq.(7A) and $\Psi_{\tau,\,l\to r}$ of Eq.(7B) vanish at the boundaries of zero thickness. No energy is transferred across the boundary, the oscillating waves totally repulsed to their half space of origin, and the Eqs. (4A and 4B) are in effect streamlined to

$$p_{t,r\to l} = 0 \tag{10}$$

and

$$p_{\tau,l\to r} = 0 \tag{11}$$

Equations (10) and (11) constitute the necessary and sufficient conditions for the evolving of the quantum partition that decouples the RHS Universe and the LHS Universe. They are independent of V, rendering the possibility that the formation of the quantum partition is not necessarily caused by the quantum potential barrier. The dual (t, τ)-time physics could in fact cause the boomerang-like reflection of the waves from the quantum partition in "tangential freedom" [see Appendix A], rather than the hard reflection of the waves from the extraneous quantum potential barriers.

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4.Dual-Time Universe

The concept of time "t" is in general taken to be self-evident. But, in contrast to the tangibility of space **r**(x,y,z), the orthodox account of time is illusory. Stephen Hawking asserted that the imaginary time "τ = it" is actually more real than what is called real time "t", which may be just "a figment of imagination" [7, 8].

The photoelectric effect discordant with the wave behaviour of the light called for the expansion of the classical physics into the quantum theory by incorporating the "quantum" that behaves as a wave, or a particle, depending how it is observed. The non-observable dark matter and energy discordant with the observable matter and energy now calls for the expansion of the standard physics into a dual-time theory, where a real time becomes another real time through the transmuting imaginary time.

The familiar observable physics in the RHS Universe takes place in the 4- dimensional space-time {r(x,y,z), t}. The "Four Universal Tenets" now dictate the physics in the LHS Universe to take place in the context of the 4-dimensional space-time { r(x,y,z), τ }.

The dual-time milieu in the Hermitean-antiHermitean symmetry for the physics of the Universe is now evident. While the time "t" is the innate real time for the physics of the RHS Universe, transmuting into " t→ i τ " across the quantum partition to the LHS Universe [see Eq.(5A)], the time "τ" is the innate real time for the physics of the LHS Universe, transmuting into "τ→ i t " across the quantum partition to the RHS Universe [see Eq.(5B)]. The imaginary time transmutation in the dual-time physics thus manifests the phase transition that is real in consequence.

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5.Dual-Time Quantum Physics

The momentum p_t of Eq. (2) that is observable in the RHS (x, t)-zone Universe is represented by,

$$P_t = m \frac{dx}{dt} \Rightarrow \left(\frac{\hbar}{i}\right)\frac{\partial}{\partial x} \tag{12}$$

the Hermitean operator [1]. The average value p_t of the Hermitean momentum operator P_t is determined with wave function $\psi_t(x)$ in the RHS (x, t)-zone:

$$Ave(P_t) = \int_{-\infty}^{\infty} \Psi_t(x)^* \left(\frac{\hbar}{i}\right)\frac{\partial \Psi_t(x)}{\partial x} dx = \left[Ave(P_t)\right]^* = p_t \tag{13}$$

which is a characteristic real physical quantity.

The momentum $P_t = m\, dx/dt$ in the RHS Universe in terms of time "t" in Eq. (12) , however, is meaningless in the LHS (x, τ)-zone that gauges its time in "τ". To measure it from the LHS (x, τ)-zone, the P_t needs to be translated into the terms of time "τ", that is,

$$P_{t\to\tau} = m \frac{dx}{d\tau} \Rightarrow -\hbar \frac{\partial}{\partial x} \tag{14}$$

which is an anti-Hermitean operator in the manner described in § 3.

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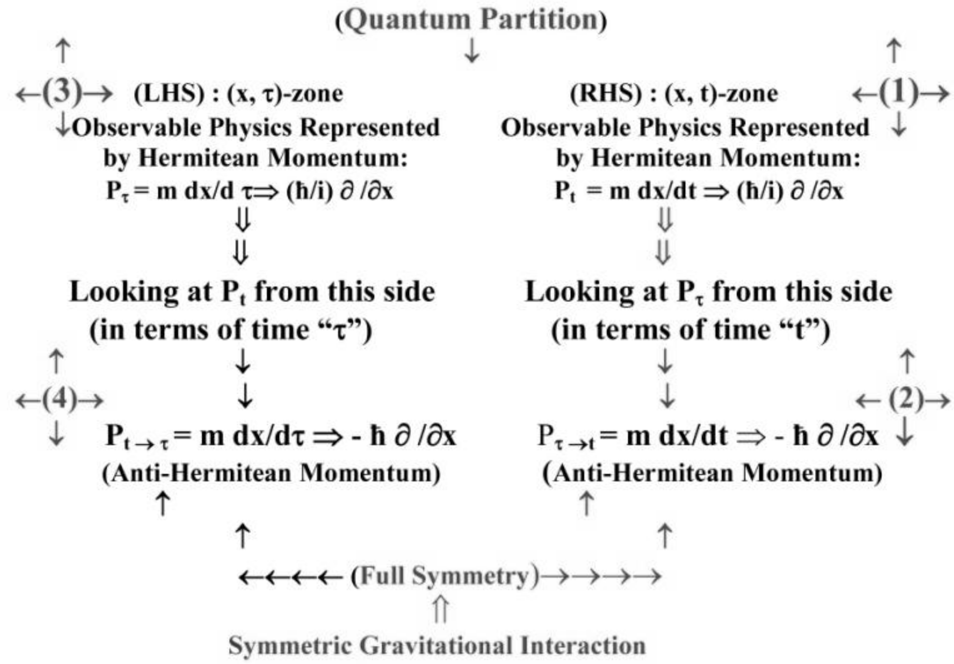

Fig. 2. Representation of the Four Dual-Time Universe

The real momentum p_τ of Eq. (8) in the LHS (x, τ)-zone Universe would be likewise represented by the Hermitean operator,

$$P_\tau = m\, {dx}/{d\tau} \Rightarrow \left({\hbar}/{i} \right) {\partial}/{\partial x} \tag{15}$$

To measure it from the RHS (x, t)-zone Universe, P_τ needs to be translated into the terms of the time "t", that is,

$$P_{\tau \to t} = m\, {dx}/{dt} \Rightarrow -\hbar\, {\partial}/{\partial x} \tag{16}$$

which is an anti-Hermitean operator. The Hermitean operator P_τ in the LHS (x,τ)-zone thus transforms across the quantum partition into an anti-Hermitean operator, $P_{\tau \to t}$, the non-observable trait of the dark matter and energy as perceived in the RHS (x, t)-zone.

The average value p_τ of the Hermitean momentum operator P_τ of Eq.(15) with the wave function $\psi_\tau(x)$ in the LHS (x,τ)-zone is mirrored from Eq. (13),

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$$Ave(P_\tau) = \int_{-\infty}^{\infty} \Psi_\tau(x)^* \left(\hbar/i\right) \partial\Psi_\tau(x)/\partial x \, dx = \left[Ave(P_\tau)\right]^* = p_\tau \quad (17)$$

which also is a real physical quantity as the Ave(P_t) = p_t of Eq. (13). The τ-zone energy E_τ of the τ-zone Hamiltonian, H_τ, is physical, establishing the τ-zone dynamics that is commensurate with the t-zone dynamics. The "Four Universal Tenets" are related in Figure 2 to demonstrate that the dual times {t, τ} in fact clock the fully symmetric physics of the Universe.

It is crucial to examine the dark matter and energy in the perspective of the LHS Universe-the facet 3 in Fig. 2-in terms of their own dynamics, where the dark matter and energy are visible and interacting. Reconnoitring entirely from the RHS Universe-the facet 2 in Fig. 2-the observer plays the characters in the Hindu fable "The Blind Men and the Elephant." The pretension has not worked, and is not likely to.

6. Tangential Freedom and Quantum Partition

Pending a fully developed dual-time physics, it is resolved in Appendix A that the physical eigenvalues of the anti-Hermitean momenta of $P_{t\to\tau}$ and $P_{\tau\to t}$ are, respectively, $p_{t\to\tau} = 0$ of Eq. (A8) and $p_{\tau\to t} = 0$ of Eq. (A10) in concurrence with the Eq. (10) and Eq. (11) that have been stipulated in § 3 as necessary and sufficient conditions for the evolving of the quantum partition.

The waves $\psi_{\tau\to t}(x)$ of Eq.(A.3) and $\psi_{t\to\tau}(x)$ of Eq. (A.4) entirely vanish, and the waves $\psi_\tau(x)$ and $\psi_t(x)$ that represent the observable physics in their respective LHS Universe and RHS Universe, fully reflect back boomerang-like to their own Universes without impacting the other Universe. The total reflection of the waves in *tangential freedom* from the quantum partition as represented in Fig.

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3 is the inevitable consequence of the dual-time Hermitean-antiHermitean symmetry physics as set forth in the Four Universal Tenets. Though the concept of "tangential freedom" appears to be counter-intuitive, it has a parallel in the "asymptotic freedom" of particle physics.

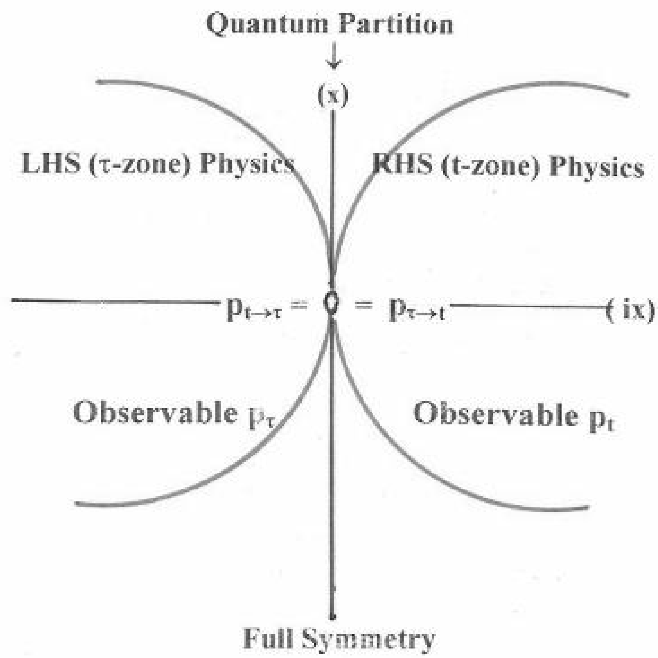

Fig. 3. Tangential Freedom away from the Quantum Partition

7. The Physics of the LHS (r, τ)-Zone Universe

In Appendix C, it is shown that the Coulomb potentials change signs from one Universe to the other as summarized in Table 1, where "←→" and "→ ←" represent, respectively, the repulsive and attractive forces. The behavior of dark matter and energy is unconventional, and the unusual sign transposition in the Coulomb potentials here proves to be one of the attributes indispensably required of them to perform their very unconventional roles in the evolving Universe.

The repulsing like charges in the t-zone Coulomb interaction disperse out to be neutralized by attracting opposite charges. The attracting like charges via the (dark) τ -zone Coulomb interaction would clump together to produce profuse τ-zone energy, while the opposite charges, exerting repulsive forces, not only foster the charge clumping of the same charges, but avert the binding neutralization. There are no τ -zone p – e bound states like the t-zone hydrogen atom. The τ -zone matter and energy are fated to be permanently coupled to pervade the Universe as collision-free plasma, where the long-range electromagnetic forces dominate, liberally absorbing and emitting τ-zone radiation of any wavelength.

(A) RHS (t-zone) Universe:(+) ←→ (+): (-) ←→ (-): (+) → ← (-) A proton-electron system forms neutral bound states with binding energy of O(eV): the (radiation) energy decouples from the matter and fades into the cosmic microwave background (CMB).

(B) LHS (τ -zone) Universe:(+) → ← (+): (-) → ← (-): (+) ←→ (-) Never form neutral bound states, and the (radiation) energy, permanently coupled with the matter, does not fade into CMB. The like charges may clump with binding energy of O (GeV).

Table 1: The Coulomb Interactions in the Dual-time Universe

If the τ -zone matter were to interact only through the attractive gravitational forces as assumed by the standard theory, it would actively condense into stars and black holes. In contrast, the tracking of the τ-zone matter indicates that it is not a mere agent of gravitational attraction, indicating that the condensation of the dark matter generates something highly repulsive [9].

The Coulomb forces are additive, while the nuclear forces are not; the t-zone proton-proton Coulomb repulsions outdo the much stronger, yet non-additive nuclear attractions to limit the stable t-zone nuclei to atomic number $z_{t,\,max} = 92$ in nature. The attractive as well as additive Coulomb force of the like τ-zone charges, in contrast, escalate the charge clumping and copiously generate τ-zone energy as

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the charges fall into a deep potential well. The τ-zone energy, simulating the scalar field [see Appendix D], would exert the repulsive force as observed.

The (radiation) energies would produce pairs in their respective Universe,

$$\begin{aligned} &\gamma_\tau \rightarrow p_\tau^{\;+} + p_\tau^{\;-}, e_\tau^{\;+} + e_\tau^{\;-}, \text{etc. (repulsive pair)} \\ &\gamma_t \rightarrow p_t^{\;+} + p_t^{\;-}, e_t^{\;+} + e_t^{\;-}, \text{ etc. (attractive pair)} \end{aligned} \tag{18}$$

Because of the repulsive force between them, the τ-zone pairs would be apt to behave more particle-like than t-zone pair and may escape the prompt annihilation to break away.

The charge clumping in space, the electric forces strengthening in proportion to the clustered charges, promotes further clumping of the same charges, while preventing the annihilation of the (repulsive) oppositely charged pair clumps. Therefore, supplementing the residual τ-zone energy that arises from the pair annihilation earlier in the big-bang, primarily the clumping of the τ-zone charged particles in space gradually transforms the τ-zone matter into the τ-zone energy. The ratio $\Gamma = \rho_\varepsilon / \rho_\tau$ increases over the age of the Universe, where $\{ \rho_\tau , \rho_\varepsilon \}$ represent the average densities of the {τ-zone matter, τ-zone energy} in space. The standard theory, in contrast, attributes the dark energy to the quantum bubbling of the Universe's empty space. This not only violates the conservation of τ-zone mass/energy in the Universe, but also the energy percolated from the vacuum surpasses the observed dark energy content by an enormous factor of Q = $O(10^{120})$ [10]. This plainly indicates [see § 8 and Appendix D] that the τ-zone (dark) energy is not the vacuum energy, and the catastrophe Q-factor is irrelevant to the evolving of it.

The presence of the τ-zone matter and energy of densities $\{ \rho_\tau , \rho_\varepsilon \}$ along with the t-zone matter of density, ρ_t, plays out everywhere in

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terms of the Einstein-Friedmann equation with the scale factor "s" [11],

$$\frac{d^2 s}{dt^2}\left(\frac{1}{s}\right) = -\left(\frac{4\pi G}{3}\right)\left(\rho_t + \rho_\tau + \rho_\varepsilon + 3p\right) \tag{19}$$

where $p \approx \omega_\varepsilon\ \rho_\varepsilon$ represents pressure density in the main with equation of state of the (dark) τ-zone energy $\omega_\varepsilon = -1$.

8. Charge-Clumping in Space

The WMAP[12] gives the prevailing density ratios in the Universe as

$$\frac{\{\rho_n\}}{\rho_t} = \{1.0, 5.2, 16.6\} \text{ for } \{\rho_n\} = \{\rho_t, \rho_\tau, \rho_\varepsilon\} \tag{20}$$

Quantum partitioned away from the t-zone matter/energy in the RHS Universe, the total mass/energy in the τ-zone LHS Universe, $\rho_\tau + \rho_\varepsilon \approx 21.8\ \rho_t$, is conserved through the age of Universe [see § 13]. Meanwhile, the meandering τ-zone protons would charge clump in space. Eventually $z_{c,\,p}$ τ-zone protons dig deep potential wells to form an aggregate of charge clumped flecks to settle in with the average binding energy ε per a τ -zone proton [13] of

$$\varepsilon \approx \left(\frac{3}{5}\right)\left(z_{c,\,p} - 1\right)\frac{e^2}{z_{c,\,p}^{\ 1/3}\, r_c}. \tag{21}$$

where r_c is the effective proton radius.

The collisions in space that form the clumping of the τ-zone flecks in general would be complicated, and r_c would depend on $z_{c,\,p}$ (or $z_{c,antip}$). But the course of the clumping of the protons and antiprotons, separated by the strong mutual repulsion with increasing $z_{c,p}$ (or $z_{c,antip}$) would be the same and independent. The protons in the τ-zone proton clumped flecks would be bound tighter than electrons in the

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τ–zone electron clumped flecks, providing the major portion of the τ -zone energy generation in space.

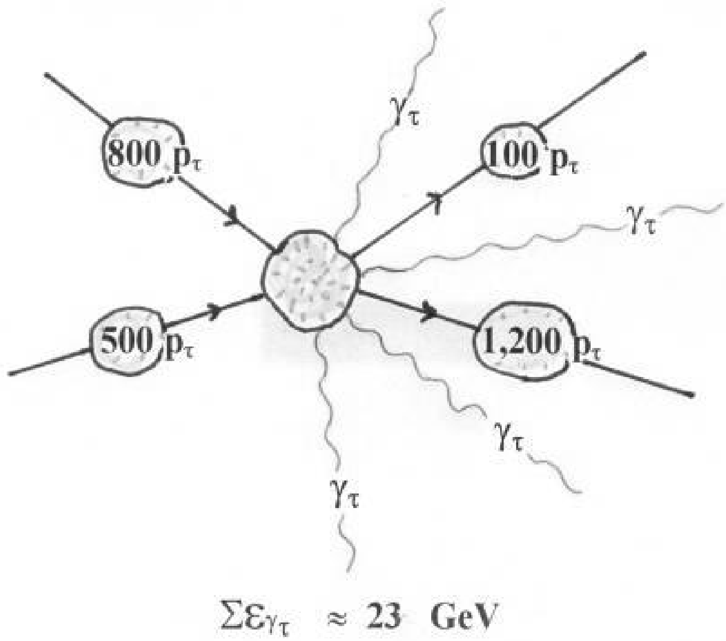

Fig. 4. A collision of the τ-proton flecks in Space.

With $r_c \approx \lambda_p$, the proton Compton wavelength, a simple example of two τ-proton specks of charges $z_{c,\ p,\ 1} = 500$ and $z_{c,\ p,\ 2} = 800$ colliding to emerge as two new τ-proton specks of charges $z_{c,\ p,\ 3} = 1{,}200$ and $z_{c,\ p,\ 4} = 100$ is shown in Fig. 4. The collision produces total τ-zone proton binding originated energy of $\Sigma\ \varepsilon\gamma_\tau \approx 23$ GeV, a substantial portion of the τ -zone mass *melting* in space to supplement the already existing τ-zone energy. Note that such processes in space are not unique, because the interstellar t-zone molecules are known to collide and stick together, and the binding energy is emitted as radiation.

To further demonstrate the powerful energy production mechanism of the τ -zone proton charge clumping, the total τ-zone proton binding originated energies, $\Sigma\ \varepsilon_{\gamma\tau}$, in the charge doubling collisions of,

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$$\left(z_{c,\,p}p_{\tau}\right)+\left(z_{c,\,p}p_{\tau}\right)\Rightarrow\left(2z_{c,\,p}p_{\tau}\right)+\Sigma\varepsilon_{\gamma\tau} \tag{22}$$

are shown in Table 2, where the $\Sigma\ \varepsilon_{\gamma\tau}$ grows steeply as a function of $z_{c,\,p}$. The energy generation by the charge clumping of the τ -zone matter in space soon becomes the dominant source for the τ -zone energy in the Universe.

$Z_{c,p}$	100	200	500	1,000	2,000	5,000	10,000	20,000
$\Sigma\varepsilon_{\gamma\tau}$ (GeV)	1.6	5	23	73	231	1,065	3,381	10,735

Table 2. The charge-doubling collisions of the τ-proton flecks.

If a portion of τ -zone matter, $\Delta\ \rho_{\tau}$, transforms through the charge clumping into the τ -zone energy $\Delta\ \rho_{\varepsilon} = \Delta\ \rho_{\tau}$, the conservation of energy in Eq. (19) gives with $\omega_{\varepsilon} = -1$.

$$\left[\rho_{t}+\rho_{\tau}+\rho_{\varepsilon}-3\rho_{\varepsilon}\right]\rightarrow\left[\rho_{t}+\rho_{\tau}+\rho_{\varepsilon}-3\rho_{\varepsilon}\right]-3\Delta p_{\tau} \tag{23}$$

Thus, an extra three fold of $\Delta\ \rho_{\tau}$ arises to repulse the Universe. This indicates that (dark) τ–zone matter is intrinsically incompressible, taking an incredibly strong force in a certain extraordinary condition to greatly compress it.

The Universe at the age of 380,000 years already had $\rho_{\varepsilon}\rfloor_0 \approx\ 5.52\ \ \rho_{t}\rfloor_0$, out of which $\rho_{\varepsilon}\rfloor_{ann} \approx 4.0\ \rho_{t}\rfloor_o$ came from the τ-zone Baryon pair annihilation early in the post-interlude for baryon sorting (see §13 and Fig.8). Thus, out of the $\rho_{\varepsilon} \approx 16.6\ \rho_{t}$ of Eq. (20), the charge clumping generates only the portion of $\Delta\ \rho_{\varepsilon} \approx (16.6 – 4.0)\ \rho_{t}$, yielding the prevailing average charge $z_{c,\,p}$. in terms of (21),

$$z_{c,\,p}\approx 3.5x10^{4} \tag{24}$$

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The corresponding charge clumping τ-proton fleck mass is $M_{p,cc} \approx z_{c,\,p}(1 - \varepsilon/m_pc^2)\, m_p \approx 8 \times 10^3\, m_p$, much less than $M_p \approx z_{c,\,p}\, m_p \approx 3.5 \times 10^4\, m_p$. This $z_{c,\,p}$ seems incredibly large,but it corresponds to 15 charge doubling collisions, on average slightly more than 1 per a billion years. The theory of Minimal Dark Matter also suggests that the mass of the dark matter particle is about $10^4\, m_p$ [14].

Note that, with

$$m_{p,\,cc} = \left(1 - \varepsilon \big/ m_pc^2\right) m_p, \tag{25}$$

$$m_{p,\,cc} \to 0 \text{ and } z_{c,\,p} \to z_{c,\,p\_crit} \approx 5.8x10^4 \text{ for } \varepsilon \to m_pc^2$$

in the approximation of Eq. (21). The ramifications of Eq. (25) are explored in §9, §11, and Appendix B for the unfolding of "the quantum partition free windows."

9. Black Hole and Supernovae

The conventional theory, based on the 4 % constituent of the Universe—the visible (t-zone) matter—fails to provide a physical agent for avoiding the singularity at a black hole core, where the physics breaks down [15]. A question arises here what the dark 96 % constituent of the Universe might be doing. With the black hole formation, the local τ-zone matter, unencumbered by the turmoil of the amassing t-zone matter in tangential freedom (see Appendix A), is also pulled into the black hole. The τ-zone matter compacted into high density creates the very high energy τ-zone photons that in turn create the τ-zone pair particles (see §10) to escalate the charge clumping barrage. A portion of the extremely repulsive τ-zone energy may be trapped toward the black hole core to neutralize the singularity.

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The black hole has a mass of $M_b \approx b\ M_\odot$ ($M_\odot$ = the mass of the Sun) in the Schwarzschild sphere of radius $R_b = 2\ G\ M_b/c^2 = \alpha\ b$ where $\alpha = 3 \times 10^3$ m [16]. With the circumvention of the singularity at the core, the density distribution in the black hole is meaningful. A possible reference matter density in the black hole would be proportional to $1/ r^2$ (r = radial distance in m) that would purpose a gravitationally durable black hole. For the purpose of an exploratory demonstration, the τ-zone matter densities at the boundaries of the respective charge clumping are assumed to match this local matter density, that is, $n_b \approx 3 \times 10^{52}/ r^2$ in terms of nucleons per m^3.

Regardless of the constituents involved, the pertinent quantity in the charge clumping is the total τ-zone charge in units of "e." The τ-zone charge density inside the clumping would settle down in the durable Coulomb potential configuration, increasing in proportion to $1/r_\tau^2$ (r_τ = radial distance of the spherical charge clumping in m) from the density n_b at the radius r_p. The indomitable force that skirts the singularity toward the black hole core pushes the charge clumping through the quantum partition free window, and give,

$$v\left(r, r_p\right) \approx -5.6x10^{35}\left(\frac{r_p}{r}\right)^2 \text{ GeV per } \tau\text{-zone charge "e"} \qquad (26)$$

This yields V(0.2 m,10^{-17} m) ≈ - 1.4 x 10^3 GeV , V(0.2 m,10^{-16} m) ≈ - 1.4 x 10^5 GeV, and V(0.2 m, 10^{-14} m) ≈ -1.4 x 10^9 GeV , which arise, respectively, from the charge clumping of 10^4 τ-zone charge "e" in the volume of 4 x 10^{-51} m^3 , 10^7 τ-zone charge "e" in the volume of 4 x 10^{-48} m^3 , and 10^{13} τ-zone charge "e" in the volume of 4 x 10^{-42} m^3. These figures at the simplest approximation (where accuracy is given up for clarity) are quoted to highlight that immensely repulsive τ-zone energies can be produced on demand by the τ-zone charge clumping *inside* the black hole.

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An appropriate amount of the close-knit τ-zone matter charge clumping distribution, concentrating toward the core, may self-consistently adjust the space-time curvature [17] to circumvent the black hole singularities. The rest of the τ-zone matter—which is intrinsically incompressible—would be expelled out of the black hole before the establishment of the black hole event horizon.

The τ-zone matter that is subsequently attracted to the black hole would be compacted to high density around it, and the abundance of the τ-zone matter at the core of the Milky Way Galaxy has in fact been observed [18]. That promotes the strongly density sensitive τ-zone matter charge clumping that transforms its mass into the τ-zone energy, countermanding the τ-zone matter accretion into the black hole. The τ-zone matter would continue to amass around the black hole in the course of time into an extremely high density, and the $z_{c,p}$ at one time or another may increase to $z_{c,p\rfloor crit}$, culminating in $m_{p,cc} \rightarrow 0$. The quantum partition between the RHS and LHS Universes would break down [see Appendix B].

The matter and energy in the LHS (τ-zone) Universe collapse into the RHS (t-zone) Universe with the energy enhanced by the prevailing zonal energy shift of $U_{\tau\rightarrow t}$ [see § 11]. Not only the antimatter in the LSH (τ−zone) Universe interacts with the matter in the RHS (t-zone) Universe, but the more populous LSH (τ−zone) matter converts to RHS (t-zone) matter pairs to be annihilated. A catastrophic explosion would occur, producing the two large bubbles of energy that had erupted from the core of the Milky Way Galaxy.

It extends 25,000 light years from each side of the Galaxy, manifesting mass annihilation of about 6 $M_\odot$ (equivalent to 100,000 supernova explosion!) The annihilation from the core of galaxy expands outward with the shock wave compression, spreading around

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the vertical axes to rapidly release energy into the large uniform bubbles with sharp boundaries as observed [19].

Such catastrophic explosions in various scales, including the type Ia supernovae, have also been observed. Decades of debates and computations in conventional theories have failed to explain how the supernova explosion can release as much transient power as the rest of the visible Universe combined [19A]. They explode with the same amount of matter, the Chandrasekhar mass, making it a "standard candle" to gauge distance across the Universe. Some of them, however, are also observed with certain variations that further confound the understanding [19B]. This difficulty is not surprising, because the analysis again ignored the important roles of the dynamic 96 % content of the Universe—the τ-zone matter and energy.

With the white dwarf star mass density distribution $\rho_n = K / r^n$, the gravity force for a test mass m is $F_n(r) = -\{2\pi K G m(2 - n)/(3 - n)\}/ r^{n-1}$. Reflecting that the white dwarf star is in a degenerate matter state, its starting density could be approximated to be uniform in $\rho_{n=0} = K$. Then the gravitational force, $F_{n=0}(r) = - \{4 \pi K G m/ 3\} r$, is stronger toward the star boundary. As the white dwarf star accretes mass from the companion star, the density in the outer layer may grow progressively higher, steadily strengthening the gravitational force there.

Depending on the setup in the binary star system, the mass accretion rate may vary to temper the collapsing of the white dwarf star. If the mass accretion rate is slow, the τ-zone energy from the charge clumping τ-zone matter inside the receiver white dwarf star could leak out of it, leaving inconsequential residual repulsive forces inside the star. The leaked τ-zone energy now forming a halo around the dwarf star further slows down the matter accretion rate. The $m_{p,cc}$ decreases with increasing $z_{p,c}$, and the accreted τ-zone matter gets less

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weighty inside the dwarf star, contributing much less than the incipient mass entering the white dwarf star. With the τ-zone energy drained out of the star, the (post charge-clumping) τ-zone mass and t-zone mass behave alike under gravity, and the white dwarf star collapses at close to the Chandrasekhar mass to become the standard candle of the Universe.

As the white dwarf collapses, the density sensitive $z_{c,p}$ bounds to $z_{c,p}\rfloor_{crit}$ with $m_{p,cc} \rightarrow 0$, leading to the opening of the quantum partition window [see Appendix B]. As happens in the production of huge Bubbles in the Milky Way Galaxy, this locally leads to the mini big-bang scale power explosion to the supernova explosion, also hatching the extremely high energy cosmic rays unaccountable by the conventional explosions.

If the mass accretion rate is fast, the τ-zone energy generated by the τ-zone matter charge clumping in the white dwarf star would remain with the τ-zone matter, and spontaneously support heavier mass. White dwarf stars collapsing into the supernova, therefore, have a range of masses and brightness. The standard theory solves this problem by imposing a fast makeshift rotation to the star, so the centrifugal force might help balance the gravity [20]. A pair of white dwarfs may also collide head-on, and the powerful explosion of the overlapping layer might catapult the supernovae into the space, sending the rebounding partner in opposite direction in appropriate speed [21].

The observed massive star [22] may be caused by the dark matter in the star formation internally balancing the gravity with the charge clumping emanated dark energy to hold off the collapsing. The pervasive τ-zone matter and energy also might on occasion act to slow down the evolution of the sun-sized stars into white dwarfs [23].

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10 The Big-Bang

One of the greatest unsolved problems [15] is what has powered the big-bang to create the entire Universe out of the point space of horizon scale radius of $r_h \approx 3 \times 10^{-27}$ m [24]. The RHS (t-zone) matter and energy are in fact inadequate to produce the big-bang scale power. Inside the tiny space of the big-bang, the strongly interacting (t-zone) quarks become non-interacting in asymptotic freedom. Neither can the electric forces, being neutralized inside the tight space, produce enough power for the big-bang. The standard theory exploits the gravity interaction [10], but it by itself is definitely too weak to account for the task.

Because the LHS (τ-zone) matter is intrinsically incompressible, the process would take time. But, once the formidable barrier was overcome, being propelled by *the additively attractive Coulomb forces between the same charge quarks,* the LHS (τ-zone) charge clumping in *asymptotic and tangential freedom* can become a self-energizing mechanism that finds the converging infinitesimal big-bang space fits for a self-sustaining avalanche production of immense τ-zone matter and energy in cycles that can lead to the creation of the big-bang:

⇒⇒ The more charged quarks, the tighter binding among them ⇐⇐

⇑ ⇓ ⇓ ⇑

⇑ The tighter the quark binding, the more production of the energy ⇑

⇑ ⇓ ⇓ ⇑

⇑ ⇐ The more energy, the more production and sorting of quark pairs ⇒⇑

The main driving force here is the electromagnetic force, which is $O(10^{40})$ times stronger than the gravitational force—an immense

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boon to the big-bang mechanism. In the rapid repetition of cycles, the charges multiply with a critical barrage factor, say $B_{c.} = O(10^{13})$, here the exponent corresponding to the inferred peak charge clumping of the black holes (see § 9). A sufficient portion of opposite charges of the quark pairs would evade annihilation by their push-and-pull τ-zone Coulomb force, maneuvering into contiguous charge clumpings. The τ-zone energy at the peak provides the intense scalar field akin to the false vacuum that is assumed for Guth's inflationary explosion [25].

The proposition can be gleaned in simplest terms. An extrapolation of the examples considered in § 9 for the τ-zone charge clumping Coulomb potentials in a black hole (say, of b ≈ 10) into the immensely tighter spot of the big-bang leads to still greater binding, respectively, to the levels of $O(-10^{42}$ GeV), $O(-10^{44}$ GeV), and $O(-10^{48}$ GeV) per a figurative charge "e". The total binding energies for all of the charges inside each of these τ-zone charge clumpings are immense, corresponding, respectively, to the energy equivalent masses in the order of 10^{-3} $M_{pl.}$, M_E, and 10^4 $M_{\odot}$, where {$M_{pl.}$, M_E, $M_{\odot}$} represent the masses of {Pluto, Earth, Sun}. Since the constituent elements at this stage are the freely moving quarks with their charges in fractions of "e", the detailed enumeration of the charge clumping would be in term of the fundamental charges $z_{c,f,}$, rather than in $z_{c,p}$ of the protons.

Although the incredibly large vacuum catastrophe factor $Q \approx O(10^{120})$ has vanquished the strained presumption of the dark (τ-zone) energy as the cosmological constant vacuum energy (see § 7), the average τ-zone energy density of $\rho_\varepsilon \approx 7 \times 10^{-30}$ g/cm^3 associated with it provides the vacuum energy density of $\rho_\varepsilon{}^* \approx \rho_\varepsilon Q \approx 7 \times 10^{90}$ g/cm^3. This corresponds to the mass of $N_h \approx 5 \times 10^{44}$ protons inside the big-bang volume of horizon scale radius of $r_{h.}$

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The part of the N_h, $N_{h,\tau}$, must be the number of τ-zone protons that imparts inside the tiny big-bang volume by the vacuum fluctuation. Their charge clumping cycles follow, and each proton would avalanche produce quarks to multiply charges by the critical barrage factor $B_{c.}$. The energy generated by the each clumping charge "e" is as great as $E_{c.c.} \approx O(10^{42 \rightarrow 48}\ \text{GeV})$.

Much information is needed by way of hard data. Yet, in the spirit of the inductive proof, this evolution may in principle generate the big-bang mass/energy in the order of $E_{total} \approx O(N_{h,\tau} B_{c.} E_{c.c})$, more than sufficient magnitude for various corrective adjustments to cause the big-bang explosion as well as the inflationary expansion to bring forth the observed Universe of $O(10^{24}\ M_{\odot})$. The physics here skirts the extreme limits, never breaking down.

Without the pulling from the pre-existing core that skirts the singularity, the spontaneous vacuum fluctuations of the intrinsically incompressible τ-zone matter would fizzle out. But the scale of time is immaterial to the nature. The process could eventually succeed (perhaps, once in many trillions of years) to erupt into the enduring big-bang Universe of critical density out of nothing.

11. Inflationary Expansion and the Quantum Partition Free Window

The big-bang would begin in the LHS (τ-zone) Universe with the effective τ-zone matter charge clumpings ascending to the level of , say, $z_{c,f} \rfloor_0 \geq O(10^{13}) \geq B_{c,}$, which means an extremely powerful presence of the τ-zone energy that manifests itself as the repulsive scalar field [see Appendix D]. The quantum partition arises in term of the conjugate waves in the ultra high density of the LHS Universe,

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likely leaving the RHS (t-zone) Universe comparatively unsubstantial due to its lack of any energy self-boosting mechanism.

At the critical phase in the end, the immensely intense τ-zone energy executes the inflationary expansion that increases the size of the big-bang by $10^{30} \sim 10^{50}$ times in O(10^{-32} second). The τ-zone matter charge clumpings rupture by absorbing the τ-zone energy, and a great part of the repulsive τ-zone energy is converted back to τ-zone matter mass, the $z_{c,f}$ rapidly diminishing to some $z_{c,f} > z_{c,f}\rfloor_{crit}$. With the reduced density of the τ-zone energy, the inflation spontaneously eases down, and the Universe begins the slow, steady expansion. This contrast with the cases of the standard theory, where the ad hoc second scalar field is required to stop the inflationary expansion that the first scalar field had started [15].

Toward $\tau \approx 10^{-10}$ second, the defining state of $z_{c,f} \approx z_{c,f}\rfloor_{crit}$ (or $m_{f,cc} \approx 0$) is reached for the τ-zone charge clumping. The quantum partition vanishes (see Fig. 5), and the LHS (τ-zone) Universe rolls down to the RHS (t-zone) Universe with its energy uplifted by the prevailing zonal energy shift of $U_{\tau \to t}$ [see Appendix B]. This is like a physical detail of the false vacuum (LHS Universe) decaying into the true vacuum (RHS Universe) [25].

Proceeding in strong ($\eta \to \infty$) breakup collisions, the lingering charge clumpings of the fundamental elements are fully pulverized to establish the "Epoch of free Quarks" toward $\tau \approx 10^{-8}$ second. A

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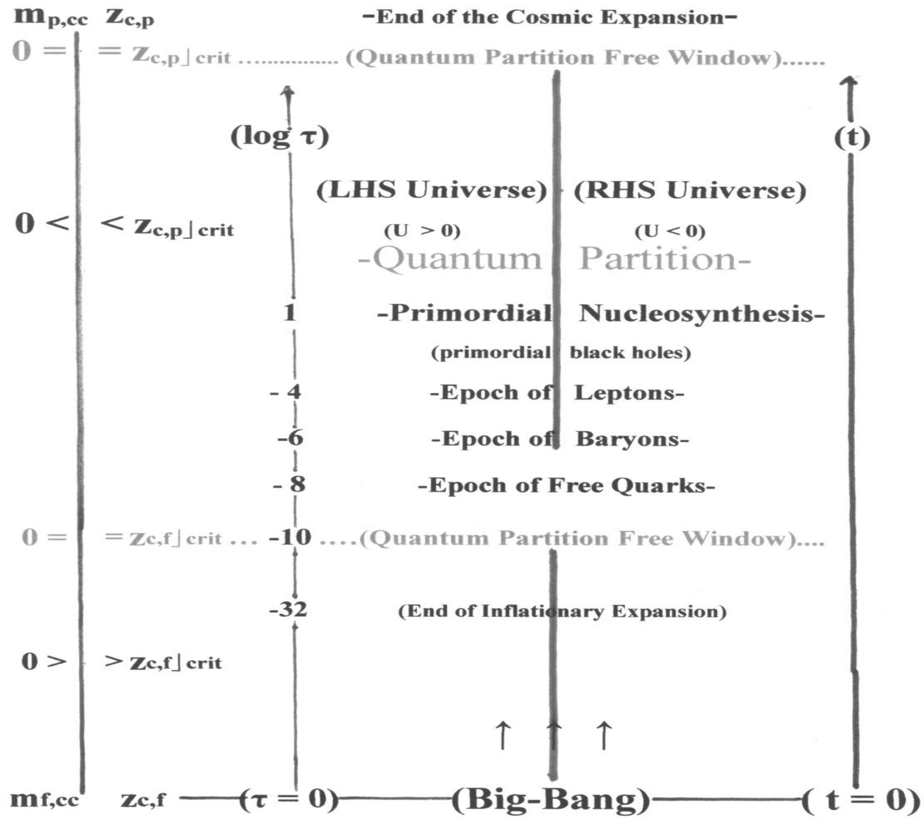

Fig. 5. Time-line of the Big-Bang Universe

significant portion of the t-zone quark pairs would annihilate into the t-zone photons. By $\tau \approx 10^{-6}$ second, the the collision energies drop to about 1 GeV, and the quarks hang onto one another, and enter the "Epoch of Baryons." Because of the quantum interactions in thermal equilibrium, the details of the big-bang Universe through the epoch of quarks will not be notably consequential [26].

The whole array, extricated down into the RHS (t-zone) Universe, cools down, and the energy available from the collisions is no longer enough to produce baryon pairs, and their annihilation into (t-zone) photons proceeds unabated. This copious decays of the particle pairs during the epochs of quarks and baryons into the photons leads to their superabundance in the RHS (t-zone) Universe (see § 12). Only a relatively negligible portion of proton-antiproton and neutron-antineutron pairs remains intact, perfectly balanced in "total number of baryons = total number of antibaryons." The entire matter content

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of the Universe is now established, being interwoven with abundant t-zone photons.

The characteristics of the matter—charge, mass, and spin—do not provide distinct earmark divisions of matter into two groups. But the magnetic moments, **p** , of the baryons are either positive or negative as given below in unit of the nuclear magneton:

Positive moment: Proton: +2.79275; Anti-neutron: +1.91128

Negative moments: Anti-proton: - 2.79275; Neutron: -1.91128,

and split the entire baryons into two populations.

A substantial cosmic magnetic field is observed to pervade even the vacant regions of the Universe that do not contain stars or galaxies [27], its origin pointing toward the big-bang. The magnetic field around the stars may become extremely strong, possibly as much as 10^{15} Gauss. Many astronomical bodies have an internally generated magnetic field with a certain electrically conducting fluid; the charged quarks in asymptotically free motion must have turned into superfluids to engender an extraordinarily strong magnetic field in the big bang.

The baryons become polarized with their magnetic moments parallel to the magnetic field, **H,** and the polarization energy U is given by [28],

$$U = -p \bullet H \tag{27}$$

With the strong magnetic field **H** in the big bang, the U would be extremely large, and

U < 0 for the protons and antineutrons,

U > 0 for the antiprotons and neutrons.

The protons and antineutrons with p > 0 at once phase shift into the U < 0 track of the RHS t-zone Universe, while the antiprotons and neutrons with p < 0 phase shift into the U > 0 track of the LHS τ-zone

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Universe. The neutral stabilization, ”U = 0 “, would establish the quantum partition between the U < 0 Universe and U > 0 Universe. This affirms that the particle masses both in the LHS Universe and the RHS Universe are the same.

The strong residual magnetic field is the primary agent that helps establish the quantum partition, but likely not the maintenance of it. That would require certain subtler space-time aspect of the Hermitian-antiHermitian symmetry.

12. Asymmetric Matter and Energy Universe

The number of the surviving baryons in $N_{\text{time-zone, baryon kind}}$ is now counted:

$$\begin{aligned} &N_{t,p} \text{ protons and } N_{t,an} \text{ antineutrons in the RHS t-zone Universe,} \\ &N_{\tau,ap} \text{ antiprotons and } N_{\tau,n} \text{ neutrons in the LHS } \tau\text{-zone Universe} \end{aligned} \tag{28}$$

where $N_{t,p} - N_{t,an} = N_{\tau,ap} - N_{\tau,n}$. The number of the baryons in one Universe are counter-balanced by the same number of anti-baryons across the quantum partition in the other Universe. The Universe as a whole is baryon-antibaryon symmetric, and all baryons and anti-baryons are paired. Once separated by the quantum partition, however, they cannot pair annihilate across it.

The “Epoch of Leptons” follows, during which the protons and antiprotons continuously convert into neutrons and antineutrons and vice versa:

$p + e^- \leftarrow\rightarrow n + \nu_e$, $n + e^+ \longleftrightarrow p + \nu_{e,a}$, $n_a + e^- \longleftrightarrow p_a + \nu_e$, etc.

Throughout the primordial expansion, the universe follows the rules of statistical mechanics in a state of thermal equilibrium.

With the leptonic conversions, the baryons of Eq.(28) in the RHS Universe are changed to,

$$N^{\#}{}_{t,p}\text{protons, } N^{\#}{}_{t,n} \text{ neutrons; } N^{*}{}_{t,p}\text{protons} = N^{*}{}_{t,ap}\text{antiprotons,} \\ \mathrm{N}^{*}{}_{t,n}\text{neutrons } = N^{*}{}_{t,an}\text{antineutrons} \tag{29}$$

Similarly, the baryons in the LHS Universe are changed to,

$$N^{\#}{}_{\tau,ap}\text{antiprotons, } N^{\#}{}_{\tau,an}\text{antineutrons; } N^{**}{}_{\tau,p}\text{protons} = N^{**}{}_{\tau,ap}\text{antiprotons,} \\ \mathrm{N}^{*}{}_{\tau,p}\text{protons } = N^{*}{}_{\tau,ap}\text{antiprotons, } N^{*}{}_{\tau,n}\text{neutrons} = N^{*}{}_{\tau,an}\text{antineutrons} \tag{29A}$$

This interim shall be called: "Interlude for Baryon Sorting".

The $N^*_{t,\,p}$ - $N^*_{t,\,a\,p}$ proton-antiproton pairs as well as the $N^*_{t,\,n}$ - $N^*_{t,\,an}$ neuron-antineutron pairs annihilate to supplement the t-zone photons abundantly produced earlier in the RHS Universe (see §11), eventually establishing the total number of t-zone photons $N(\gamma_t)$ for

$$\left(N^{\#}{}_{t,p} + N^{\#}{}_{t,n}\right) \Big/ N\left(\gamma_t\right) \approx O\left(10^{-10}\right) \tag{30}$$

which has been confirmed so by observation [29]. The surviving baryons $N^{\#}_{t,\,p}$ and $N^{\#}_{t,\,n}$, with their antibaryons lost to the LHS τ-zone Universe, establishes the matter asymmetric RHS t-zone Universe. The asignment of $N^{\#}_{t,\,p} / N^{\#}_{t,\,n} \approx 7$ also meets the requirement for the primordial nucleosynthesis of the Deuterium and Helium in the RHS Universe [30].

Because of the strong push-and-pull τ-zone Coulomb force maneuvering (see §10), only the $N^*_{\tau,\,p} + N^*_{\tau,\,a\,p}$ proton-antiproton pairs as well as the $N^*_{\tau,\,n} + N^*_{\tau,\,a\,n}$ neutron-antineutron pairs suffer annihilation to provide the first batch of the τ-zone photons to the expanding LHS Universe, while the $N^{**}_{\tau,\,p} + N^{**}_{\tau,\,a\,p}$ proton-antiproton pairs in the LHS Universe evade the pair annihilation, enumerating,

$$\left(N^{\#}{}_{\tau,ap} + N^{\#}{}_{\tau,an}\right) + \left(N^{**}{}_{\tau,p} + N^{**}{}_{\tau,ap}\right) \approx \theta^{*}{}_{\tau}\left(N^{\#}{}_{t,p} + N^{\#}{}_{t,n}\right), \text{ or } \rho_{\tau} \approx \theta^{*}{}_{\tau}\rho_{t} \tag{31A}$$

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$$\left(N^{*}_{\tau,p} + N^{*}_{\tau,ap}\right) + \left(N^{*}_{\tau,n} + N^{*}_{\tau,an}\right) \approx \theta^{*}_{\varepsilon}\left(N^{\#}_{t,p} + N^{\#}_{t,n}\right), \text{ or } \rho_{\varepsilon} \approx \theta^{*}_{\varepsilon}\rho_{t} \quad (31\mathrm{E}$$

where $\theta*_{\tau}$ and $\theta*_{\varepsilon} \approx \theta*_{ann}$ are proportioning factors.

In time, the $(N^{\#}_{\tau,\,ap} + N^{\#}_{\tau,\,an})$ and $(N^{**}_{\tau,\,p} + N^{**}_{\tau,\,a\,p})$ as a whole are also affected by the charge clumping conversion of the τ-zone matter into the τ-zone energy, and the following modifications take place toward the year 380,000,

$$\theta*_{\tau} \to \theta_{\tau} = \theta*_{\tau} - \theta_{cc} \text{ and } \theta*_{\varepsilon} \to \theta_{\varepsilon} = \theta*_{\varepsilon} + \theta_{cc},$$

where θ_{cc} represents the shifts caused by the the charge clumping. Note that $\theta*_{\tau} + \theta*_{\varepsilon} = \theta_{\tau} + \theta_{\varepsilon}$..

13. Conservation Law of total dark matter and energy

After the τ-zone pair annihilation for the τ-zone energy production, the only other mechanism for the τ-zone energy production is the charge clumping of the τ-zone matter of proportion θ_{cc}. The extrapolation of the $z_{c,p}$ through the expansion of the Universe, i.e., $\{z_{c,p}, z_{c\rfloor crit.}, z_{c,sw}, z_{c,cross}\}$ of Eqs. {24,25,47,48}, indicates that the charge clumping rises outside of the big-bang, reaching, say, $z_{c,p} \approx O(10^{3})$ by the year 380,000.

That gives $\theta_{cc}/\theta_{\varepsilon} \approx 0.27$, confirming that the large portion of the τ-zone energy at the year 380,000 comes from the earlier annihilation of the τ-zone pairs with the τ-zone energy remaining at nearly constant $\theta*_{\varepsilon}/\theta_{\varepsilon} \approx \theta_{ann}/\theta_{\varepsilon} \approx 0.73$. Since $N^{\#}_{\tau,\,ap} + N^{\#}_{\tau,\,a\,n} = N^{\#}_{t,\,p} + N^{\#}_{t,\,n}$, the most of the τ-zone matter is the aftermath of the τ-zone pairs that had evaded the annihilation. The τ-zone matter charge clumping continues to grows after the year 380,000.

Invoking Eq.(44) of §17 in conjunction with Eq. (20), the θ_{τ} and θ_{ε} in the year 380,000 can be determined:

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$$\theta_\tau \approx 16.29 \text{ and } \theta_\varepsilon \approx 5.52,$$

that is

$$\rho_\tau + \rho_\varepsilon \approx (\theta_\tau + \theta_\varepsilon)\,\rho_t \approx 21.8\ \rho_t \tag{32}$$

This results in the asymmetric surplus population of matter and energy in the LHS τ-zone Universe (96 %) over that of the RHS t-zone Universe (4 %) [see Fig. 8]. The situation remains the same after the rise of the quantum partition, establishing the "Conservation Law of the total τ-zone mass/energy" throughout the history of the Universe.

Accordingly, the τ-zone constituents inside the big-bang are estimated to be,

$$\rho_\tau/\rho_t \approx 17.8 \text{ and } \rho_\varepsilon/\rho_t \approx \rho_{an}/p_t \approx 4.0 \tag{33}$$

This is confirmed with the observed mass correlation between the massive black hole and the large galaxy duos (see § 14).

Explanation of the asymmetric t-zone baryons in the RHS Universe through CP violation in the standard theory [31] remains a conjecture; particle accelerators measure too small a violation of CP-symmetry to account for the baryon asymmetry [32]. Moreover, if the asymmetric protons can be created in this manner, they can also be spontaneously destroyed. But the underground experiments in the 1980s to test this possibility all turned out negative [33], and the observational results plainly repudiate the conventional theories of dark matter and energy [34]. [For the general conservation law, see Appendix D.]

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14. Development of the massive black holes and galaxies in the big-bang

The black holes are observed to originate from collapsing stars, and reach the mass of $M_b = O(30\ M_\odot)$. The small black holes and galaxies in the conventional theories grow incrementally in the open Universe, the gravity pulling small masses together, then through mergers, accretions, and AGN processes to form larger structures step by step, eventually to the ultra-massive core black holes of $M_b = O(10^{10}\ M_\odot)$ with large host galaxies in the observed linear mass correlation [36].

What was actually observed is quite different; the tally encounters a dearth of intermediate-mass black holes from $M_b = O(30\ M_\odot)$ to $M_b = O(10^5\ M_\odot)$. Then the dark galaxies that correspond to the black holes of $M_b = O(10^5\ M_\odot)$ manifest themselves with disparately abundant dark matter. The increasingly heavier core black holes then materialize with host dwarf galaxies with high densities $\{\rho_t, \rho_\tau\}$, then eventually to the super-massive core black holes along with very large galaxies in the mass correlation with their prevalent densities lower than those of the dark and dwarf galaxies. This is a declaration that the roots of the massive black holes and the light mass black holes must be different and disconnected.

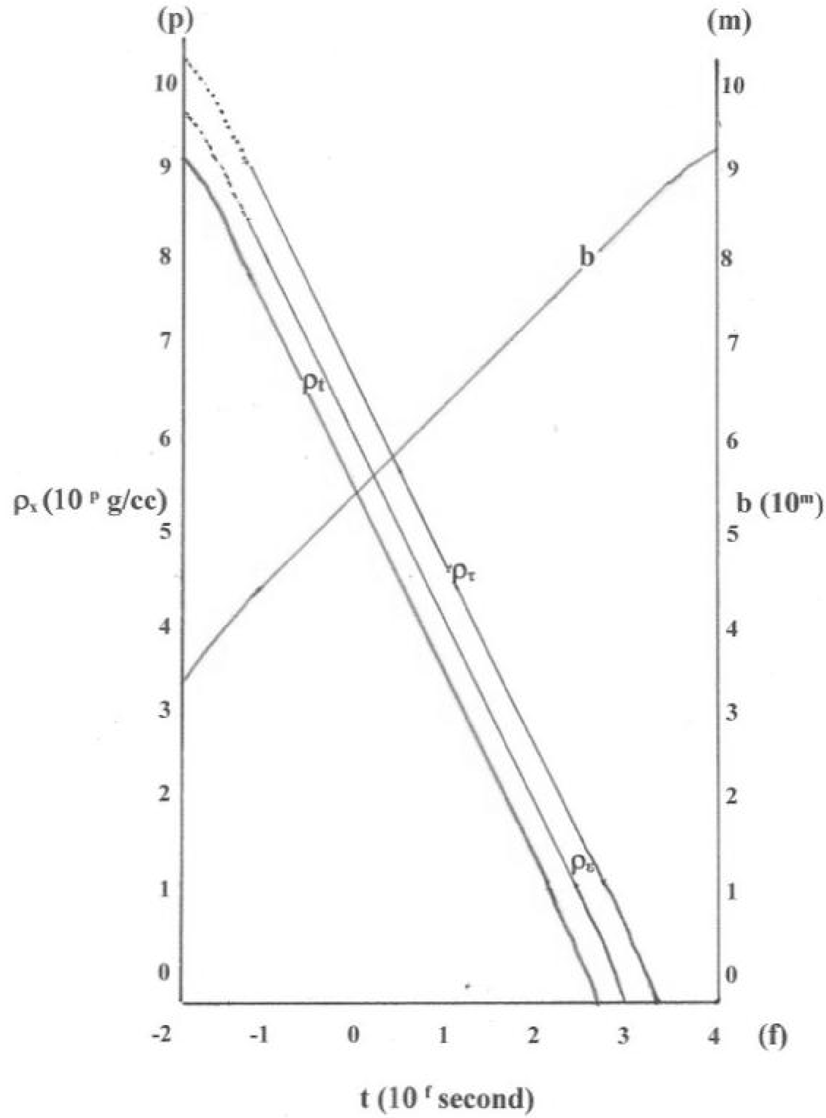

Fig. 6. The average densities {ρ_t, ρ_τ, ρ_ε} and b in the big-bang .

A black hole of mass $M_b = b\ M_\odot$ corresponds to the equivalent average black hole mass density ρ_t(g/cc) with $\alpha = 3 \times 10^3$ m by [see § 9],

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$$\rho_t = M_b \Big/ \left[4\pi R_b^3 \big/ 3 \right] = 3M_\odot \Big/ \left[4\pi \alpha^3 b^2 \right], \text{ that is}$$

$$b = \left\{ 3M_\odot \Big/ \left[4\pi \alpha^3 \rho_t \right] \right\}^{1/2} = 1.34x\,10^8 \Big/ \rho_t^{1/2} \tag{34}$$

The variations of ρ_t and b, along with ρ_τ and ρ_ε from Eq. (33) are estimated and shown in Fig. 6 as functions of time in the big-bang Universe [35]. If the seeds of the larger black hole and galaxy duos are formed inside the big-bang, the observed variation in the density $\{\rho_t, \rho_\tau\}$ in the host galaxy would be realized.

The big-bang in the nuclear matter domination continues expansion with its average t-zone matter density ρ_t decreasing to actually match the average density of the increasing larger black holes. The gravity is neutral inside the uniform (and effectively) boundless distributions of matter. The (dark) τ-zone matter and energy not only do not interact with the (visible) t-zone matter, but they—evenly distributed—are gravitationally neutral to the (visible) t-zone matter in the big-bang.

In principle, the (visible) t-zone matter with its average density presently equal to the actual average black hole density $\boldsymbol{\rho}_t$ under the local plasma perturbation may initiate an impromptu collapse into the black hole of its Schwartzschild radius $R_b = \alpha$ b in the big-bang.

The stellar black holes in the galaxies are formed by the collapsing of mass toward a preexisting gravity core star. On the other hand, the formation of the mini-sized primordial quark black holes—being speculated [37]—was never observed. Because of the powerful inertia of expansion at high temperature without the preexisting gravity core, the possible gravity collapsing into the black hole in the big-bang is

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suspended. Toward t = 0.5 second, where b ≈ 10^5 [see Fig. 6], however, the dynamics would become amenable to the formation of the black holes, accompanied by galaxies such as the dark galaxy VirgoHI21. This puts an end to the dearth of black hole formations, and the ensuing dwarf galaxies would also have excess τ-zone matter with higher than usual matter densities [38; 38A]. Proceeding to t = 10 second, the formation of Milky Way Galaxy sized black hole and galaxy duos would become possible.

The local impromptu collapse into the (t-zone matter) black hole would fortify a spontaneous "hard globule" of the residual constituents of relative mass $M_b{}^* = \kappa M_b$ inside of the R_b, where

$$\kappa = \left(\rho_t + \rho_\tau + \rho_\varepsilon + 3p\right) \Big/ \rho_t \tag{35}$$

The hard globule with its own sphere of Schwartzschild radius,

$$R_b{}^* = \kappa R_b \tag{36}$$

could entrap the residual big-bang matter within it.

The $\{\rho_t, \rho_\tau, \rho_\varepsilon\}$ of Eq. (33) gives an estimation of $\kappa \approx 10$ in the big-bang. Thus, the host galaxy of mass M_g in terms of the (visible) t-zone matter inside the sphere of the Schwartzschild radius $R_b{}^* \approx 10\, R_b$ would be formed. The mass correlation between the core black hole and host galaxy duos is as a rule established as observed {for further details, see the reference 39} by

$$M_g \Big/ M_b \approx R_b{}^{*3} \Big/ R_b{}^3 \approx O\left(\kappa^3\right) \approx O\left(10^3\right) \tag{37}$$

Here, the relative size ratio of "the core black hole: the host galaxy" is comparable with "a jack ball: a basket ball, "enormously different from the ratio of "a human: the Earth" in the open Universe. Equation (37) in agreement with the observed mass correlation is a

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verification of the density distribution of Eq.(44) against the WMAP data of Eq.(38) at the year 380,000 [see §17]. It also provide a telling insight into the big-bang, ascertaining the density distribution of Eq. (33).

Note also that, with an extrapolation to t $\approx 3.2 \times 10^4$ seconds, b $\approx 10^{10}$ and $\rho_t \approx 10^{-4}$ g/cc. This density is equal to the Hydrogen density in the normal Earth atmospheric pressure, at which point the big bang may lose its uniformity, suffering irregular disruptions. The formation of such ultra-massive black holes would end there, or might be assisted through collisions and mergers.

15. Overview of the Universe

There has been a large number of observations of the super-massive black holes and the most massive galaxies existing in the very early Universe. They emerge as if straight out of the big-bang [40; 41; 42; 43; 44; 45; 46; 47], supporting the view that the seeds of the super-massive black hole and galaxy duos are in fact formed in the big-bang by a linear mass correlation. The conventional theory, in contrast, could take up to 100 billion years to form the galaxy clusters [48], far beyond the age of the Universe.

The unexpectedly robust star-burst galaxies with SFR of up to 4,000 stars per year also act as if they were self-made in the big-bang [49A]. At this rate, the galaxies need only 50 million years to grow into galaxies equivalent to the most massive ones observed today. It is also observed [49B] that the stellar birthrate in the baby-boom galaxies is higher in the cluster's centers than at the edges in exactly opposite of what is expected in conventional theory that assumes the formation of black hole and galaxy duos well into the expanding Universe.

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In the big-bang, the ρ_ε is much less than $\rho_\tau + \rho_t$ [see Eq. (33)], allowing to form the observed dense galaxy clusters. The dark energy in time aggrandize and form repulsive halos around the clusters and could cause the "dark flow" [50], eventually into the cosmic structures of walls, filaments, and the great voids [for the detail see 51]. The observed void is as wide as 0.9 billion light years; the conventional theory fails to measure it up, its super computer simulation indicating that the biggest voids feasible would be about 75 million light years across [52].

The flows in the early Universe could have incidentally ruptured in certain directions. It has been shown [53] that such large-scale local structural alignments toward the sun at the early age of the Universe could imprint the "Cosmic Axis of Evil."

16. Stars, Galaxies, and the Galaxy Clusters

As suspected (see §14), there in fact are two kinds of black holes and galaxies: those from the massive seeds formed in the big-bang, and those formed from the congregation of the mobile matter in the open Universe. The black holes and galaxies of both origins would be aggrandized through collisions and mergers.

The computer simulation in the standard theory indicates that the first stars would be formed as early as 30 million years in the open Universe [54]. The formations of stars, however, should include the local influence of the more populous τ-zone matter and energy. Observations in fact indicate such stars had begun to form much later, toward 300 million years after the big-bang [55]. This explains why the dark matter and ordinary matter seem to conspire with each other as if a fifth force were ruling the dark matter, leaving similar finger-prints on galaxies [56].

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The τ-zone matter of high density ρ_τ by itself is attractive, and would help cause the t–zone matter of density ρ_t to congregate and attempt to form star. However, this process is slackened and even opposed by the repulsive τ-zone energy produced by the charge clumping of the compressed τ-zone matter. Thus, although the availability of a sufficient t-zone matter is essential for the star formation, the hardiness of ρ_t is less consequential than that of ρ_τ , which --with a certain deterministic critical density $\rho_{\tau,crit}$ –settles on formation of stars.

The prominent example is the dark galaxy VirgoHI 21 with its disparately abundant τ -zone matter [57]. It contains enough t-zone hydrogen to produce 100 million stars, but the star formation in it—irrespective of the possible disruptive swirl from its black hole—has not happened.

As shown in Fig. 6, the matter densities $\{\rho_t , \rho_\tau \}$ in the dwarf galaxies would be relatively more diluted than those in the dark galaxies, yet still noticeably denser than those in the massive galaxies. The characteristic density dependence for the star formations have further been confirmed by observations [37]; the star abrogating effect of the τ-zone matter and energy in the dwarf galaxies becomes moderate to keep the star formation going, but at a slow-pace. The densities $\{\rho_t , \rho_\tau \}$ in the large galaxies further diminish. As the cool t-zone matter congregates to make stars, the attractive τ-zone matter gravity would initially aid it as usual. But the process is slow, and the τ-zone energy generated would leak out of the star formation region, and no appreciable residual repulsive τ-zone energy force persists to seriously slow the early making of stars. Observations indicate that the bulk of stars in the massive galaxies–despite their comparatively lower source density ρ_t --formed earlier at the higher rate than in the less massive system [57; 58].

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17. The Chronicle of Dark Matter and Energy

The Five-Year WMAP [59] reports that,

$$\{\rho_n\}\big/\rho_t \approx \{1.0, 5.25, 0\},\ \text{where}\ \{\rho_n\} = \{\rho_t, \rho_\tau, \rho_\varepsilon\} \quad (38)$$

at the Universe's age of 380,000 years.

The total amount of the t-zone matter in the Universe is constant, and its average density ρ_t changes in proportion to the inverse volume it occupies. The Eq. (38) in comparison with Eq. (20) appears to indicate that the total amount of the τ-zone matter in the Universe also is constant, while seemingly in agreement with a constant τ-zone energy density through the age of the Universe.

To assimilate the effect of the Universe's expansion, the variations of the densities ρ_t, ρ_τ, and ρ_ε under the above premises of the standard theory are plotted in Fig. 7 in terms of $\rho_t = 1$. Thus, $\rho_\tau \approx 5.2$ and $\rho_{\varepsilon,u} \approx R_u^3 \{ \rho_{\varepsilon,u}^*/(R_u^*)^3 \}$, where $\rho_{\varepsilon,u}^* \approx 16.6$ and R_u^* are the prevailing τ-zone energy density and the radius of the Universe, while $\rho_{\varepsilon,u}$ and R_u are their proportions as function of the Universe's age.

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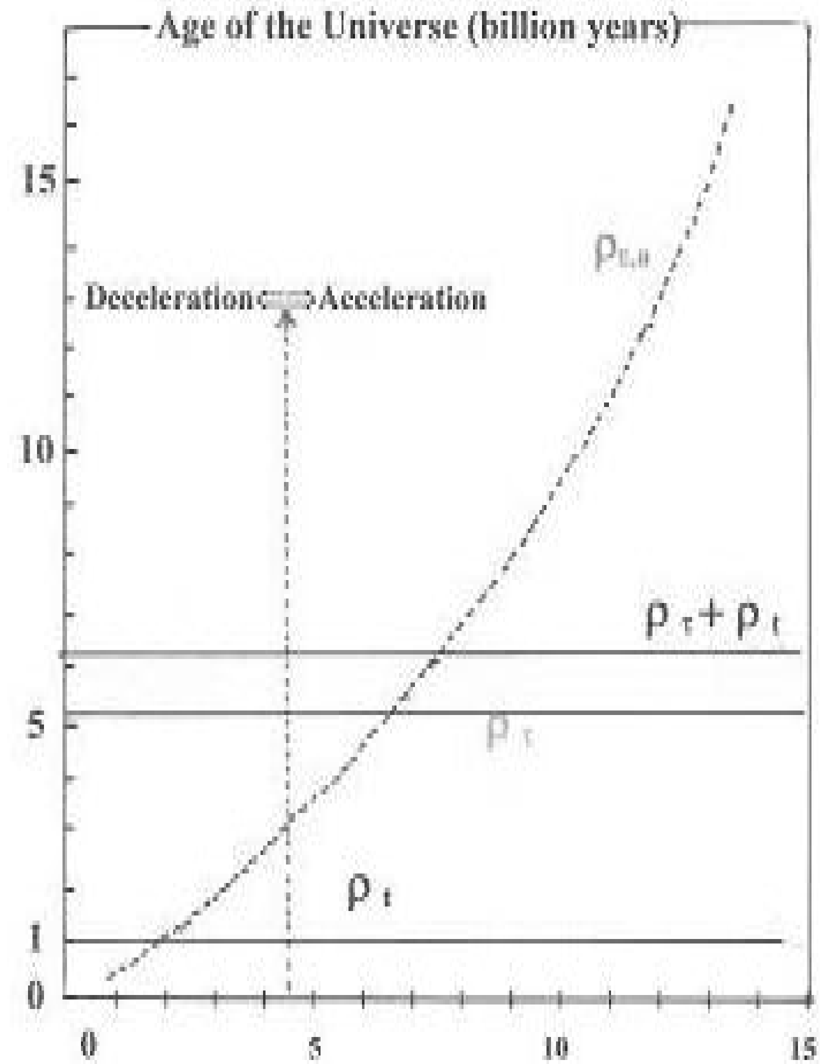

Fig. 7. The average density (in unit of $\rho_t = 1$) in conventional theory

However, there are obvious problems with the implication of Eq. (38): First, solving the Einstein-Friedmann Equation (19) with p = $\omega_\varepsilon \rho_{\varepsilon,u}$ and $\omega_\varepsilon = -1$ for,

$$\rho_t + \rho_\tau + \rho_{\varepsilon,u} + 3p \approx 0$$

the switch from the deceleration to the acceleration of the Universe's expansion occurs at around the Universe's age of 4.5 billion years as indicated in Fig. 7. This disagrees with the observation—the

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expansion speed switch from deceleration to acceleration at the Universe's age of about 8.5 billion years [60, 61].

Second, the reported data in Eq.(38) at 380,000 years,

$$\rho_{\tau,total} \approx \rho_\tau + \rho_\varepsilon \approx 5.25\rho_t \text{ with } \rho_\varepsilon \approx 0,$$

is only a small portion of the actual $\rho_{\tau,\ total} \approx \rho_\tau + \rho_\varepsilon \approx 21.8\ \rho_t$ as determined in Eq. (32) and the prevailing data of Eq. (20), violating the conservation of the total τ-zone mass/energy in the Universe.

It is obvious that the Eq. (38) has fallen short in tracking down all of the τ-zone matter and energy existing at the age 380,000 years of the Universe. Still, the WMAP data can be useful in extracting insights into the nature of physics to help determine the correct density distribution in the early Universe.

The state of the τ-zone plasma can be gauged by its electrical resistivity, η , which is estimated (in an order of approximation for the purpose of exploratory demonstration) by [62],

$$\eta \approx O\left\{5.x10^{-5}\, z_{c,p} \Big/ \left[\mathrm{T}_{p,cc}\ (eV)\right]^{3/2}\ \text{Ohm-m}\right\}, \tag{39A}$$

where $v_{p,cc}$ = the speed of the τ-proton charge clumped flecks, and

$$\mathrm{T}_{p,cc}(eV) \approx m_{p,cc} {v_{p,cc}}^2 \Big/ 2\ , \text{ with } m_{p,cc} = \left(1 - \varepsilon \Big/ m_p c^2\right) m_p \tag{39B}$$

At 380,000 year, the charged τ-zone particles would be at a high average temperature, say, $T_{p,cc} \approx O(0.1\ \text{MeV})$, and it was shown (see §13) that the degree of charge clumping at the time was moderate $z_{c,p} \approx O(10^{3})$. That yields $\eta \approx O(10^{-9}\ \text{Ohm-m})$, and thus the τ-zone plasma is fully collision-free. The freely moving τ-zone matter in the perpetually coupling plasma would act in concert with the τ-zone

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energy, and the gravitational forces and pressure arising from the τ-zone matter and energy in opposite directions would superimpose to proportionally cancel each other as their presence is observed now from Earth in the haze of remote time and distance. The data in Eq. (38) would thus be subjected to certain distortion that limits their reliability.

The densities ρ_τ and ρ_ε in the Einstein-Friedmann Equation (19), could thus be apportioned into $\rho_\tau = \rho_{\tau,1} + \rho_{\tau,2}$ and $\rho_\varepsilon = \rho_{\varepsilon,1} + \rho_{\varepsilon,2}$ so that the attractive gravitational force from the dark matter part, $\rho_{\tau,2}$, can be superimposed to neutralize the repulsive pressure that arises from the dark energy part $p_2 = \omega_\varepsilon \rho_{\varepsilon,2}$, that is,

$$\rho_{\tau,2} + \rho_{\varepsilon,2} + 3p_2 \approx \rho_{\tau,2} + \rho_{\varepsilon,2}\left(1 + 3\omega_\varepsilon\right) \approx 0 \tag{40}$$

with $\rho_{\varepsilon,1} \approx 0$ at 380,000 years. The application of the superposition of Eq.(40) in the Einstein-Friedmann Equation (19), yields

$$\rho + 3p \approx \rho_t + \rho_{\tau,1} + \rho_{\varepsilon,1}\left(1 + 3\omega_\varepsilon\right) + \left[\rho_{\tau,2} + \rho_{\varepsilon,2}\left(1 + 3\omega_\varepsilon\right)\right] \approx \rho_t + \rho_{\tau,1} \tag{41}$$

Although there actually are $\rho_{\tau,1} + \rho_{\tau,2}$ of dark matter and $\rho_{\varepsilon,2}$ of dark energy (with $\rho_{\varepsilon,1} \approx 0$) that pervade the universe at 380,000 years, only the excess portion of the dark matter part $\rho_{\tau,1}$ along the ordinary matter ρ_t could leave its imprint of interaction on the cosmic background radiation without any hint of dark energy as manifested by Eq. (38).

Solving Eq. (41) with $\rho_{\tau,1} \approx 5.25\ \rho_t$ and $\rho_{\varepsilon,1} = 0$ of Eq.(38) along with $\rho_{\tau,1} + \rho_{\tau,2} + \rho_{\varepsilon,2} \approx 21.8\ \rho_t$ of Eq. (20),

$$\rho_{\tau,2} \approx 5.52\left(3 + {}^{1}\!/\!{}_{\omega_\varepsilon}\right)\rho_t \text{ and } \rho_{\varepsilon,2} \approx \left({}^{-5.52}\!/\!{}_{\omega_\varepsilon}\right)\rho_t \tag{42}$$

The density array of Eq.(38) at year 380,000 is thus amended to,

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$$\left\{\rho_{n\_|o}\right\}\Big/\rho_{t\_|o} \approx \left\{1, 21.81 + 5.52\big/\omega_{\varepsilon}, -5.52\big/\omega_{\varepsilon}\right\}, \tag{43}$$

Now, the τ-zone matter charge clumping for generating τ-zone energy, $\rho_{\varepsilon,1}$ begins to grow, increasing $z_{c,p}$. The $T_{p,cc}$ (eV) in turn decreases, and the η becomes larger with its motion randomized. This destroys the balancing in the superposition of the forces in Eq.(40), gradually losing the equipoise during the first couple of billion years.

As the average dark matter charge clumping increases, eventually to the prevailing $z_{c,\ p} \approx 3.5 \times 10^4$ of Eq. (23) at a notably low temperature [63], though the τ-zone plasma is still inside the collision-free limit, the η presently being observed from Earth could become large enough to lose the coherence of linear superposition of Eq. (40) in the Einstein-Friedmann Equation (19).

The Eq. (43) predicts the densities in the year of 380,000,

$$\left\{\rho_{n\_|o}\right\}\Big/\rho_{t\_|o} \approx \left\{1.0, 16.29, 5.52\right\} \text{ for } \omega_{\varepsilon} = -1.0 \tag{44}$$

as compared with {1, 14.91 , 6.9 } for ω_ε = - 0.8 and {1, 17.18, 4.63 } for ω_ε = - 1.2. The correctness of Eq. (44) has been verified consistently by the gamut of seemingly unrelated experimental observations, including the mass correlation between the black hole and galaxy duos [see Eq. (37) and § 14].

Moreover, the correctness of the prediction, Eq. (44), has recently been further verified by the QUaD data [64] which, by creating the maps of polarization, determined the precise picture of the Universe at 400,000 years. The new data indicate that the early Universe did contain about 95 % dark matter and energy with the ordinary matter of about 5 %, i.e.,

$$\left\{\rho^*_{t\_|o} : \rho^*_{\tau\_|o} + \rho_{\varepsilon}{}^*_{\_|o}\right\} \approx \left\{5 : 95\right\} \tag{45A}$$

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at the year 400,000 in close agreement with the prediction in Eq.(44), i.e.,

$$\left\{\rho_{t\rfloor o} : \rho_{\tau\rfloor o} + \rho_{\varepsilon\rfloor o}\right\} \approx \left\{4 : 96\right\} \tag{45B}$$

The QUaD data, Eq. (45A), and the predicted data in this paper, Eq. (45B), supersede the WMAP data of Eq. (38).

Though the QUaD data did not specify the ratio between the dark matter and dark energy, the correctness of $\rho_{n\rfloor o}$ determined in Eq. (44) is plainly seen by denoting,

$$\rho_{eff\rfloor o} = \rho_{t\rfloor o} + \rho_{\tau\rfloor o} + \left(1 + 3\omega_{\varepsilon}\right)\rho_{\varepsilon\rfloor o} \qquad \text{for Eq.(45B),}$$

$$\rho^{*}_{eff\rfloor o} = \rho^{*}_{t\rfloor o} + \rho^{*}_{\tau\rfloor o} + \left(1 + 3\omega_{\varepsilon}\right)\rho^{*}_{\varepsilon\rfloor o} \qquad \text{for Eq.(45A)}$$

If the entire 95% of the QUaD data of Eq.(45A) is the dark matter without any dark energy,

$$\rho^{*}_{eff\rfloor o} \approx 20\rho^{*}_{t\rfloor o} \text{ with } \rho^{*}_{\varepsilon\rfloor o} \approx 0 \,,$$

as compared with $\rho_{eff\rfloor o} \approx 6.25\ \rho_{t\rfloor o}$ of Eq. (38). The attractive gravitational force from $\rho^{*}_{eff\rfloor o} \approx 20\ \rho^{*}_{t\rfloor o}$ would dominate the cosmos at the age of 400,000 years, and divert the subsequent expansion and development of the Universe into what it is today. The standard theory cannot explain how the dark matter of $\rho^{*}_{\tau\rfloor o} \approx 19\ \rho_{t}{}^{*}{}_{\rfloor o}$ at the year of 400,000 could decrease to the current $\rho_{\tau} \approx 5.2\ \rho_{t}$.

The other extreme that accept the ρ_{τ} in the WMAP data of Eq. (38), i.e., $\rho_{\tau} / \rho_{t} \approx 5.25$, assigns the balance of the QUaD dark component data to be the dark energy at the 400,000 years, i.e., $\rho^{*}_{\varepsilon\rfloor o} / \rho^{*}_{t\rfloor o} \approx 13.75$, indicating that the dark energy density never was a constant in the Universe, and thus rejecting the Cosmological Constant. The presumption also yields $\rho^{*}_{eff\rfloor o} / \rho^{*}_{t\rfloor o} \approx -21.25$ with $\omega_{\varepsilon} = -1$, which is nonsensical, indicating the expansion of the Universe was already in acceleration before the year 400,000.

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18. The Acceleration of the Universe's Expansion

The total amount of (observable) t-zone matter in the universe remains the same, and thus its average density ρ_t decreases solely due to the space expansion. The average τ-zone matter density ρ_τ decreases not only due to the space expansion, but also through the conversion of the τ-zone matter mass into the τ-zone energy mainly owing to its charge clumping in space over the billions of years.

The average density ρ_ε of the (dark) τ-zone energy is the sum of the existing τ-zone energy and the supplementary τ-zone energy arising from the charge clumping of the τ-zone matter in space. The average density ρ_τ of the (dark) τ-zone matter in the aging Universe thus decreases faster than the average density ρ_t of the (ordinary) t-zone matter, while the average density ρ_ε of the (dark) τ-zone energy first grows slowly (in units of $\rho_t = 1$), then in time overtakes ρ_τ.

According to the Einstein-Friedmann Equation (19), the switching-over from the deceleration to the acceleration at $z_{c,p} \approx z_{c,sw}$ in the course of Universe's expansion occurs at,

$$\rho_t + \rho_\tau + \left(1 + 3\omega_\varepsilon\right)\rho_\varepsilon = 0 \tag{46A}$$

Solving Eq. (46A) with Eq. (32), the switching-over in the expansion speed of the Universe occurs at,

$$\frac{\rho_{\tau\_|sw}}{\rho_{t\_|sw}} = 21.81 + \frac{7.6}{\omega_\varepsilon} \text{ and } \frac{\rho_{\varepsilon\_|sw}}{\rho_{t\_|sw}} = \frac{-7.6}{\omega_\varepsilon} \tag{46B}$$

which gives,

$$\frac{\left\{\rho_{\tau\_|sw}, \rho_{\varepsilon\_|sw}\right\}}{\rho_{t\_|sw}} = \left\{14.21, 7.6\right\} \, for \omega_\varepsilon = -1.0 \tag{46C}$$

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as compared with { 12.31, 9.5 } for ω_ε = - 0.8, and { 15.48, 6.33 } for ω_ε = - 1.2.

Out of the $\rho_\varepsilon \rfloor_{sw} \approx 7.6\, \rho_t \rfloor_{sw}$ of Eq. (46C), only the portion of $\Delta\rho_\varepsilon \rfloor_{sw} \approx (7.6 - 4.0)\rho_t \rfloor_{sw}$ was generated through the charge clumping of the τ-zone matter, yielding in term of Eq. (21),

$$z_{c,sw} \approx 5.36 \text{ x } 10^3 \tag{47}$$

The crossover charge clumping charge, $z_{c,cr}$ —where the ρ_ε crosses over ρ_τ—can be similarly estimated in terms of Eq. (21),

$$z_{c,cross} \approx 1.5 \text{ x } 10^4 \tag{48}$$

The variations of the densities ρ_t, ρ_τ , ρ_ε and $\rho_\tau + \rho_t$—through the charge clumping stages of $z_{c,sw}$, $z_{c,cross}$, and the current $z_{c,p}$, balancing between the actual boundary densities of Eq. (44) at 380,000 years, the switching-over densities of Eq. (46C), and prevailing density of Eq.(20)—are shown in Fig. 8 in unit of $\boldsymbol{\rho_t}$ = 1 to mask the effect of the space expansion.

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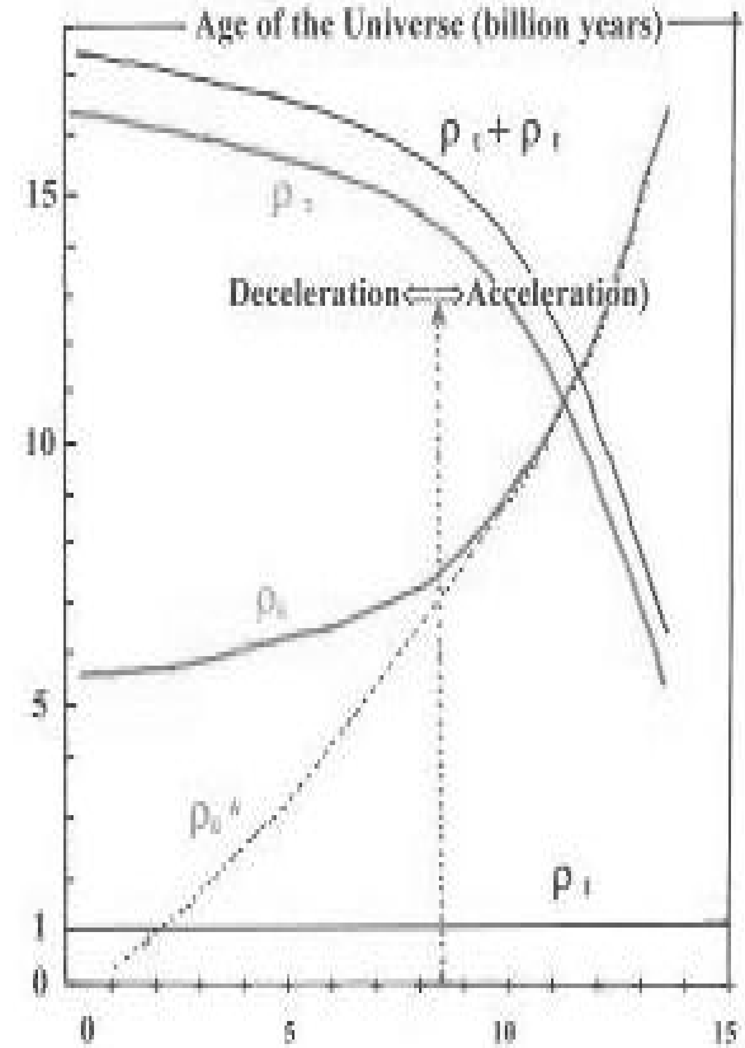

Fig. 8 Actual average densities in unit of $\rho_t = 1$

Because of the developing bent in time against the gravitational force superposition in the Einstein-Friedmann Equation (19) as discussed in §17, the dark energy density detected from Earth could be misidentified to be ρ_ε* (the dotted line in Fig.8), not the factual dark energy density ρ_ε (the solid line in Fig. 8). The dark energy density ρ_ε* thus closely matches the constant dark energy density $\rho_{\varepsilon,u}$ in Fig. 7. The difference between ρ_ε and ρ_ε* is conspicuous in the early age of the Universe. The spurious ρ_ε* grows close to the actual ρ_ε toward $z_{c,p} \approx z_{c,sw}$, in time becoming the same. This explains why

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the (dark) τ-zone energy has been misinterpreted, despite the very large vacuum catastrophe factor Q = O (10^{120}), to be the Cosmological Constant.

The density ratio, $\Gamma = \rho_\varepsilon / \rho_\tau$, in the primordial Universe is small, facilitating the structural formation in the early Universe. It progressively increases in the aging Universe, eventually toward $z_{c,p} \approx z_{c,sw} \approx 3.5 \times 10^3$ when the deceleration of the Universe's expansion changes to the cosmic acceleration at the Universe's age,

$$T(\omega_\varepsilon = -1.0) \approx 8.5 \text{ billion years} \tag{49}$$

as shown in Fig. 8. That compares with T (ω_ε = - 1.2) ≈ 9.2 billion years, and T(ω_ε = - 0.8) ≈ 7.25 billion years. The Eq.(49) in agreement with the observations [60; 61; 65] also substantiates the $\{\rho_{n\rfloor o}\}/\rho_{t\rfloor o}$ of Eq. (44) at the year 380,000.

The expansion of the Universe is not entirely regulated by the equation of state, but also is checked by the conservation of the τ-zone mass/energy in the Universe. Inconsistencies arise with relative overpopulation of ρ_τ for ω_ε < - 1.0 and of ρ_ε for ω_ε - > 1.0 at 380,000 year (see § 17).

19. Collisions of the Galaxies and Galaxy Clusters

In the collisions of galaxy clusters, the three main components in them—individual galaxies composed of billions of stars, gas in and between the galaxies, and the overlying dark matter and energy—were enmeshed in the interaction. The stars of the galaxies passed right through the collision, being gravitationally slowed but otherwise unaltered. The (ordinary) t-zone gas was slowed down by the force similar to the air resistance, the clouds of gas forming

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behind. In the Bullet Cluster [66], the (dark) τ-zone matter was not slow down by the impact and moved forward, obviously interacting mainly through gravitation.

With $z_{c,p} \approx O(10^4)$ and $v_{p,cc} \approx O(10^6$ m/sec), the observed galactic cluster collision speed [67], $T_{p,cc} \approx O(10^3$ eV) and thus $\eta \approx O(10^{-6}$ Ohm-m) from Eq.(39A). Despite of the extraordinarily large $z_{c,p}$, the τ-zone matter as plasma medium here in effect is collisionless.

In the Abell 520 [68], however, a certain portion of (dark) τ-zone matter appears to have remained in the middle of the clusters after collisions. The appearance of the Abel 520 after the clash also indicates a true galaxy cluster collision had taken place, as compared to the brief encounter-collision of the Bullet Cluster, which still carried the image of the original galaxy cluster.

The dark (τ-zone) matter components of the equal-sized high mass clusters in the Abell 520 collision could have participated in a concentrated high-speed head-on collision, intensifying the highly density-sensitive charge clumping in the course(see §9 and §17). The local resistivity η for the certain fraction of the τ-zone matter could have incidentally—thus yielding consequences that are statistically much less conspicuous—become substantial to enable the portion to interact like the visible (t-zone) matter.

Likely due to the prevailing dark matter and energy interactions, a similar shifting behavior is also observed as the settings are changed from the collisions of the galaxy clusters to the collisions of the galaxies—the low-velocity collisions between small and medium-sized galaxies [69] as compared with the collision between a large elliptical galaxy and a large spiral galaxy [70].

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20. Conclusion

Based on the symmetric affirmation of the basic principles of the quantum theory, all the matter and energy—including the dark matter and energy—are not only observable, but also interacting. The consequences are dramatic and far-reaching, providing the elucidation of the working mechanisms of the Universe.

A portion of the tour de force that upholds the basic correctness of the theory is listed in the Abstract. The incomprehensible cosmos has become comprehensible. The work is still in an early stage of development, but it provides a true and correct course toward the full understanding of the Universe. It is hoped that future exploratory efforts will proceed on broad collaborations.

Appendix A: Tangential Freedom and Quantum Partition

An observable particle is represented by a normalized wave packet, which is a superposition of plane waves. With this understanding, the wave packets can be represented by the characteristic plane wave eigenfunction with real eigen-momentum [1]. The wave packet for an observable particle with a (real quantity) momentum eigenvalue p_t in the t-zone is thus represented by,

$$\psi_t(x) = A \exp\left({ip_t x}/{\hbar} \right) \tag{A.1}$$

A corresponding observable particle with a (real quantity) momentum eigenvalue p_τ in the τ-zone is represented by,

$$\psi_\tau(x) = B \exp\left({ip_\tau x}/{\hbar} \right) \tag{A.2}$$

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If a particle in the τ-zone could be observable in the t-zone, it would manifest itself as a wave packet that can be represented by an eigenfunction with a (real quantity) eigenvalue $p_{\tau\to t}$,

$$\psi_{\tau\to t}(x) = C\ \exp\left(-ip_{\tau\to t}\, x/\hbar\right) \tag{A.3}$$

If a particle in the t-zone were to be observable in the τ-zone, it would manifest itself as a wave packet that can be represented by an eigenfunction with a (real quantity) eigenvalue $p_{t\to\tau}$,

$$\psi_{t\to\tau}(x) = D\ \exp\left(-ip_{t\to\tau}\, x/\hbar\right) \tag{A.4}$$

The Hermitean momentum operators P_t of Eq. (12) and P_τ of Eq. (15) in their respective time-zone yield the observable (real quantity) momentum eigenvalues, p_t and p_τ:

$$P_t\psi_t(x) \Rightarrow \left(\hbar/i\right)\partial\psi_t(x)/\partial x = p_t\psi_t(x) \text{ in the t-zone} \tag{A.5}$$

$$\textit{and}\quad P_\tau\psi_\tau(x) \Rightarrow \left(\hbar/i\right)\partial\psi_\tau(x)/\partial x = p_\tau\psi_\tau(x) \text{ in the } \tau\text{-zone} \tag{A.6}$$

The anti-Hermitean momentum operator $P_{t\to\tau}$ of Eq. (14) in

$$P_{t\to\tau}\psi_{t\to\tau}(x) \Rightarrow -\hbar\,\partial\psi_{t\to\tau}(x)/\partial x = ip_{t\to\tau}\psi_{t\to\tau}(x), \tag{A.7}$$

limits to the real quantity eigenvalue,

$$p_{t\to\tau} = 0 \tag{A.8}$$

The anti-Hermitean momentum operative $P_{\tau\to t}$ of Eq. (16) in

$$P_{\tau\to t}\psi_{\tau\to t}(x) \Rightarrow -\hbar\,\partial\psi_{\tau\to t}(x)/\partial x = ip_{\tau\to t}\psi_{\tau\to t}(x), \tag{A.9}$$

also limit to the real quantity eigenvalue,

$$p_{\tau\to t} = 0 \tag{A.10}$$

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The Eqs.(A.8) and (A.10) corroborate Eqs. (10) and (11) of §3, the necessary and sufficient conditions for the establishment of the quantum partition.

There are essential differences between the two cases, however. The Eqs. (10) and (11) are externally simulated with an infinite quantum potential barrier, while the Eqs.(A8) and (A.10) are the innate structural consequences of the dual-time zone transition free of interaction caused uncertainties.

To explicate the nature of the quantum partition in the dual-time physics, consider the matter wave in the LHS(**r**, τ)-zone,

$$\psi_\tau = \mathrm{A}\exp\left\{ i \left(E_\tau \tau - p_\tau \bullet r \right) \big/ \hbar \right\} \tag{A.11}$$

where $E_\tau = \mathrm{SQR}\{ (m_p c^2)^2 + (p_\tau c)^2 \}$ [71]. When the wave ψ_τ is viewed from the RHS (**r, t**)-zone, that is, $\tau \to it$:

$$\psi_{\tau\to t} = \mathrm{A}\exp\left\{ i \left(\mathrm{E}_{\tau\to t} (\tau \to it) - p_{\tau\to t} \bullet r \right) \big/ \hbar \right\} \tag{A.12}$$

From $p_{\tau\to t} = 0$ of Eq. (A.10), $E_{\tau\to t} = \mathrm{SQR}\{ (m_{p,cc} c^2)^2 + (p_{\tau\to t} c)^2 \} = m_{p,cc} c^2$ and $\Delta E_{\tau\to t} = p_{\tau\to t} c^2 \Delta p_{\tau\to t} / E_{\tau\to t} = 0$, yielding from the uncertainty principle for $\tau \to t$,

$$< \Delta t > \to \infty \tag{A.13}$$

For the τ-zone proton charge clumping of $z_{c,p}$, the ε and $m_{p,cc}$ can be determined, respectively, by Eq. (21), Eq. (24), and Eq. (25), yielding,

$$m_p \Rightarrow m_{p,cc} > 0 \text{ for } z_{c,p} < z_{c,p\_crit} \tag{A.14}$$

Equations (A.13) and (A.14) transform the wave of Eq.(A.12) into,

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$$\psi_{\tau \to t} = \mathrm{A} \exp\left\{ -\left[{m_{p,cc} c^2}/{\hbar} \right] < \Delta t > \right\}, \tag{A.15}$$

whereupon $\psi_{\tau \to t} \to 0$ with $< \Delta t > \to \infty$ of Eq. (13). The wave ψ_τ in the LHS (**r**, τ)-Universe fully reflects back to the (**r**, τ)-zone boomerang-like, leaving no trace of itself in the RHS (**r**, t)-Universe.

For the case of $p_{t \to \tau} = 0$ in $\psi_{t \to \tau}$, $E_{t \to \tau} = m_t c^2$ in terms of the t-zone mass m_t (extricated from the charge clumping), and $\Delta E_{t \to \tau} = p_{t \to \tau} c^2 \Delta p_{t \to \tau} / E_{t \to \tau} = 0$. Thus,

$$< \Delta \tau > \to \infty \tag{A.16}$$

also rendering the wave to,

$$\psi_{t \to \tau} = A \exp\left\{ -\left[m_t {c^2}/{\hbar} \right] < \Delta \tau > \right\} \to 0 \tag{A.17}$$

The ψ_t(**r**, t) in the RHS (**r**, t)-Universe fully reflects back boomerang-like to the (**r**, t)-zone. The dual-time physics with non-vanishing mass of $m_{p,cc} > 0$ (or $m_t > 0$) establish the quantum partition between the RHS Universe and LHS Universe, without an intimation of the external quantum potential barrier simulated in §3. The antiHermitean momentum operators, the tangential derivatives in the physical (real) space, equip the dual time physics with the innate quantum partition that fully reflects the waves back to their original Universes in "Tangential Freedom" as shown in Fig. 3. The photons, as non-vanishing mass pairs [see Eq.(18)], would submit to the quantum partition.

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Appendix B. The Quantum Partition Free Window

Based on the approximation of Eq. (21), as the τ-zone charge $z_{c,p}$ of the charge clumped fleck in space increases towards $z_{c,p}\rfloor_{crit}$, $\varepsilon \rightarrow m_p$, and thus [see Eq.(25)]

$$\left(m_p\right)_{cc} \rightarrow 0 \qquad \text{(B.1)}$$

yielding $T_{p,\,cc} \rightarrow 0$ from Eq. (39B). That gives through Eq. (39A),

$$\eta \rightarrow \infty \qquad \text{(B.2)}$$

On the other hand, the uncertainty principle with $(m_p)_{cc} \rightarrow 0$ of Eq. (B.1) gives,

$$v_{eff} \approx \Delta x / \Delta t \approx p_\tau \, c^2 \Big/ \left[\left\{\left(m_p\right)_{cc} c^2\right\}^2 + \left\{p_\tau c\right\}^2\right]^{1/2} \rightarrow c \qquad \text{(B.3)}$$

This creates highly charged massless τ-zone particles that are inordinately interactive, moving at the speed of the light.

Eqs. (A.10) and (B.1) cause a disintegration of the exponent $[E_{\tau\rightarrow t}(\tau \rightarrow it) - \mathbf{p}_{\tau\rightarrow t} \bullet \mathbf{r}]/\hbar$] and $\psi_{\tau\rightarrow t}$ of Eq. (A. 12) transits into,

$$\psi_{\tau\rightarrow t} = A = \text{a non-vanishing constant} \qquad \text{(B.4)}$$

with the once impenetrable quantum partition collapsing! The LHS (τ-zone) Universe ($U_\tau > 0$) would devolve to the RHS (t-zone) Universe ($U_t < 0$), the energetics bolstered by the (τ→t) -zonal energy shift of $U_{\tau\rightarrow t} = U_\tau + |U_t|$. The wave ψ_τ, bypassing the wave $\psi_{\tau\rightarrow t}$, simply steps down to ψ_t, i.e.,

$$\psi_\tau \rightarrow \psi_t = A \exp\left\{ i \left(p_t c t - p_t \bullet r\right) \Big/ \hbar \right\} \qquad \text{(B.5)}$$

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This may cause various type of catastrophic explosions, being actually observed but unexplainable in terms of the conventional interactions. Only in the indomitable collapse into the super-density cores where the gravity skirts the singularity, the charge clumping may continue to move on to $z_{c,p} > z_{c,p}\rfloor_{crit}$ and $m_{p,cc} < 0$, bypassing the quantum partition free window. The quantum partition is re-established in terms of the conjugate wave:

$$\psi^*_{\tau\to t} = A\ \exp\left\{+\left[m_{p,cc}c^2 \big/ \hbar \right] < \Delta t > \right\} \tag{B.6}$$

Similarly, the big-bang explosion begins in $z_{c,f} >> z_{c,f}\rfloor_{crit}$ and $|m_{f,cc}| >> m_f$ for $m_{f,cc} < 0$, with the quantum partition in effect in terms of the conjugate wave with $m_{p,cc} \Rightarrow m_{f,cc}$.

Appendix C: The τ-zone Coulomb Potential

Consider a proton-electron system in the {**r**(x,y,z), t}-zone of the RHS Universe. The Schrödinger equation is derived with the Hermitean momentum operators $P_{t,\nu} \Rightarrow (\hbar/i)\,\partial/\partial\nu$ of Eq. (12), where $\nu = (x, y, z)$:

$$-\frac{\hbar^2}{2\mu}\nabla^2\psi_t + V^{p-e}{}_t\psi_t = \mathrm{E}_t\psi_t \tag{C.1}$$

with the attractive proton-electron Coulomb potential in the t-zone, $V^{p-e}{}_t = -\,e^2 / r$, and the negative (bound) energy E_t.

The Schrödinger equations for the proton-electron interaction in the {**r**(x,y,z),τ }-zone of the LHS Universe is determined by applying the τ-zone Hermitean operators, $P_{\tau,\nu} \Rightarrow (\hbar/i)\,\partial/\partial\nu$ of Eq. (15), where $\nu = (x, y, z)$:

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$$-\frac{\hbar^2}{2\mu}\nabla^2\psi_\tau + V^{p-e}{}_\tau\psi_\tau = \mathrm{E}_\tau\psi_\tau \qquad \text{(C.2)}$$

Here, $V^{p-e}{}_\tau$ is the proton-electron Coulomb potential in the τ-zone.

Eq. (C.2) can also be derived by projecting the proton-electron interaction through the tangential (t → τ) window with the anti-Hermitean operators, $P_{t\to\tau,\,\nu} \Rightarrow -\hbar\,\partial/\partial\nu$ of Eq. (14), where ν = (x, y, z):

$$\frac{\hbar^2}{2\mu}\nabla^2\psi_\tau + V^{p-e}{}_t\psi_\tau = \mathrm{E}_{t\to\tau}\psi_\tau \qquad \text{(C.3)}$$

Eq. (C.3) gives no proton-electron bound state, the negative (attractive) potential in effect becoming positive (repulsive). Because $p_{t\to\tau} = 0$ in tangential freedom (see Fig. 4) across the quantum partition, the $E_{t\to\tau}(p_{t\to\tau} = 0)$ from the negative (bound) energy E_t state of Eq. (C.1) in the t-zone shifts its sign along with the potential into $-E_{t\to\tau}(p_{t\to\tau} = 0) \Rightarrow E_\tau$, which is a positive (unbound) state of Eq. (C.2) in the τ-zone. Thus, Eq. (C.3) recasts into,

$$-\frac{\hbar^2}{2\mu}\nabla^2\psi_\tau + \left(-V^{p-e}{}_t\right)\psi_\tau \Rightarrow \mathrm{E}_\tau\psi_\tau \qquad \text{(C.4)}$$

By comparing Eq. (C.2) with Eq.(C.4),

$$V^{p-e}{}_\tau \Rightarrow -V^{p-e}{}_t = +e^2/r \qquad \text{(C.5)}$$

that is, the signs of the potential are inverted.

In the transition from one time-zone to the other, the interaction signs also are inverted in the proton-proton and electron-electron Coulomb potentials:

$$V^{p-p}{}_\tau \Rightarrow -V^{p-p}{}_t = -e^2/r, \text{ and } V^{e-e}{}_\tau \Rightarrow -V^{e-e}{}_t = -e^2/r \qquad \text{(C.6)}$$

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In a simple premise of symmetry, the elemental charge "e" shall be taken to be the same in both the RHS and LHS Universes. Eqs.(C.5) and (C.6) for the Coulomb potentials provide dynamics indispensable for the development of the Universe from the big-bang to the prevailing state of today.

Appendix D. The Scalar Field Dark Energy

The τ-zone matter spreading out into the voluminous halos of the galaxies and galaxy clusters is a perpetual collisionless plasma medium in which the long-range electromagnetic forces are so much stronger than the forces due to ordinary local collisions; the latter can be neglected by comparison especially in the early Universe. The motion of the plasma in collective behavior depends not only on the local condition, but on the state of *the plasma in remote regions as well, behaving as if it had a mind of its own, without tending to conform to external influences* [62].

The τ-zone radiation is more particle-like than the t-zone radiation [see Eq. (18)], and it would gain more energy being accelerated into the galaxies than through the deceleration outward in the expanding Universe. Any τ-zone energy that might have been lost due to the space dilation could be recouped in this incessant motion through the galaxies and galaxy clusters. Moreover, with the $z_{c,p}$ increasing with the expansion of the Universe, the τ-zone (radiation) energy continually grows through the age of the Universe. As the temperature (heat) arising from the internal energy of the trapped particles manifests a scalar field, the trapped τ-zone (radiation) energy permanently coupling with the τ-zone plasma matter would simulate a scalar field.

The matter and energy dilate in the scale of $s^{-3(1+\omega n)}$, where ω_n is the respective equation of state [72]. The t-zone matter thus dilates in s^{-3} with $\omega_n = \omega_t = 0$. The τ-zone matter also dilates in s^{-3} with $\omega_n = \omega_\tau$

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= 0 . The trapped τ-zone (radiation) energy with equation of state $\omega_{\varepsilon,\tau} \Rightarrow \omega_\varepsilon = -1.0$ yields $s^{-3(1+\omega n)} = s^0$, where $\omega_n = \{\omega_\tau\} + \omega_\varepsilon = -1.0$ against the τ-zone matter milieu. The τ-zone (radiation) energy in the form of repulsing scalar field is not the vacuum fluctuation energy, but by and large simulates the cosmological constant.

The t-zone (radiation) energy of the vector field that has decoupled early from the t-zone matter and propagates independently with equation of state $\omega_n = \{\omega_t\} + \omega_{\varepsilon,t} = 1/3$ with $\omega_{\varepsilon,t} = 1/3$, yields s^{-4}. The $E = m c^2$ had generalized the conservation law of the total dynamical energy into that of the total mass + dynamical energy. Despite of the ambivalance, the red-shifted t-zone (radiation) energy in the expanding Universe, being discerned in proper perspective, is also conserved [73], fully upholding the energy conservation law in the Universe [also see § 13].

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