The History of The Cosmos; From The Big-Bang to The Present-Epoch

Riccardo C. Storti[1]

Abstract — In 2007, *Storti* predicted that the value of the **C**osmic **M**icrowave **B**ackground **R**adiation (CMBR) Temperature may be improved by one-order-of-magnitude; from the **P**article **D**ata **G**roup (PDG) value of [T_0 = 2.725 ± 0.001 (K)] to [T_0 = 2.7254 (K)]. In 2011, the PDG revised their value of CMBR to [T_0 = 2.7255 ± 0006 (K)]; confirming Storti's prediction. In 2008, *Storti* predicted a Λ_{CDM} Hubble Constant of [H_0 = 67.0843 (km/s/Mpc)]. In the same year, the PDG published their value as being [H_0 = 73 ± 3 (km/s/Mpc)]. In 2013 the PDG published a revised value of [H_0] distributed via the **P**lanck **C**ollaboration (PC) utilizing the **P**lanck **S**atellite (PS) as being considerably lower [H_0 = 67.3 ± 1.2 (km/s/Mpc)]; again confirming Storti's prediction. These predictions & experimental confirmations, in particular the value of [H_0] being successfully predicted five (5) years in advance of the PC & without PS instrumentation, demonstrates the power of the technique applied; *i.e.* the **E**lectro-**G**ravi-**M**agnetic (EGM) **P**hoton **R**adiation **M**ethod (PRM). Herein, we utilize the EGM-PRM technique {*constrained by the present value of CMBR* [T_0 = 2.7255 (K)]} to calculate the present values of: (*i*) the Λ_{CDM} Hubble Constant [H_0 = 67.1181447977434 (km/s/Mpc)] {*whereas the PDG-2022 value is* [H_0 = 67.4 ± 0.5 (km/s/Mpc)]}, (*ii*) the Dark Energy Density Parameter [Ω_Λ = 0.677345709533812] {*whereas the PDG-2022 value is* [Ω_Λ = 0.685 ± 0.007]}, (*iii*) the Pressureless Matter Parameter [Ω_m = 0.322654290466188] {*whereas the PDG-2022 value is* [Ω_m = 0.315 ± 0.007]}, (*iv*) the Deceleration Parameter [q_0 = −0.338672854766906] {*whereas a PDG-2022 value is not specified*} & (*v*), the Cosmological Constant [Λ = 0.789639109726698 •10^{-56} (cm^{-2})] {*whereas the PDG-2022 value is* [Λ = 1.088 •10^{-56} (cm^{-2})]}. The EGM-PRM is subsequently utilized to describe the complete History of The Cosmos from the instant of The Big-Bang to the Present-Epoch; in complete agreement with the **S**tandard **M**odel **o**f **C**osmology (SMoC) & compliant with all currently available experimental observations. In addition, **C**osmological **I**nflation (CI) & **A**ccelerated **C**osmological **E**xpansion (ACE) are derived organically, demonstrating that CI ceased by approximately [t = 7.8793484858429 •10^{-23} (s)] & *apparent* ACE [q = 0] commenced at approximately [t = 9.63456829206598 (Gyr)]; in precise agreement with the *Frieman et. al*. {FermiLab: 2008} determination of [~ 10 (Gyr)]. We also demonstrate that the PDG-ACE 2019-2022 "*age when acceleration was zero*" value of [7.7 (Gyr)] denotes a misinterpretation of results; that is, the PDG misinterpret [Λ = 0] for [q = 0] at [7.7 (Gyr)]. Subsequently, we assert that the PDG value proximally corresponds to our determination that [Λ = 0] at [t = 7.28426797653236 (Gyr)].

Keywords — CMBR, Cosmological Acceleration, Cosmological Constant, Λ_{CDM} Hubble Constant, Dark Energy, Dark Energy Density Parameter, Dark Matter, Deceleration Parameter, Pressureless Matter Parameter.

I. INTRODUCTION

THE central tenet in the **S**tandard **M**odel **o**f **C**osmology (SMoC) is **G**eneral **R**elativity (GR). Since its appearance, GR has replaced Newtonian Gravitation as the Cosmological Instrument of choice. GR successfully predicted the existence of **B**lack **H**oles (BH's), decades prior to their experimental confirmation; hence (*for this & other reasons*), GR is often touted as a 'well tested' theory. However, this view should be balanced against the fact that GR failed to predict the existence of **A**ccelerated **C**osmological **E**xpansion (ACE). Considering that GR introduced the concept of Space-Time to Physics, failing to predict Accelerated Space-Time Expansion is no minor oversight. Moreover, arguments may be positioned such that, if GR successfully predicted the missing mass associated with BH's, it should also have predicted the existence of other forms of missing Mass-Energy such as Dark Matter &/or Dark Energy. Since Baryonic Mass only occupies approximately 5-6% of **T**otal **C**osmological **M**ass (TCM), insisting that GR is 'well tested' appears to be somewhat of an obtuse perspective when 94-95% of TCM evaded prediction. In addition, the persistent fact that GR doesn't integrate seamlessly & convincingly into any widely accepted **Q**uantum **M**echanical **M**odel (QMM) reinforces the assertion that GR is incomplete. Evidence confirming this assertion has been published utilizing The **P**olarizable-**V**acuum (PV) Model of Gravity[2] to capture & correct a flaw in the SMoC [1]. Consequently, we also assert that GR is incomplete at the Cosmological Scale.

The preceding comments should not be perceived as slights against GR, rather, they represent 'alerts' for relying too heavily upon a single theory; implying that caution should be exercised when navigating Cosmological History exclusively utilising GR as a Cosmological Compass; particularly so in the absence of QMM integration. To help put this into perspective, we shall ask a 'big question':

- Is a *single* widely accepted gravitational model reliable enough to adequately describe **The History of The Cosmos;** From The Big-Bang to The Present-Epoch?

To digest this 'big question', we shall first metabolize a 'smaller question':

- If a foot-mounted expedition team sought to trek through a sparsely inhabited area (*e.g. the Siberian forest*) bound for Moscow; how many correctly functioning handheld **G**lobal **P**ositioning **S**ystem (GPS) Units[3] would the expedition team require at the start of their journey in order to safely execute the trek?

Answer = Three (3):

- Two GPS Units are utilised for navigation; it may prove fatal to rely upon a single GPS Unit. Hence, a third GPS Unit is required to determine which one of the first two GPS Units may be faulty.

Similarly, if the expedition embarkation point represents the Present-Epoch & the destination represents the Big-Bang, it

[1] Chief Engineer, Delta Group Engineering (dgE), Melbourne, Australia: (rstorti@gmail.com).

[2] A stand-alone optically-derived alternative to GR.

[3] Also applicable to GLONASS & GALILEO variants.

becomes apparent that navigating Cosmological History utilising a single *Cosmological Scale* Gravitational Model is possible, but risky because no widely accepted failover presently exists[4] to compensate for any potential inadequacies inherently embedded within GR.

In stark contrast, many research communities utilise multiple scientific principles to quantify temperature, so why does Cosmology rely so heavily upon a single scientific principle (GR) to describe **The History of The Cosmos;** From The Big-Bang to The Present-Epoch? Possibly, at least in part, this reliance may be due to overconfidence in the notion of GR being 'well tested'. However, this notion is open to challenge & the latitude for considering multiple Cosmological models becomes self-evident. To this end, we develop a convergent solution in accordance with the following strategy:

1. {1st GPS Unit} = GR.
2. {2nd GPS Unit} = The PV Model of Gravity; a stand-alone optically-derived alternative to GR [2].
3. {3rd GPS Unit} = The **E**lectro-**G**ravi-**M**agnetic (EGM) construct[5] [3]; a quantised mathematical interface between the {2nd GPS Unit} & **Z**ero-**P**oint-**F**ield (ZPF) Theory [a branch of **Q**uantum **F**ield **T**heory (QFT)].

One of the numerous issues our strategy resolves relates to the significant contradiction between key authoritative information sources. The Epoch when **Ap**parent **C**osmological **A**cceleration (ApCA) commenced (q = 0) according to *Frieman et. al*. [4], [5], conflicts dramatically with the **P**article **D**ata **G**roup (PDG) [6], as follows:

TABLE I
Frieman vs. PDG vs. Storti

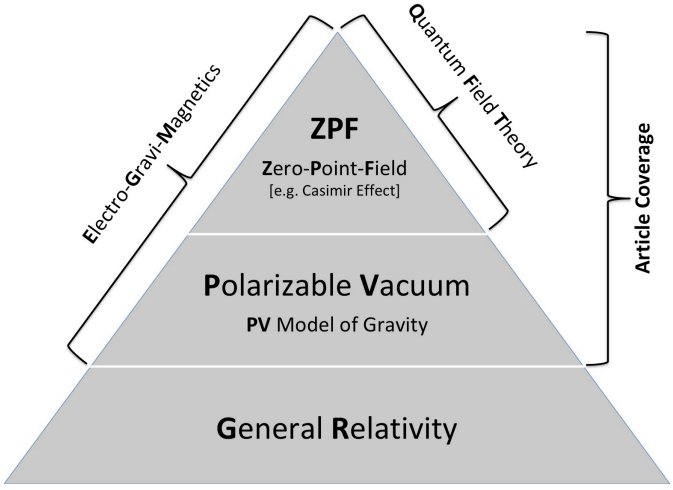
Frieman [FermiLab: 2008] (q = 0) at ~ 10 (Gyr)	**PDG [2019-2022]** (q = 0) at 7.7 (Gyr)
Storti	
Cosmological Parameter	Cosmological Age
Λ = -2.22376857629328 •10^{-51} (cm^{-2}) Ω_Λ = -20.3663665048511 Ω_M = 21.3663665048511 q = 42.7934922366636 H = 4.44141364417471 •10^{3} (km/s/Mpc) T = 27.1485657602659 (K)	220 (Myr) [7] Approximate Observational Limit of James Webb Space Telescope (JWST)
Λ = -2.10642093369767 •10^{-53} (cm^{-2}) Ω_Λ = -3.70060063106724 Ω_M = 4.70060063106724 q = 8.63456829206598 H = 977.367413495266 (km/s/Mpc) T = 11.8385613648457 (K)	1 (Gyr)
Λ = -2.52684515112544 •10^{-55} (cm^{-2}) Ω_Λ = -0.290617161864751 Ω_M = 1.29061716186475 q = 1.64530858093238 H = 268.409597017716 (km/s/Mpc) T = 5.82842830809797 (K)	3.64213398826618 (Gyr)
Λ = 0 Ω_Λ = 0.354691419067625 Ω_M = 0.645308580932375 q = 0.322654290466188 H = 134.220589740631 (km/s/Mpc) T = 3.98569741894682 (K)	**7.28426797653236 (Gyr)** Proximal agreement with: PDG [2019-2022] = 7.7 (Gyr)
Λ = 0.880880602181968 •10^{-56} (cm^{-2}) Ω_Λ = 0.512110923025149 Ω_M = 0.487889076974851 **q = 0** H = 101.483006965613 (km/s/Mpc) T = 3.41912708997334 (K)	**9.63456829206598 (Gyr)** Proximal agreement with: Frieman [FermiLab: 2008] ~ 10 (Gyr)
Λ = 0.935868574490902 •10^{-56} (cm^{-2}) Ω_Λ = 0.569794279378417 Ω_M = 0.430205720621583 q = -0.118230473022542 H = 89.4865230672685 (km/s/Mpc) T = 3.19119125008962 (K)	10.9264019647985 (Gyr)
Λ = 0.789639109726698 •10^{-56} (cm^{-2}) Ω_Λ = 0.677345709533812 Ω_M = 0.322654290466188 q = -0.338672854766906 H = 67.1181447977434 (km/s/Mpc) T = 2.7255 (K)	Present-Epoch [1] 14.5685359530647 (Gyr)
Λ = 1.99238131202798 •10^{-81} (cm^{-2}) Ω_Λ = 0.999999999999885 Ω_M = 1.14602568513654 •10^{-13} q = -0.999999999999765 H = 23.9423691019193 (nm/s/Mpc) T = 398.834623345483 (nK)	Distant Future 4.10165382157836 •10^{13} (Gyr)

Nomenclature: [Λ] Cosmological Constant, [Ω_Λ] Dark Energy Density Parameter, [Ω_M] Pressureless Matter Parameter, [q] Deceleration Parameter, [H] Λ_{CDM} Hubble Constant, [T] CMBR

Key Points:

1. Frieman *correctly* identifies when (q = 0).
2. The PDG misidentify (Λ = 0) as (q = 0).
3. The Frieman vs. PDG conflict is resolved.
4. [Λ], [Ω_Λ], [Ω_M], [q], [H] & [T] are not constants.

The Solution Architecture utilized to formulate [Tab. I] - appears in [Fig. 1] - illustrating that GR establishes the foundation upon which is placed the PV Model of Gravity. The pyramid is crowned with ZPF Theory, incorporating the Quantum Mechanical attributes associated with the vacuum occupying the Cosmological Space-Time Manifold. This **Q**uantum **V**acuum (QV) association has been well explored by *Haisch*, *Rueda*, *Puthoff* & *Dobyns* [8]-[12]. In order to facilitate integration between PV & ZPF Theory, the EGM construct is utilized; analogous to the procedure defined by *Storti* [13]. The complete Solution Algorithm pertaining to this article is available in PDF [14].



[Fig. 1] Solution Pyramid

[4] Including **Mo**dified **N**ewtonian **D**ynamics (MoND) Theory.
[5] Engineering methodology equilibrating the PV Model of Gravity to the ZPF.

II. METHODOLOGY & CONSTANTS

From the Solution Architecture described in the preceding section, a suite of equations are derived to completely articulate **The History of The Cosmos;** From The Big-Bang to The Present-Epoch. However at this juncture, it is important to identify the impracticality of including the detailed derivation of all equations contained herein due to submission length limitations; several text books & numerous scholarly articles have been published containing all derivations in stepwise detail[6]. Notably, *all* equations & declared constants (H_Φ, μ, λ_x, H_α) have been forwardly derived from first principles & no Reverse Engineering, ad-hoc action, Fine Tuning or 'convenient problem solving' has been undertaken to guide or produce results. The list of physical & mathematical constants utilized herein appear as follows:

- **N**ational **I**nstitute of **S**tandards & **T**echnology (NIST)[7]
  $c = 2.99792458 \cdot 10^{8}$ (m/s)
  $G = 6.6743 \cdot 10^{-11}$ ($m^3/kg/s^2$)
  $h = 6.62607015 \cdot 10^{-34}$ (J/Hz)
- **P**article **D**ata **G**roup (PDG) [6]
  $M_\odot = 1.98841 \cdot 10^{30}$ (kg)
- Planck Frequency
  $\omega_h = \sqrt{\frac{c^5}{Gh}}$ $\omega_h = 7.3998153159224 \cdot 10^{42}$ (Hz)
- Λ_{CDM} Constants [1]
  $H_\Phi = 67.1181447977434$ (km/s/Mpc)
  $t_\Phi = 14.5685359530647$ (Gyr)
  $\Omega_\Phi = 0.677345709533812$
  $\Omega_m = 0.322654290466188$
  $\Omega_K = 0.000654290466188$
- Λ_{CDM} Constants [14]: [pg. 6]
  $\Omega_c = 0.262875350332401$
  $\Omega_b = 0.059778940133786$
- Cosmological Constant [14]: [pg. 34]
  $\Lambda_\Phi = 0.789639109726698 \cdot 10^{-56}$ (cm^{-2})
- Cosmological Mass (*Total*) [14]: [pg. 7]
  $M_\Phi = \frac{c^3}{2GH_\Phi}$ $M_\Phi = 4.66692747982406 \cdot 10^{22}$ ($M_\odot$)
- Cosmological Mass (*Dark Energy*) [14]: [pg. 64]
  $\Omega_\Phi \cdot M_\Phi = 3.16112330516428 \cdot 10^{22}$ ($M_\odot$)
- Cosmological Mass (*Cold Dark Matter*) [14]: [pg. 64]
  $\Omega_c \cdot M_\Phi = 1.22682019623466 \cdot 10^{22}$ ($M_\odot$)
- Cosmological Mass (*Baryonic Matter*) [14]: [pg. 64]
  $\Omega_b \cdot M_\Phi = 2.78983978425125 \cdot 10^{21}$ ($M_\odot$)
- Hubble Radius [14]: [pg. 7]
  (*Hubble Length, Schwarzschild Radius*)
  $R_\Phi = \frac{2GM_\Phi}{c^2}$ $R_\Phi = 14.5685359530647$ (GLyr)
- Observational Radius [14]: [pg. 48, 60]
  $\pi \cdot R_\Phi = 45.7684055237069$ (GLyr)
- Observable Universe [14]: [pg. 48, 60]
  $2\pi \cdot R_\Phi = 91.5368110474138$ (GLyr)
- Critical Density [14]: [pg. 7, 24, 26, 58, 64]
  $\rho_\Phi = \frac{3H_\Phi^2}{8\pi G}$ $\rho_\Phi = 8.46163851959276 \cdot 10^{-27}$ (kg/m^3)
- 1st EGM Constant (*assigned value*)
  $\mu = \frac{1}{3}$
- 2nd EGM Constant [15]: [pg. 327-328]
  $\lambda_x = 4\sqrt{\frac{2\mu}{\pi\mu}}$ $\lambda_x = 2.69870895208366$
- Big-Bang Hubble Constant [15]: [pg. 343-344]
  $H_\alpha = \frac{\omega_h}{\lambda_x} = \frac{1}{t_\alpha}$ $H_\alpha = 8.46087689814736 \cdot 10^{61}$ (km/s/Mpc)
- Cosmological Time Constant [14]: [pg. 58]
  $t_{\Phi\rho} = \sqrt[3]{\frac{1}{H_\Phi H_\alpha^2}}$ $t_{\Phi\rho} = 3.93967424292145 \cdot 10^{-23}$ (s)

III. COMPARING COSMOLOGIES

A Present-Epoch comparison between the EGM Construct & the SMoC, exhibits significant synergy; with the exception of Cosmological Age as explained by *Storti* [1]. The EGM Construct [14] offers corrections to greater than 23% of the data published by The **P**article **D**ata **G**roup (PDG) [6]. *Most importantly*, the corrections generated by the EGM Construct are constrained by **C**osmic **M**icrowave **B**ackground **R**adiation (CMBR); unlike PDG data. Consequently, the constraint of a substantial portion of PDG data to the CMBR is an extraordinary development for the SMoC.

TABLE II
Electro-**G**ravi-**M**agnetics (EGM) vs. **S**tandard **M**odel **o**f **C**osmology (SMoC)

	EGM	**PDG-2022**
1	$H_\Phi = 67.1181447977434$ (km/s/Mpc)	$H_0 = 67.4$ (km/s/Mpc)
2	$t_\Phi = 14.5685359530647$ (Gyr)	$t_0 = 13.797$ (Gyr)
3	$\Omega_\Phi = 0.677345709533812$	$\Omega_\Lambda = 0.685$
4	$\Omega_m = 0.322654290466188$	$\Omega_m = 0.315$
5	$\Omega_c = 0.262875350332401$	$\Omega_c = 0.265$
6	$\Omega_b = 0.059778940133786$	$\Omega_b = 0.0493$
7	$\Omega_K = 0.000654290466188$	$\Omega_K = 0.0007$
8	$\rho_\Phi = 8.46163851959276 \cdot 10^{-27}$ (kg/m^3)	$\rho_{crit} = 8.53286 \cdot 10^{-27}$ (kg/m^3)
9	$\rho_\Lambda = 5.73145454687219 \cdot 10^{-30}$ (gm/cm^3)	$\rho_\Lambda = 5.83 \cdot 10^{-30}$ (gm/cm^3)
10	$n_\gamma = 410.726847902135$ (cm^{-3})	$n_\gamma = 410.73$ (cm^{-3})
11	$\rho_\gamma = 0.260570578238883$ (eV/cm^3)	$\rho_\gamma = 0.260$ (eV/cm^3)
12	$\eta = 7.35787809937048 \cdot 10^{-10}$	$\eta = 6.14 \cdot 10^{-10}$
13	$n_b = 3.02207807900259 \cdot 10^{-7}$ (cm^{-3})	$n_b = 2.515 \cdot 10^{-7}$ (cm^{-3})
14	$\Omega_\gamma = 5.48958983118303 \cdot 10^{-5}$	$\Omega_\gamma = 5.38 \cdot 10^{-5}$
15	$R_\Phi = 14.5685359530647$ (GLyr)	$c/H_0 = 14.502$ (GLyr)
16	$\Lambda_S = 6.33200653109817 \cdot 10^{51}$ (m^2)	$\Lambda_S = 6.28 \cdot 10^{51}$ (m^2)
17	$\Lambda_\Phi = 0.789639109726698 \cdot 10^{-56}$ (cm^{-2})	$\Lambda = 1.088 \cdot 10^{-56}$ (cm^{-2})

Nomenclature: [H_Φ, H_0] Λ_{CDM} Hubble Constant, [t_Φ, t_0] Cosmological Age, [Ω_Φ, Ω_Λ] Dark Energy Density Parameter, [Ω_m] Pressureless Matter Parameter, [Ω_c] Cold Dark Matter Density Parameter, [Ω_b] Baryon Density Parameter, [Ω_K] Curvature, [ρ_Φ, ρ_{crit}] Critical Density, [ρ_Λ] Energy Density of Dark Energy, [n_γ] CMBR Photon Number Density, [ρ_γ] CMBR Photon Density, [η] Baryon-to-Photon Ratio, [n_b] Baryon Number Density, [Ω_γ] CMBR Density of the Universe, [R_Φ] Hubble Radius (*Length*) (*Schwarzschild Radius*), [Λ_S] Scaling for Cosmological Constant, [Λ_Φ, Λ] Cosmological Constant

[6] https://scholar.google.com.au: Riccardo C. Storti.
[7] https://physics.nist.gov/cuu/Constants/.

IV. COSMOLOGICAL CALENDAR

TABLE III
Cosmological Calendar of Events

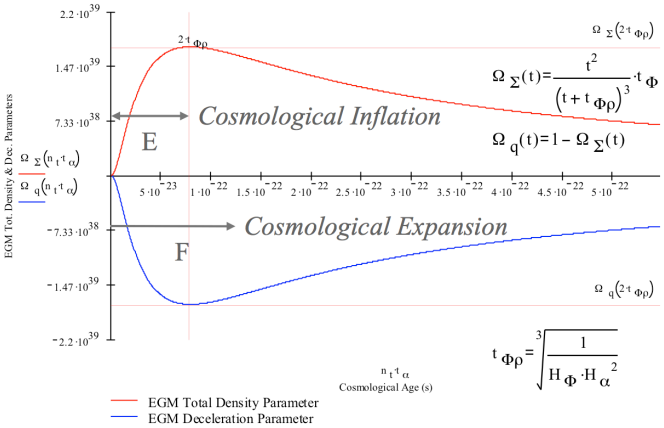
- **1st Event** (Big-Bang)
  - $H_\alpha = 8.46087689814736 \cdot 10^{61}$ (km/s/Mpc)
  - $\Lambda = 1.25481446197314 \cdot 10^{64}$ (cm^{-2})
  - $[t_\alpha = 1/H_\alpha] = 3.64699500847915 \cdot 10^{-43}$ (s)
  - T = 0 (K)
- **2nd Event** ($\Lambda = 0$)
  - $\sqrt{2} \cdot t_\alpha = 5.1576298028982 \cdot 10^{-43}$ (s)
  - $T = 1.37954687987071 \cdot 10^{31}$ (K)
- **3rd Event** (Maximum Cosmological Temperature)
  - H = 0 (km/s/Mpc)
  - $\Lambda = -1.18624205780952 \cdot 10^{64}$ (cm^{-2})
  - $t_1 = 2.20630341057726 \cdot 10^{-42}$ (s)
  - $T_{Max} = 3.19549736932411 \cdot 10^{31}$ (K)
  - Actual Cosmological Acceleration Commences
- **4th Event** (Maximum Hubble Constant after 3rd Event)
  - $H_{Max} = 7.56269951315196 \cdot 10^{60}$ (km/s/Mpc)
  - $\Lambda = -1.23585741192738 \cdot 10^{64}$ (cm^{-2})
  - $t_2 = 4.19618421889086 \cdot 10^{-42}$ (s)
  - $T = 3.03430237848861 \cdot 10^{31}$ (K)
- **5th Event** (Cosmological Inflation Ceases)
  - $\Lambda = -4.64746097027082 \cdot 10^{62}$ (cm^{-2})
  - $2 \cdot t_{\Phi\rho} = 7.8793484858429 \cdot 10^{-23}$ (s)
  - $T = 1.14034359584969 \cdot 10^{22}$ (K)
- **6th Event** (Dark Energy Redshift = 0) [$z_\Lambda = 0$]
  - ➢ From this instant, Dark Energy commences influencing Cosmological Age calculations executed within the **S**tandard **M**odel **o**f **C**osmology (SMoC). However, this flaw has been captured & corrected [1]
  - $\Lambda = -8.33809806581153 \cdot 10^{-56}$ (cm^{-2})
  - $t_{\Lambda\Lambda} = 4.70060063106724$ (Gyr)
  - $T = 5.06763484690411$ (K)
- **7th Event** (*Pressureless Matter Parameter = Deceleration Parameter*)
  - $\Lambda = -6.55880817006801 \cdot 10^{-56}$ (cm^{-2})
  - $t_M = 4.93396766099874$ (Gyr)
  - $T = 4.93478316528$ (K)
- **8th Event** ($\Lambda = 0$)
  - $\frac{1}{2} \cdot t_\Phi = 7.28426797653236$ (Gyr)
  - $T = 3.98569741894682$ (K)
- **9th Event** (*Dark Energy Density Parameter = Deceleration Parameter*)
  - $\Lambda = 0.650672352266949 \cdot 10^{-56}$ (cm^{-2})
  - $t_\Lambda = 8.45941813429917$ (Gyr)
  - $T = 3.67189222792196$ (K)
- **10th Event** (q = 0)
  - $\Lambda = 0.880880602181968 \cdot 10^{-56}$ (cm^{-2})
  - $t_q = 9.63456829206598$ (Gyr)
  - $T = 3.41912708997334$ (K)
- **11th Event** (*Maximum positive value since 2nd Event*)
  - $\Lambda = 0.935868574490902 \cdot 10^{-56}$ (cm^{-2})
  - $\frac{3}{4} \cdot t_\Phi = 10.9264019647985$ (Gyr)
  - $T = 3.19119125008962$ (K)
- **12th Event**
  - ➢ *Dark Energy Density Parameter = Pressureless Matter Parameter*
  - $\Lambda = 0.915258960009848 \cdot 10^{-56}$ (cm^{-2})
  - $t_{\Lambda M} = 11.9848686075996$ (Gyr)
  - $T = 3.03343411286503$ (K)
- **13th Event** (*Present-Epoch*)
  - $\Lambda = 0.789639109726698 \cdot 10^{-56}$ (cm^{-2})
  - $[t_\Phi = 1/H_\Phi] = 14.5685359530647$ (Gyr)
  - $T = 2.7255$ (K)
- **14th Event** (*Distant Future*)
  - $\Lambda = 1.99238131202798 \cdot 10^{-81}$ (cm^{-2})
  - $T_L = 4.10165382157836 \cdot 10^{13}$ (Gyr)
  - $T = 398.834623345483$ (nK)

V. COSMOLOGICAL PHASES

Throughout the history of science, most theories have undergone an evolutionary process. The same is true of the **S**tandard **M**odel **o**f **C**osmology (SMoC). **G**eneral **R**elativity (GR) is the primary constituent of the SMoC & when the Cosmological Clock was wound backwards to the Big-Bang, it was discovered that a patch was required for the early moments of the Universe. This patch is now known as Cosmological Inflation; a fleeting period of exponential growth in the size of the Universe. However within The **E**lectro-**G**ravi-**M**agnetic (EGM) Construct, Cosmological Inflation is derived organically, without the need for patches or modifications [15].

By inspection of [Fig. 2], Cosmological Inflation commenced at [t = 0] & ceased by [$t = 2 \cdot t_{\Phi\rho}$]. Whereas Cosmological Expansion commenced at [$t = t_\alpha$] & continues to the Present-Epoch [$t = t_\Phi$]. The implication being that Cosmological Inflation is a precursor to Cosmological Expansion. The evidence for this appears in [Fig. A2] (*see Appendix*). It is shown that *the rate of change of the Hubble Constant in the time domain* becomes positive at [$t = t_1$]; *i.e.* [$dH_{\alpha dt} > 0$] when [$t > t_1$]; therefore:

- [Fig. 2] illustrates that Cosmological Inflation commenced at [t = 0]; Cosmological Expansion commenced at [$t = t_\alpha$].
- [Fig. A2] illustrates that *Accelerated Cosmological Expansion* commenced at the instant of Maximum Cosmological Temperature [$T = T_{Max}$] at [$t = t_1$].



[Fig. 2] Cosmological Inflation & Expansion within the EGM Construct[8]

TABLE IV
Cosmological Inflation & Expansion Phases

Cosmological Phase	Start	End
Planck Inflation	0	t_α
Thermal Inflation	t_α	t_1
Hubble Inflation	t_1	t_2
Hubble Expansion	t_2	T_L
Cosmological Inflation	0	$2 \cdot t_{\Phi\rho}$
Cosmological Expansion	t_α	T_L
• Cosmological Acceleration	t_1	

Description
$[t_\alpha = 1/H_\alpha] = 3.64699500847915 \cdot 10^{-43}$ (s)
$t_1 = 2.20630341057726 \cdot 10^{-42}$ (s)
$t_2 = 4.19618421889086 \cdot 10^{-42}$ (s)
$2 \cdot t_{\Phi\rho} = 7.8793484858429 \cdot 10^{-23}$ (s)
$T_L = 4.10165382157836 \cdot 10^{13}$ (Gyr)

[8] See Appendix; also review the supplementary material listed in the references for High & Ultra-High resolution imagery in multiple formats.

VI. COSMOLOGICAL EQUATIONS

Within the **E**lectro-**G**ravi-**M**agnetic (EGM) Construct, the effect of Dark Energy is organically derived & does not exist as a distinct concept or **P**ost-**F**acto **C**orrection (PFC). The EGM Total Density Parameter [Ω_Σ] represents the Total Cosmological Density because it includes the mass contributions of Photons & Gravitons. The Mass-Energy of these particles were theorized in 2005 as follows [16]:

- Photon: $m_{\gamma\gamma} = 3.19515507344683 \cdot 10^{-45}$ (eV)
- Graviton: $m_{gg} = 6.39031014689365 \cdot 10^{-45}$ (eV)

However, the **S**tandard **M**odel **o**f **C**osmology (SMoC) representation of Pressureless Matter Parameter [Ω_m] does not include Photonic or Gravitonic mass contributions; *i.e.* Photons & Gravitons are massless within the SMoC [17].

Dark Energy is not required to exist within the EGM Construct because a relationship between **C**osmic **M**icrowave **B**ackground **R**adiation CMBR [T_0] & Λ_{CDM} Hubble Constant [H_0] is defined [1]; this relationship inevitably incorporates any effects that the SMoC regards as Dark Energy contributions. Upon inspection, one finds that the EGM Construct obeys the following register of primary assumptions:

1. The Universe is 'Flat'; as confirmed by the **B**alloon **O**bservations **o**f **M**illimetric **E**xtragalactic **R**adiation **a**nd **G**eophysics (BOoMERanG) experiments [2000].
2. In order to generate a net Cosmologically Flat Space-Time Manifold, the **Z**ero-**P**oint-**F**ield (ZPF) acts as a Cosmological Expansive Force; which opposes the Cosmological Contraction influence induced by gravitational attraction.
3. The Expansive-Contractive pairing described above, is a requirement of **Newton's 3rd Law**; consequently, the EGM Deceleration Parameter [Ω_q] opposes the EGM Total Density Parameter [Ω_Σ]; thus, [$\Omega_q = 1 - \Omega_\Sigma$].

Through the lens of the SMoC, the preceding assumptions may be construed as attributing the effects of Dark Energy to the ZPF. However, the existence of Dark Energy is not a requirement within the EGM Construct & if the discovery of Dark Energy had not occurred, it would not modify the logic presented within the primary assumptions register.

The SMoC expected a positive value of Deceleration Parameter to be observed [+q], however a negative value has been experimentally confirmed [-q]. Hence, when relating the SMoC to the EGM Construct, it follows that [$-q = \Omega_q$]; thus, [$q = -\Omega_q$]. All equations necessary to articulate **The History of The Cosmos;** From The Big-Bang to The Present-Epoch, appear herein; as follows [14]: [pg. 32-35, 58, 59, 61-75]:

EGM Solution

$$\Lambda(t) = \frac{3}{c^2 t^2}\left(1 - \frac{1}{2}\Omega_\Sigma(t)\right) \quad (1)$$

$$\Omega_\Lambda(t) = 1 - \frac{1}{2}\Omega_\Sigma(t) \quad (2)$$

$$\Omega_M(t) = \Omega_m \Omega_\Sigma(t) \quad (3)$$

$$q(t) = \frac{1}{2}\Omega_\Sigma(t)(\Omega_m + 1) - 1 \quad (4)$$

$$\Omega_\Sigma(t) = \frac{t^2}{(t + t_{\Phi\rho})^3} t_\Phi \quad (5)$$

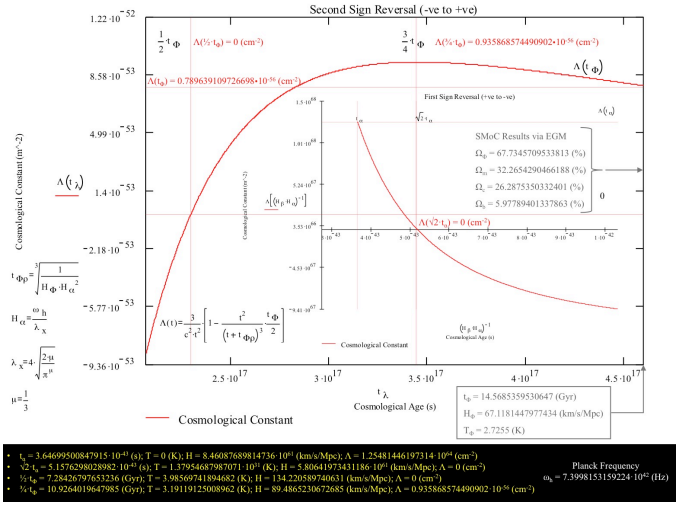
$$\rho_m(t) = \frac{3M_\Phi}{4\pi c^3 (t + t_{\Phi\rho})^3} \quad (6)$$

EGM vs. SMoC

TABLE V
Cosmological Constant: [Λ] (cm^{-2})

#	Event	EGM: Eq. (1)	SMoC
1	t_α	$1.25481446197314 \cdot 10^{64}$	
2	$\sqrt{2} \cdot t_\alpha$	0	
3	t_1	$-1.18624205780952 \cdot 10^{64}$	
4	t_2	$-1.23585741192738 \cdot 10^{64}$	
5	$2 \cdot t_{\Phi\rho}$	$-4.64746097027082 \cdot 10^{62}$	
6	$t_{\Lambda\Lambda}$	$-8.33809806581153 \cdot 10^{-56}$	
7	t_M	$-6.55880817006801 \cdot 10^{-56}$	
8	$\frac{1}{2} \cdot t_\Phi$	0	
9	t_Λ	$0.650672352266949 \cdot 10^{-56}$	Constant Value $\Lambda = \frac{3H_\Phi{}^2}{c^2}\Omega_\Phi$
10	t_q	$0.880880602181968 \cdot 10^{-56}$	
11	$\frac{3}{4} \cdot t_\Phi$	$0.935868574490902 \cdot 10^{-56}$	
12	$t_{\Lambda M}$	$0.915258960009848 \cdot 10^{-56}$	Above: Equation Result $1.06971732610696 \cdot 10^{-56}$
13	t_Φ	$0.789639109726698 \cdot 10^{-56}$	
14	T_L	$1.99238131202798 \cdot 10^{-81}$	PDG-2022 $1.088 \cdot 10^{-56}$

- $H_\Phi = 67.1181447977434$ (km/s/Mpc), $\Omega_\Phi = 0.677345709533812$ [1]



[Fig. 3] Cosmological Constant [Λ]; EGM Solution: Eq. (1)

TABLE VI
Dark Energy Density Parameter: [Ω_Λ]

#	Event	EGM: Eq. (2)	SMoC
1	t_α	0.500000000000004	
2	$\sqrt{2} \cdot t_\alpha$	0	
3	t_1	-17.2991172218388	
4	t_2	-65.1924961397111	
5	$2 \cdot t_{\Phi\rho}$	$-8.64403506392045 \cdot 10^{38}$	Constant Value
6	$t_{\Lambda\Lambda}$	-0.549646215079224	
7	t_M	-0.476350976945372	*Storti* [1] 0.677345709533812
8	$\frac{1}{2} \cdot t_\Phi$	0	
9**	t_Λ	0.138916192474527	
10	t_q	0.243944538487426	PDG-2022 0.685
11	$\frac{3}{4} \cdot t_\Phi$	⅓	
12***	$t_{\Lambda M}$	0.39221127781798	
13	t_Φ	½	
14	T_L	0.999999999999822	

- 9** [$\Omega_\Lambda = q$]; 12*** [$\Omega_\Lambda = \Omega_M$]

TABLE VII
Pressureless Matter Parameter: [Ω_M]

#	Event	EGM: Eq. (3)	SMoC
1	t_α	0.322654290466185	
2	$\sqrt{2}\bullet t_\alpha$	0.64530858093237	
3	t_1	11.80857736674	
4	t_2	42.7145857522887	
5	$2\bullet t_{\Phi\rho}$	5.5780700006282 $\bullet 10^{38}$	Constant Value
6	$t_{\Lambda\Lambda}$	1	
7*	t_M	0.952701953890743	*Storti* [1]
8	$\frac{1}{2}\bullet t_\Phi$	0.645308580932375	0.322654290466188
9	t_Λ	0.555664769898109	
10	t_q	0.487889076974851	PDG-2022
11	$\frac{3}{4}\bullet t_\Phi$	0.430205720621583	0.315
12***	$t_{\Lambda M}$	0.392211277817981	
13	t_Φ	0.322654290466188	
14	T_L	1.14602568513654 $\bullet 10^{-13}$	

- 7* [$\Omega_M = q$]; 12*** [$\Omega_\Lambda = \Omega_M$]

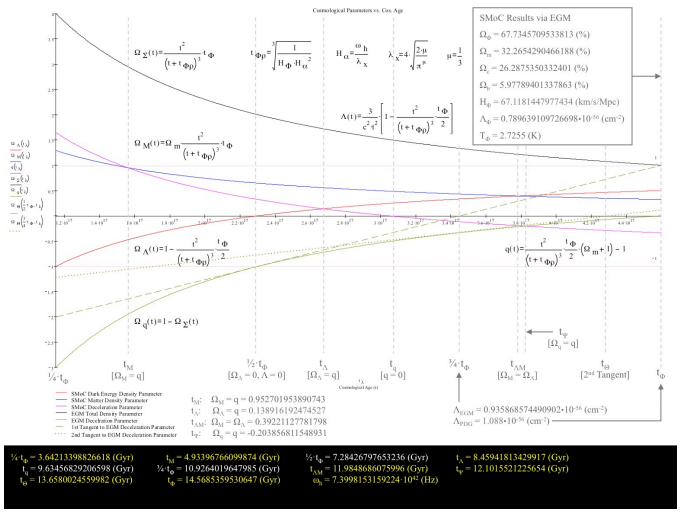
TABLE VIII
Deceleration Parameter: [q]

#	Event	EGM: Eq. (4)	SMoC
1	t_α	-0.338672854766912	
2	$\sqrt{2}\bullet t_\alpha$	0.322654290466176	
3	t_1	23.2034059052088	
4	t_2	86.5497890158555	
5	$2\bullet t_{\Phi\rho}$	1.14330700642345 $\bullet 10^{39}$	Constant Value
6	$t_{\Lambda\Lambda}$	1.04964621507922	$q = \frac{1 - 3\Omega_\Phi}{2}$
7*	t_M	0.952701953890743	
8	$\frac{1}{2}\bullet t_\Phi$	0.322654290466188	Above: Equation Result
9**	t_Λ	0.138916192474527	-0.516018564300719
10	t_q	0	
11	$\frac{3}{4}\bullet t_\Phi$	-0.118230473022542	
12	$t_{\Lambda M}$	-0.196105638900899	
13	t_Φ	-0.338672854766906	
14	T_L	-0.999999999999765	

- $\Omega_\Phi = 0.677345709533812$ [1]
- 7* [$\Omega_M = q$]; 9** [$\Omega_\Lambda = q$]

Utilizing EGM Methodology, we estimate that the SMoC Deceleration Parameter (*above*) equalled ZERO [q = 0] at:

- t = 7.05090077314579 (Gyr) when [$\Omega_\Lambda = \frac{1}{3}$, $\Omega_M = \frac{2}{3}$].



[Fig. 4] Cosmological Parameters [Ω_Λ, Ω_M, q]; EGM Solution: Eq. (2-4)[9]

[9] See Appendix; also review the supplementary material listed in the references for High & Ultra-High resolution imagery in multiple formats.

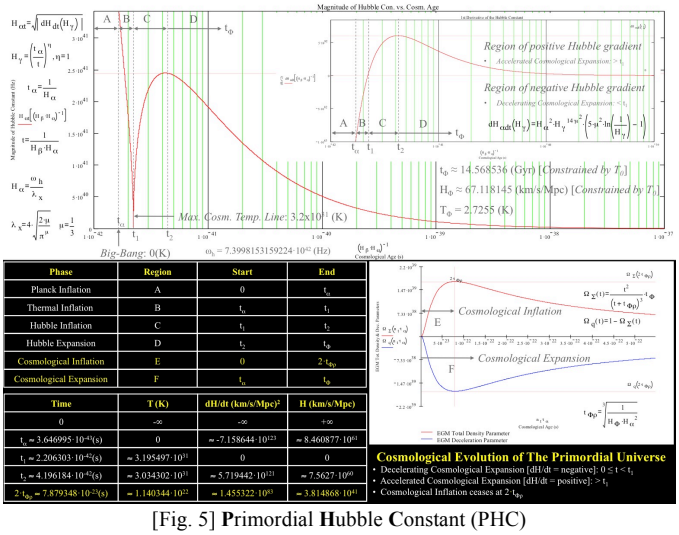
TABLE IX
Cosmological Mass Density: [ρ_m] (kg/m^3)

#	Event	EGM: Eq. (6)	SMoC
1	t_α	1.34463785488649 $\bullet 10^{94}$	
2	$\sqrt{2}\bullet t_\alpha$	1.34463785488649 $\bullet 10^{94}$	
3	t_1	1.34463785488649 $\bullet 10^{94}$	
4	t_2	1.34463785488649 $\bullet 10^{94}$	Constant Value
5	$2\bullet t_{\Phi\rho}$	4.98014020328328 $\bullet 10^{92}$	$\rho_\Phi = \frac{3H_\Phi{}^2}{8\pi G}$
6	$t_{\Lambda\Lambda}$	2.51908101549827 $\bullet 10^{-25}$	
7	t_M	2.1782779871506 $\bullet 10^{-25}$	Above: Equation Result
8	$\frac{1}{2}\bullet t_\Phi$	6.76931081567421 $\bullet 10^{-26}$	8.46163851959276 $\bullet 10^{-27}$
9	t_Λ	4.3219597983025 $\bullet 10^{-26}$	
10	t_q	2.92553582188553 $\bullet 10^{-26}$	PDG-2022
11	$\frac{3}{4}\bullet t_\Phi$	2.00572172316273 $\bullet 10^{-26}$	8.53286 $\bullet 10^{-27}$
12	$t_{\Lambda M}$	1.51985573707603 $\bullet 10^{-26}$	
13	t_Φ	8.46163851959276 $\bullet 10^{-27}$	
14	T_L	3.79162334771292 $\bullet 10^{-64}$	

- $H_\Phi = 67.1181447977434$ (km/s/Mpc) [1]
- [ρ_m] remains relatively constant during the **C**osmological **I**nflationary **P**rocess (CIP) from [t_α] to [$2\bullet t_{\Phi\rho}$]; reducing to [$1/27\bullet\rho_m(t_\alpha)$] by [$2\bullet t_{\Phi\rho}$]

Critical Density

In 2007, the EGM Cosmological Construct was developed [15], yielding a solution for the Primordial Evolution of the Hubble Constant as shown in [Fig. 5]. It was determined that the Hubble Constant equalled ZERO [H = 0] at the instant of Maximum Cosmological Temperature [T_{Max}] at [t = t_1]. In addition, it was determined that the Hubble Constant was a local maximum [$H = H_{Max}$] at [$t = t_2$].



Phase	Region	Start	End
Planck Inflation	A	0	t_α
Thermal Inflation	B	t_α	t_1
Hubble Inflation	C	t_1	t_2
Hubble Expansion	D	t_2	t_Φ
Cosmological Inflation	E	0	$2\bullet t_{\Phi\rho}$
Cosmological Expansion	F	t_α	t_Φ

Time	T (K)	dH/dt (km/s/Mpc)^2	H (km/s/Mpc)
0	-∞	-∞	+∞
$t_\alpha \approx 3.646995\bullet 10^{-43}$(s)	0	≈ -7.158644$\bullet 10^{123}$	≈ 8.460877$\bullet 10^{61}$
$t_1 \approx 2.206303\bullet 10^{-42}$(s)	≈ 3.195497$\bullet 10^{31}$	0	0
$t_2 \approx 4.196184\bullet 10^{-42}$(s)	≈ 3.034302$\bullet 10^{31}$	≈ 5.719442$\bullet 10^{121}$	≈ 7.5627$\bullet 10^{60}$
$2\bullet t_{\Phi\rho} \approx 7.879348\bullet 10^{-23}$(s)	≈ 1.140344$\bullet 10^{22}$	≈ 1.455322$\bullet 10^{83}$	≈ 3.814868$\bullet 10^{41}$

[Fig. 5] **P**rimordial **H**ubble **C**onstant (PHC)

In 2020, the solution for the Primordial Evolution of the Hubble Constant was developed to include improved estimates relating to the instants of [T_{Max}] & [H_{Max}] [14]. It was shown that the values for [t_1] & [t_2] may be refined according to:

- [H = 0] & [T_{Max} = 3.19549736932411 $\bullet 10^{31}$ (K)] at [t_8]:
  - $t_1 \rightarrow$ [t_8 = 2.26081970290932 $\bullet 10^{-42}$ (s)].
  - $\Delta t = t_8 - t_1 = 0.054516292332061 \bullet 10^{-42}$ (s).
- [H_{Max} = 7.56269951315196 $\bullet 10^{60}$ (km/s/Mpc)] at [t_7]:
  - $t_2 \rightarrow$ [t_7 = 3.13285308937301 $\bullet 10^{-42}$ (s)].
  - $\Delta t = t_7 - t_2 = -1.06333112951785 \bullet 10^{-42}$ (s).

The transformation from [t_1] to [t_8], & from [t_2] to [t_7] may seem innocuous, but when considering the SMoC concept of

Critical Density [$\rho_{\Phi c}$], a precise temporal ordinate describing the Hubble Constant at Maximum Cosmological Temperature [T_{Max}] is essential. [$\rho_{\Phi c}$] is based upon Cosmological Expansion, more specifically, the speed at which the Universe is expanding; as described by Eq. (7):

$$\rho_{\Phi c}(t) = \frac{3H(t)^2}{8\pi G} \quad (7)$$

The SMoC does not currently offer any solution for the Hubble Constant in the time domain [H(t)]; hence, the EGM Solution for [H(t)] was applied in order to formulate [Tab. X]:

- The superscript '♯' has been introduced to identify the required temporal fertilization by the EGM Construct.

TABLE X
Critical Density: [$\rho_{\Phi c}$] (kg/m^3)

#	Event	EGM: [H] (km/s/Mpc)	SMoC$^{\sharp}$: Eq. (7) (kg/m^3)
1	t_α	8.46087689814736 •10^{61}	1.3446378548865 •10^{94}
2	$\sqrt{2}$•t_α	8.21275042509452 •10^{61}	1.26692770018022 •10^{94}
3	t_8	0	0
4	t_7	7.56269951315196 •10^{60}	1.07430666717249 •10^{92}
5	2•$t_{\Phi\rho}$	3.81486814920045 •10^{41}	2.73359169001477 •10^{53}
6	$t_{\Lambda\Lambda}$	207.978981370331	8.12481487954829 •10^{-26}
7	t_M	198.14361251548	7.37453658226295 •10^{-26}
8	½•t_Φ	134.220589740631	3.38386373680183 •10^{-26}
9	t_Λ	115.578100123515	2.50914456150404 •10^{-26}
10	t_q	101.483006965613	1.93446659645543 •10^{-26}
11	¾•t_Φ	89.4865230672685	1.50414550214435 •10^{-26}
12	$t_{\Lambda M}$	81.5846210288534	1.25023364489876 •10^{-26}
13	t_Φ	67.1181447977434	8.46163851959298 •10^{-27}
14	T_L	2.39423691019193 •10^{-11}	1.07673498524308 •10^{-51}

- Hubble Constant [H] [14]: [pg. 19, 21-24, 65, 79]

Swinburne University of Technology defines [$\rho_{\Phi c}$] as "…. the average density of matter required for the Universe to 'just' halt its expansion, but only after infinite time. A Universe with Critical Density is said to be Flat". This definition leads to another important SMoC concept termed Density Parameter [Ω_ρ]; the ratio of observed Mass Density [ρ_m] to [$\rho_{\Phi c}$]. When [Ω_ρ =1], the observed Mass Density of a Universe equals its Critical Density & its Space-Time Geometry is described as 'Flat'. Combining Eq. (6) with Eq. (7) yields Eq. (8):

$$\Omega_\rho(t) = \frac{\rho_m(t)}{\rho_{\Phi c}(t)} = \frac{2GM_\Phi}{c^3(t+t_{\Phi\rho})^3 H(t)^2} \quad (8)$$

TABLE XI
EGM Total Density Parameter [Ω_Σ] vs. SMoC Density Parameter [Ω_ρ]

#	Event	EGM: Eq. (5); [Ω_Σ]	SMoC$^{\sharp}$: Eq. (8); [Ω_ρ]
1	t_α	0.999999999999991	0.999999999999991
2	$\sqrt{2}$•t_α	1.99999999999998	1.06133748176412
3	t_8	38.429215687951	Undefined
4	t_7	73.7920748283561	125.163316581241
5	2•$t_{\Phi\rho}$	1.72880701278409 •10^{39}	1.82183031265228 •10^{39}
6	$t_{\Lambda\Lambda}$	3.09929243015845	3.10047804515434
7	t_M	2.95270195389074	2.95378287550941
8	½•t_Φ	2	2.00046790952405
9	t_Λ	1.72216761505095	1.72248337724782
10	t_q	1.51211092302515	1.51232170524219
11	¾•t_Φ	1⅓	1.33346256748654
12	$t_{\Lambda M}$	1.21557744436404	1.21565736394744
13	t_Φ	1	0.999999999999974
14	T_L	3.55186873071082 •10^{-13}	3.52140814562364 •10^{-13}

[Tab. XI] offers numerous important conclusions regarding the EGM & SMoC Solutions; as follows:

1. The SMoC becomes undefined at [t_8]; the instant of Maximum Cosmological Temperature [T_{Max}].
2. [Ω_Σ] & [Ω_ρ] increase from quasi-unity [~ 1] at the instant of the Big-Bang [t_α], to their maximum values by the end of the **C**osmological **I**nflation **P**rocess (CIP) at [2•$t_{\Phi\rho}$].
3. [Ω_Σ] & [Ω_ρ] decrease from their maximum values at [2•$t_{\Phi\rho}$] to [1, ~ 1] in the Present-Epoch; in agreement with experimental observation.
4. [Ω_Σ] & [Ω_ρ] decrease to near ZERO in the Distant Future.

The 'Flatness Problem'

Presently in Cosmology, a number of significant problems have been recognized but evade widely accepted resolution. One of these is termed the 'Flatness Problem', where the coincidence of the Universe containing 'just' enough mass to halt expansion after an infinite number of years, is undeniably remarkable [18]. However, the results in [Tab. XI] offer a solution to the 'Flatness Problem'; but how can we be certain that the 'Flatness Problem' has been resolved?

To address this question, we must forensically decompose the 'Flatness Problem'. A central actor in the problem is the **S**tandard **M**odel **o**f **C**osmology (SMoC) requirement that the geometry of the Universe is constant. This may, or may not, be the correct position; however, this is challenged by [Tab. XI]. Consequently, we propose that the SMoC relationship between [Ω_ρ] & [Ω_0] as described by Eq. (9) [19]:

$$\left(\Omega_\rho = \frac{\rho}{\rho_c}\right) = (\Omega_0 = \Omega_B + \Omega_D + \Omega_\Lambda) \quad (9)$$

…. should be redefined to exclude the 'Flatness Problem'. Although Eq. (9) is a valid physical statement, as the subscript '0' refers to present day conditions, we propose that a more generalized representation of the relationship between the Density Parameter [Ω_ρ] & the *Total Density Parameter* [Ω] may be defined according to Eq. (10) as follows:

$$\left(\Omega_\rho = \frac{\rho}{\rho_c}\right) \cong (\Omega = |\Omega_B| + |\Omega_D| + |\Omega_\Lambda|) \quad (10)$$

…. such that [Ω] lacks the subscript '0', [Ω_B] denotes the Density Parameter for normal Baryonic Matter, [Ω_D] denotes the Density Parameter for Dark Matter & [Ω_Λ] denotes the Density Parameter for Dark Energy. Thus, the observation that [Ω_ρ = 1] remains valid for the Present-Epoch & avoids the 'Flatness Problem' due to the *approximate* equality statement.

Resolving The 'Flatness Problem'

Step-1: In order to build a solution to the 'Flatness Problem', we shall commence the process by defining a pathway in terms of the EGM Construct; hence – Let:

- [Ω_{EGM}] denote the *Resultant Density Parameter*.
- [$\Sigma\Omega_K$] denote the *Effective Spatial Curvature Parameter*.

[$\Sigma\Omega_K$] represents the quantity of misidentified Dark Energy. Evidence for this is shown on [Tab. VI] such that;

$[\Omega_\Lambda = ½]$ not $[\Omega_\Lambda = 0.677345709533812]$ [1]:

- This does *not* mean that the SMoC value obtained by *Storti* was/is wrong, it means that the EGM Construct can operate within the EGM Domain &/or the SMoC Domain seamlessly; it is a matter of choice.
- The Present-Epoch value of Effective Spatial Curvature is $[\Sigma\Omega_K = 0.677345709533812 - ½ = 0.177345709533812]$.

Step-2: Let the Primary EGM & SMoC Resultant Density Parameters (*respectively*) be defined by Eq. (11, 13):

$$\Omega_{EGM}(t) = \Omega_\Lambda(t) + \Omega_M(t) + \Sigma\Omega_K(t) \quad (11)$$

$$\Sigma\Omega_K(t) = \left(\frac{1}{2} - \Omega_m\right)\Omega_\Sigma(t) \quad (12)$$

$$\Omega_{SMoC}(t) = \Omega_{\Lambda\Lambda}(t) + \Omega_M(t) \quad (13)$$

$$\Omega_{\Lambda\Lambda}(t) = 1 - \Omega_m\Omega_\Sigma(t) \quad (14)$$

TABLE XII
(*Primary*) Resultant Density Parameters $[\Omega_{EGM}$ vs. $\Omega_{SMoC}]$

#	Event	EGM: Eq. (11)	SMoC♯: Eq. (13)
1	t_α	1	1
2	$\sqrt{2}\bullet t_\alpha$	1	1
3	t_8	0.999999999999999	1
4	t_7	1	1
5	$2\bullet t_{\Phi\rho}$	0	0
6	$t_{\Lambda\Lambda}$	1	1
7	t_M	1	1
8	$½\bullet t_\Phi$	1	1
9	t_Λ	1	1
10	t_q	1	1
11	$¾\bullet t_\Phi$	1	1
12	$t_{\Lambda M}$	1	1
13	t_Φ	1	1
14	T_L	1	1

EGM Solution when $[\Omega_{EGM}(2\bullet t_{\Phi\rho}) = 0]$

- $\Omega_\Lambda(2\bullet t_{\Phi\rho}) = -8.64403506392045 \bullet 10^{38}$
- $\Omega_M(2\bullet t_{\Phi\rho}) = 5.5780700006282 \bullet 10^{38}$
- $\Sigma\Omega_K(2\bullet t_{\Phi\rho}) = 3.06596506329225 \bullet 10^{38}$

SMoC♯ Representation utilizing the EGM Construct when $[\Omega_{SMoC}(2\bullet t_{\Phi\rho}) = 0]$

- $\Omega_{\Lambda\Lambda}(2\bullet t_{\Phi\rho}) = -5.5780700006282 \bullet 10^{38}$
- $\Omega_M(2\bullet t_{\Phi\rho}) = 5.5780700006282 \bullet 10^{38}$

The results displayed in [Tab. XII] demonstrate predominantly 'Flat' Cosmological Geometry, with an exception occurring at $[t = 2\bullet t_{\Phi\rho}]$; however:

- Eq. (11) does not propose any relationship to Critical Density $[\rho_{\Phi c}]$, as does Eq. (9, 10), & consequently avoids the 'Flatness Problem'.

Step-3: Let the Secondary EGM & SMoC Resultant Density Parameters (*respectively*) be defined by Eq. (15, 16):

$$\Omega_{E\Gamma M}(t) = |\Omega_\Lambda(t)| + |\Omega_M(t)| + |\Sigma\Omega_K(t)| \quad (15)$$

$$\Omega_{\Sigma MoK}(t) = |\Omega_{\Lambda\Lambda}(t)| + |\Omega_M(t)| \quad (16)$$

TABLE XIII
(*Secondary*) Resultant Density Parameters $[\Omega_{E\Gamma M}$ vs. $\Omega_{\Sigma MoK}]$

#	Event	EGM: Eq. (15)	SMoC♯: Eq. (16)
1	t_α	1	1
2	$\sqrt{2}\bullet t_\alpha$	1	1
3	t_8	37.429215687951	23.7987026419359
4	t_7	72.7920748283561	46.6186590915421
5	$2\bullet t_{\Phi\rho}$	$1.72880701278409 \bullet 10^{39}$	$1.11561400012564 \bullet 10^{39}$
6	$t_{\Lambda\Lambda}$	2.09929243015845	1
7	t_M	1.95270195389074	1
8	$½\bullet t_\Phi$	1	1
9	t_Λ	1	1
10	t_q	1	1
11	$¾\bullet t_\Phi$	1	1
12	$t_{\Lambda M}$	1	1
13	t_Φ	1	1
14	T_L	1	1

Step 4: The results displayed in [Tab. XIII] 'approximate' [Tab. XI]. Hence, for the 4th Step in the process towards resolving the 'Flatness Problem' – Let the EGM & SMoC Cosmological Curvature Parameters (Ω_ϕ, Ω_η: respectively) be defined by Eq. (17, 18):

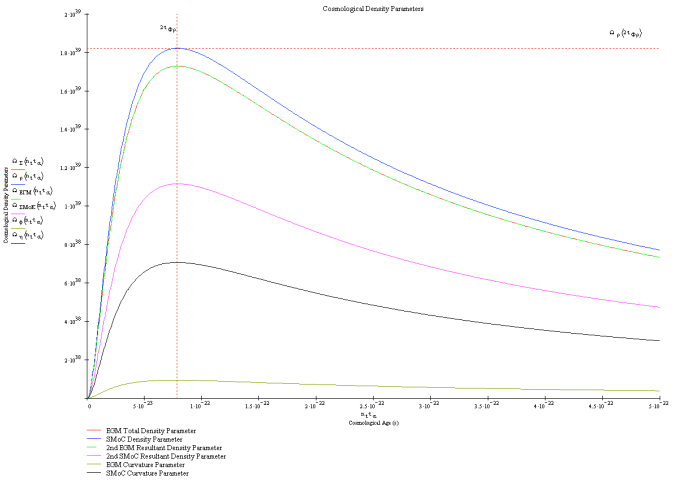
$$\Omega_\phi(t) = \Omega_\rho(t) - \Omega_{E\Gamma M}(t) \quad (17)$$

$$\Omega_\eta(t) = \Omega_\rho(t) - \Omega_{\Sigma MoK}(t) \quad (18)$$

TABLE XIV
Cosmological Curvature Parameter $[\Omega_\phi$ vs. $\Omega_\eta]$

#	Event	EGM: Eq. (17)	SMoC♯: Eq. (18)
1	t_α	$-8.32667268468867 \bullet 10^{-15}$	$-8.32667268468867 \bullet 10^{-15}$
2	$\sqrt{2}\bullet t_\alpha$	0.061337481764119	0.061337481764119
3	t_8	Undefined	Undefined
4	t_7	52.3712417528851	78.5446574896991
5	$2\bullet t_{\Phi\rho}$	$9.30232998681865 \bullet 10^{37}$	$7.06216312526637 \bullet 10^{38}$
6	$t_{\Lambda\Lambda}$	1.00118561499589	2.10047804515434
7	t_M	1.00108092161867	1.95378287550941
8	$½\bullet t_\Phi$	1.00046790952405	1.00046790952405
9	t_Λ	0.722483377247824	0.722483377247824
10	t_q	0.512321705242186	0.512321705242186
11	$¾\bullet t_\Phi$	0.333462567486536	0.333462567486536
12	$t_{\Lambda M}$	0.215657363947444	0.215657363947444
13	t_Φ	$-2.59792187762287 \bullet 10^{-14}$	$-2.59792187762287 \bullet 10^{-14}$
14	T_L	-0.999999999999648	-0.999999999999648

Plotting Primordial results yields;



[Fig. 6] Cosmological Density Parameters $[\Omega_\Sigma, \Omega_\rho, \Omega_{E\Gamma M}, \Omega_{\Sigma MoK}, \Omega_\phi, \Omega_\eta]$; EGM Solution: Eq. (5, 15, 17); SMoC Solution; Eq. (8, 16, 18)[10]

[Fig. 6] shows that:

- All curves rise quickly during the Cosmological Inflation Epoch $[t_\alpha \le t \le 2\bullet t_{\Phi\rho}]$; peaking at $[t = 2\bullet t_{\Phi\rho}]$.
- At the resolution displayed, $[\Omega_\Sigma]$ & $[\Omega_{E\Gamma M}]$ are co-located.
- All curves appear consistent with [Tab. XIV].

[10] See Appendix; also review the supplementary material listed in the references for High & Ultra-High resolution imagery in multiple formats.

Notwithstanding, critical analysis of [Fig. 6] provokes the following tabulation;

TABLE XV
Cosmological Similarities: $[\Omega_\eta / \Omega_\phi]$ vs. $[\Omega_\Sigma / \Omega_{EGM}]$

#	Event	Eq. (18 / 17)	Eq. (5 / 15)
1	t_α	1	0.999999999999991
2	$\sqrt{2}\bullet t_\alpha$	1	1.99999999999998
3	t_8	Undefined	1.02671709736953
4	t_7	1.49976694958492	1.01373775925962
5	$2\bullet t_{\Phi\rho}$	7.59182176430358	1
6	$t_{\Lambda\Lambda}$	2.09799063599507	1.47635097694537
7	t_M	1.95167326967964	1.51211092302515
8	$\frac{1}{2}\bullet t_\Phi$	1	2
9	t_Λ	1	1.72216761505095
10	t_q	1	1.51211092302515
11	$\frac{3}{4}\bullet t_\Phi$	1	$1\frac{1}{3}$
12	$t_{\Lambda M}$	1	1.21557744436404
13	t_Φ	1	1
14	T_L	1	$3.55186873071083 \bullet 10^{-13}$

- $\Omega_\Sigma(T_L) = 3.55186873071083 \bullet 10^{-13}$
- $\Omega_{EGM}(T_L) = 1$

Thus, the erroneousness of the 'Flatness Problem' may be exemplified by the following tabulation;

TABLE XVI
Cosmological Curvature

Spatial Geometry	Event	Characteristics
Barely-Open	Big-Bang	$t_\alpha = 3.64699500847915 \bullet 10^{-43}$ (s) $[\Omega_\phi, \Omega_\eta] = -8.32667268468867 \bullet 10^{-15}$
Maximally-Closed	Cosmological Inflation Ceases	$2\bullet t_{\Phi\rho} = 7.8793484858429 \bullet 10^{-23}$ (s) $\Omega_\phi = 9.30232998681865 \bullet 10^{37}$ $\Omega_\eta = 7.06216312526637 \bullet 10^{38}$
Barely-Open (*Apparently Flat*)	Present-Epoch	$t_\Phi = 14.5685359530647$ (Gyr) $[\Omega_\phi, \Omega_\eta] = -2.59792187762287 \bullet 10^{-14}$
Open	Distant Future	$T_L = 4.10165382157836 \bullet 10^{13}$ (Gyr) $[\Omega_\phi, \Omega_\eta] = -0.999999999999648$
Asymptotically[11] Open	Far-Distant Future	$t \rightarrow \infty$ $[\Omega_\phi, \Omega_\eta] \rightarrow -1$

Tab. (XIV-XVI) state or suggest that:

1. At the instant of the Big-Bang $[t_\alpha]$, the Universe was 'Barely-Open'.
2. An **U**ndefined **C**urvature **E**vent (UCE) occurred at $[t_8]$ due to Eq. (7). 'Undefined Curvature' *does not* equal 'Infinite Curvature'; [Undefined $\neq \infty$]:
   - This eventuality is likely caused by an issue specifically with SMoC Eq. (7), not the EGM Construct.
3. From $[t_\alpha]$ to $[2\bullet t_{\Phi\rho}]$, the Spatial Geometry of the Universe rapidly transitioned to a state of **M**aximal **S**patial **C**losure (MSC); hence, we describe the Universe during this period as being 'Closed'.
4. From the instant of MSC, the Universe transitioned to the 'Apparently Flat' Space-Time Curvature of the Present-Epoch.
5. The Present-Epoch denotes an inflexion node (*crossover point*) towards the ultimate state of 'Asymptotically Open' in the Far-Distant Future.

[11] All calculations were executed within a 'MathCad 8 Professional' Computational Environment. Subsequently, 'Computational Infinity' yielding 'Asymptotically Open' Cosmological Curvature $[\Omega_\phi = \Omega_\eta = -1]$ occurs at Cosmological Age $[t = 2.88756429039116 \bullet 10^{16}$ (Gyr)] [14]: [pg. 71].

Therefore, Eq. (10) may be re-written into either of the following two forms:

- EGM Form

$$\left(\Omega_\rho = \frac{\rho}{\rho_c}\right) = \left(|\Omega_\Lambda(t)| + |\Omega_M(t)| + |\Sigma\Omega_K(t)| + \Omega_\phi(t)\right) \quad (19)$$

- SMoC Form

$$\left(\Omega_\rho = \frac{\rho}{\rho_c}\right) = \left(|\Omega_{\Lambda\Lambda}(t)| + |\Omega_M(t)| + \Omega_\eta(t)\right) \quad (20)$$

Key Points:

- ❖ At the instant of the Big-Bang, the Curvature of the Universe was 'Barely Open'. **C**osmological **I**nflation (CI) continued, inducing a transition from its 'Barely Open' state to its 'Maximally-Closed' state at the instant when CI ceased.
- ❖ Subsequently, the Universe transitioned from its 'Maximally-Closed' state at the end of CI, to its 'Barely-Open' state in the Present-Epoch:
  1. However, 'Barely-Open' Cosmological Curvature is presently technologically indistinguishable from 'Flat' Space-Time Curvature.
  2. Consequently, the Universe in the Present-Epoch may be described as 'Apparently Flat'.
  3. Therefore - by useful simplification - we may define $[\Omega_\phi = 0]$ in the Present-Epoch.
- ❖ The Universe is en-route to an ultimate state of 'Asymptotically Open' in the Far-Distant Future; hence:
  4. The 'Flatness Problem' *does not exist*.

VII. The Ideal Universe

Prior to this research article, the **S**tandard **M**odel **o**f **C**osmology (SMoC) had a serious impediment; for the most part, it was only defined for the Present-Epoch. Moreover, important metrics such as the Cosmological Constant $[\Lambda]$, Dark Energy Density Parameter $[\Omega_\Lambda]$, Pressureless Matter Parameter $[\Omega_M]$, Deceleration Parameter [q] & Hubble Constant [H] were also anchored to the Present-Epoch. However, to overcome these limitations we have 'fertilized' the SMoC with the **E**lectro-**G**ravi-**M**agnetic (EGM) Construct where necessary. To establish EGM credibility for the 'fertilization' process, we presented the following evidence:

- [Tab. I]: Yields four (4) important outcomes:
  1. Frieman *correctly* identifies when (q = 0).
  2. The PDG misidentify ($\Lambda = 0$) as being (q = 0).
  3. The Frieman vs. PDG conflict is resolved.
  4. $[\Lambda]$, $[\Omega_\Lambda]$, $[\Omega_M]$, [q], [H] & [T] are not constants.
- [Tab. II]: Yields seventeen (17) important outcomes & demonstrates clear synergy between the SMoC & the EGM Construct in the Present-Epoch, with one exception; Cosmological Age $[t_\Phi]$ [1]:
  - The EGM Construct [14] offers corrections to greater than 23% of the data published by The **P**article **D**ata **G**roup (PDG) [6]. *Most importantly*, the corrections generated by the EGM Construct are constrained by **C**osmic **M**icrowave **B**ackground **R**adiation (CMBR); unlike PDG data. Consequently, the constraint of a

substantial portion of PDG data to the CMBR is an extraordinary development for the SMoC.

All equations necessary to articulate **The History of The Cosmos;** From The Big-Bang to The Present-Epoch, have been presented in two (2) simple but distinctly different mathematical solutions:

1. The EGM Solution; appearing in all tables.
2. The SMoC$^{\sharp}$ Solution[12]; appearing in Tab. (X-XV).

Both of these solutions produce similar results for the Present-Epoch; verifiable against PDG information [6]. However, a significant & singular distinction between these solutions occurs at [$t_8 = 2.26081970290932 \bullet 10^{-42}$ (s)]:

1. Eq. (8): Ω_ρ = Undefined.
2. Eq. (18): Ω_η = Undefined.

Whereas the EGM Solution produces a single 'Undefined' result at [t_8]; *see* Eq. (17). However, a workaround for this limitation exists by *defining* the Cosmological Curvature in the Present-Epoch as being exactly 'Flat' such that [$\Omega_{\phi\phi} = 0$] according to:

$$\Omega_{\phi\phi}(t) = \frac{\Omega_\Sigma(t)-1}{\Omega_\Sigma(t_\alpha)} = (\Omega_\Sigma(t) - 1)K_\phi \qquad (21)$$

- Cosmological Curvature Constant [14]: [pg. 73, 74]

$$K_\phi = \frac{1}{\Omega_\Sigma(t_\alpha)} = \frac{(t_\alpha + t_{\Phi\rho})^3}{t_\alpha^2 t_\Phi} = 1 + \frac{3t_{\Phi\rho}^2}{t_\alpha t_\Phi} + \frac{3t_{\Phi\rho}}{t_\Phi} + \frac{t_\alpha}{t_\Phi}$$

$$K_\phi = 1 + 2.77712936420964 \bullet 10^{-21} + \ldots. \\ 2.57081583518513 \bullet 10^{-40} + \ldots. \\ 7.93276460651968 \bullet 10^{-61}$$

Tabulating Eq. (21) against Eq. (17) demonstrates that the 'Undefined' discontinuity at [t_8] has been remedied by [$\Omega_{\phi\phi}$]; whilst maintaining synergy with [Ω_ϕ] & resolving the 'Flatness Problem'. Therefore [Ω_ϕ] → [$\Omega_{\phi\phi}$] such that:

- [$\Omega_{\phi\phi}$] denotes an Exact Solution for Cosmological Curvature 'From The Big-Bang to The Present-Epoch'.

TABLE XVII
Cosmological Curvature Parameter [$\Omega_{\phi\phi}$ vs. Ω_ϕ]

#	Event	EGM: Eq. (21)	EGM: Eq. (17)
1	t_α	$-8.54871728961378 \bullet 10^{-15}$	$-8.32667268468867 \bullet 10^{-15}$
2	$\sqrt{2}\bullet t_\alpha$	0.999999999999992	0.061337481764119
3	t_8	37.4292156879514	Undefined
4	t_7	72.7920748283568	52.3712417528851
5	$2\bullet t_{\Phi\rho}$	$1.72880701278411 \bullet 10^{39}$	$9.30232998681865 \bullet 10^{37}$
6	$t_{\Lambda\Lambda}$	2.09929243015847	1.00118561499589
7	t_M	1.95270195389076	1.00108092161867
8	$½\bullet t_\Phi$	1.00000000000001	1.00046790952405
9	t_Λ	0.722167615050952	0.722483377247824
10	t_q	0.512110923025153	0.512321705242186
11	$¾\bullet t_\Phi$	0.333333333333336	0.333462567486536
12	$t_{\Lambda M}$	0.215577444364041	0.215657363947444
13	t_Φ	0	$-2.59792187762287 \bullet 10^{-14}$
14	T_L	-0.999999999999653	-0.999999999999648

- Utilizing Eq. (21): the Cosmological Curvature Parameter defined by the **P**article **D**ata **G**roup (PDG) [$\Omega_K = 0.0007$] [6]; derived & explained by *Storti* [$\Omega_K = 0.000654290466188$] [1]; occurred over [9.52261898793035 (Myr)] ago [14]: [pg. 71, 74]

[12] Incorporates aspects of the EGM Construct in order to overcome Present-Epoch anchoring.

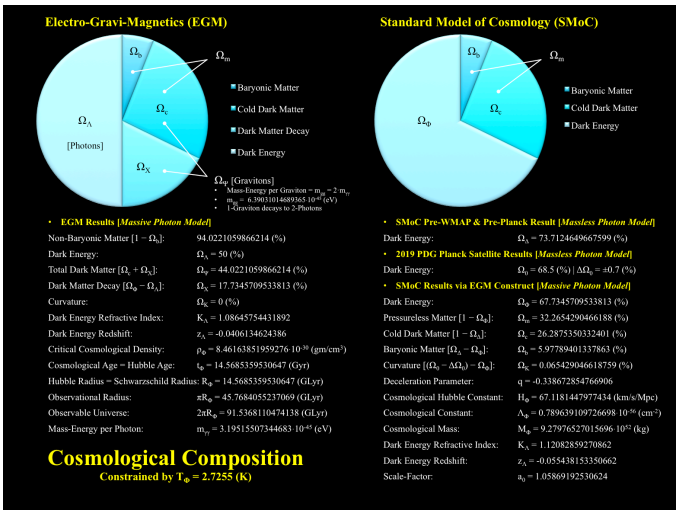
VIII. Cosmological Composition

Tab. (III-XVII) demonstrate that the EGM Construct derives a **C**osmic **M**icrowave **B**ackground **R**adiation (CMBR) *constrained*, SMoC-Aligned, **E**nd-**t**o-**E**nd (E2E) Cosmological Model organically (*without the requirement for 'fine tuning'*); including important SMoC processes, features, extensions & improvements; summarized as follows:

1. No requirement for Dark Matter / Dark Energy.
2. Cosmological Inflation & Expansion Phases.
3. Derivation & prediction of Cosmological Acceleration.
4. The Cosmological History of [Λ], [Ω_Λ], [Ω_M], [q], [ρ_m], [H], [$\rho_{\Phi c}$], [T] [1] & [$\Omega_{\phi\phi}$].
5. Resolution of the 'Flatness Problem'.
6. The Fate of The Cosmos.

Some of the exceptionally significant outcomes derived are summarized as follows:

1. [ρ_m] remains relatively constant during the **C**osmological **I**nflationary **P**rocess (CIP) from [t_α] to [$2\bullet t_{\Phi\rho}$]; reducing to [$1/27\bullet\rho_m(t_\alpha)$] by [$2\bullet t_{\Phi\rho}$]; in agreement with expectation.
2. The Dark Energy Density Parameter for the Present-Epoch is [$\Omega_\Lambda = ½$] not [$\Omega_\Lambda = 0.677345709533812$] [1]:
   - This does *not* mean that the SMoC value obtained by *Storti* was/is wrong, it means that the EGM Construct can operate within the EGM Domain &/or the SMoC Domain seamlessly; it is a matter of choice.
3. A significant proportion of Dark Matter has been misidentified as being Dark Energy. This misidentified quantity is termed 'Effective Spatial Curvature' [$\Sigma\Omega_K$]. The Present-Epoch value of [$\Sigma\Omega_K$] is:
   - $\Sigma\Omega_K = \Omega_X = 17.7345709533813$ (%).
4. Cosmological Composition in the Present-Epoch is graphically described by [Fig. 7][13]:



[Fig. 7] Cosmological Composition[14]

[13] Some differences in nomenclature exist - relative to this research article, but all values shown are identical to the content presented herein.

[14] See Appendix; also review the supplementary material listed in the references for High & Ultra-High resolution imagery in multiple formats.

IX. Cosmological Processes

The EGM Construct proposes that the dominant **C**ontinual **C**osmological **P**rocess (CCP) involves bi-directional energy exchange between our Observable Universe & a *Dark Reservoir of Quantum Potential Energy* termed the **Z**ero-**P**oint-**F**ield (ZPF) [20]; the CCP executes as follows:

❖ Fundamental Reality {the ZPF}:

1. The ZPF denotes the lowest possible energy state that empty Space-Time may possess:
   - That is, when described as a **Q**uantum **M**echanical **S**ystem (QMS) populated by harmonic oscillators governed by the Heisenberg Uncertainty Principle.
   - Also termed **Q**uantum **V**acuum (QV) Field.

❖ **G**eneral **R**elativity (GR) {applied via the **P**olarizable **V**acuum (PV) model of Gravity [2]}:

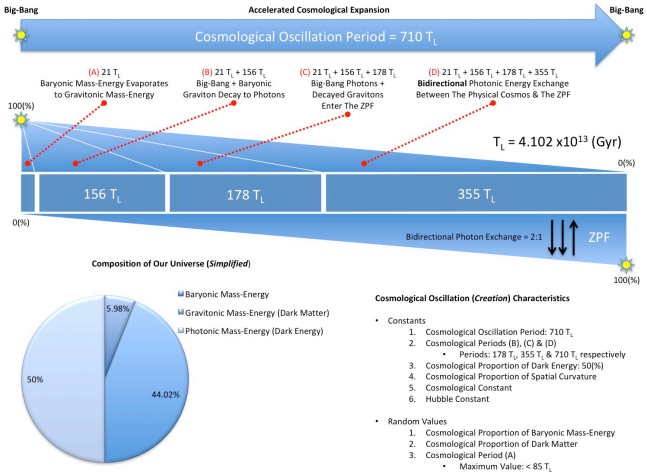
2. The presence of matter or energy induces a gradient in the ZPF; once achieved, the resultant topology is termed the PV Field:
   - Gravitational attraction between two bodies is a consequence of the gradient in the energy density of the PV Field between them.

❖ **Q**uantum **M**echanics (QM):

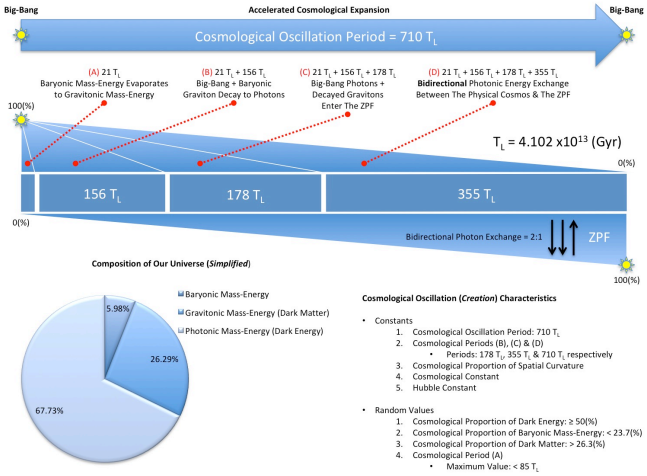
3. All matter radiates Gravitons:
   - Losing mass & sustaining the PV Field.
4. The Mass-Energy of a Graviton is given by [16]:
   - $m_{gg} = 6.39031014689365 \cdot 10^{-45}$ (eV).
   - Gravitons exist as Conjugate Photon Pairs; these may be described as entangled Photons.
   - The Mass-Energy of a Photon is given by [16]:
     - $m_{\gamma\gamma} = 3.19515507344683 \cdot 10^{-45}$ (eV).
     - $m_{\gamma\gamma} = ½ \cdot m_{gg}$.
5. The presence of Gravitons manifest as Space-Time Curvature; as described by **G**eneral **R**elativity (GR).

❖ **C**yclic **C**osmology (CC):

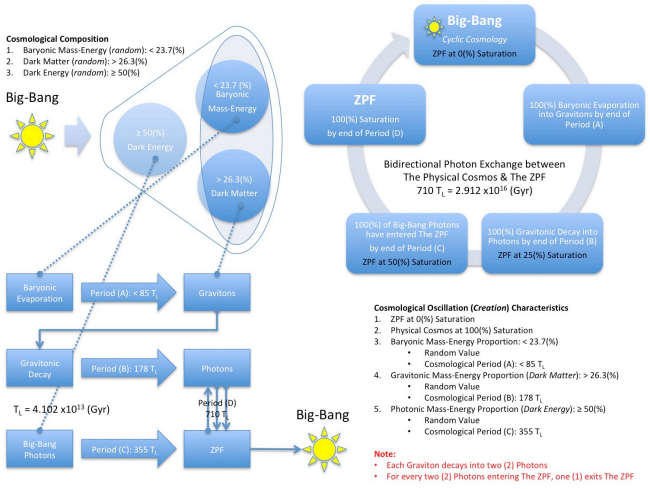
6. Gravitons are consumed by the ZPF proportional to the relationship $[1/r^2]$:
   - Hence, our Observable Universe behaves as an Energy Source & conversely, the ZPF behaves as an Energy Sink.
   - Subsequently, the process of Gravitons entering the ZPF is analogous to a transformation of Kinetic Energy to Potential Energy.
   - Consequently, the ZPF may be described as a store of Potential Energy; *i.e.* a store of Virtual Photons.
7. **Z**ero-**P**oint-**E**nergy (ZPE) physically manifests as The Casimir Effect & Dark Energy:
   - Virtual Photons exit the ZPF, becoming Real Photons. These are short-lived WaveFunctions which collapse & re-enter the ZPF in a random bi-directional energy exchange.
   - Alternative sources of Real Photons are also eligible to participate in this bi-directional process.
8. The mechanism for the expected Big-Bang Cosmological Expansion, & the mechanism for the unexpected Cosmological Acceleration are identical. Both of these forms of expansion rely upon the bi-directional energy exchange between the Observable Universe & the ZPF, as illustrated by [Fig. 8-10]:



[Fig. 8] Cosmological Matter-Energy Evaporation Process: EGM Domain[15]



[Fig. 9] Cosmological Matter-Energy Evaporation Process: SMoC Domain



[Fig. 10] Cosmological Matter-Energy Evaporation Process:
[EGM Domain: $\Omega_\Lambda = ½$], [SMoC Domain: $\Omega_\Lambda = 0.677345709533812$ [1]]

[15] See Appendix; also review the supplementary material listed in the references for High & Ultra-High resolution imagery in multiple formats.

Key points:

1. The **Z**ero-**P**oint-**F**ield (ZPF) denotes a *Dark Reservoir of Quantum Potential Energy* [20].
2. **Z**ero-**P**oint-**E**nergy (ZPE) physically manifests as Dark Energy.
3. Cosmological Expansion involves bi-directional energy exchange between the Observable Universe & the ZPF.
4. The Dark Energy Density Parameter for the Present-Epoch is [$\Omega_\Lambda = ½$] not [$\Omega_\Lambda = 0.677345709533812$] [1]:
   - [17.7345709533813 (%)] of Dark Matter has been misidentified as being Dark Energy.
5. The 'Flatness Problem' does not exist; the Curvature of the Universe changes with time. It is 'Barely Open' in the Present-Epoch, but its ultimate state is 'Asymptotically Open' [$\Omega_\phi = \Omega_{\phi\phi} = -1$] at [$t = \infty$].
6. The Universe experiences cyclic existence; termed **C**yclic **C**osmology (CC) [20]. The Big-Bang is a recurring event, with no information transfer. The conceptualization of the CC process is analogous to the inversion of an hourglass, obeying the following rules:
   - Cosmological Composition of each iteration:
     - Dark Energy = 50 (%) [*fixed value*].
     - Dark Matter > 26.3 (%) [*random value*].
     - Baryonic Matter < 23.7 (%) [*random value*].
     - Dark Matter + Baryonic Matter = 50 (%).
   - No Big-Crunch occurs.
   - No Big-Rip occurs because matter & energy evaporate into the ZPF; matter is not 'ripped-apart' by Cosmological Expansion. Since the ZPF is a *Dark Reservoir of Quantum Potential Energy*, information is never destroyed or lost, its state is 'indeterminate'; thereby avoiding violation of information conservation rules & analogous to 'Schrodinger's Cat'.

X. Discussion

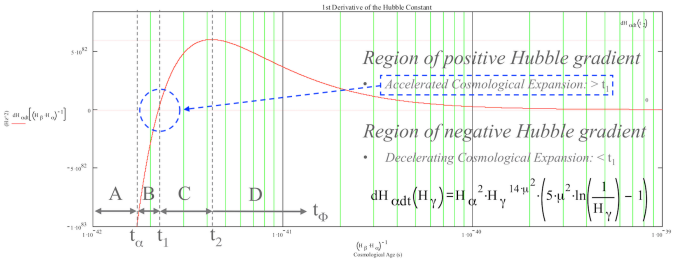
Cosmological Acceleration

Within this research article, we have investigated several important concepts & proposed some seemingly radical solutions. However, if pause is taken to consider certain features of the **S**tandard **M**odel **o**f **C**osmology (SMoC), one rationally concludes that the SMoC also sometimes acts radically. A prime example being the spontaneous Cosmological Acceleration of every point in the Universe simultaneously at [7.7 (Gyr)] for no apparent reason; as proposed by the **P**article **D**ata **G**roup (PDG) [6]. To a rational mind, this appears to be a miraculous interpretation of experimental observations; yet, it remains doctrine. The EGM Solution for this is [$\Lambda = 0$] at [~ 7.3 (Gyr)]; a radical proposition. However, the EGM Solution represents a more rational explanation.

The EGM Construct also reconciles the conflict between the PDG & Frieman regarding the commencement of **Ap**parent **C**osmological **A**cceleration (ApCA); Frieman asserts [$q = 0$] at [~ 10 (Gyr)] [4], [5]. The EGM Solution asserts that [$q = 0$] at [~ 9.63 (Gyr)]; hence validating the Frieman prediction. Notwithstanding, the PDG result proximally coincides with the EGM prediction of [$\Lambda = 0$] at [~ 7.3 (Gyr)]. This implies that the PDG have misinterpreted experimental observations; specifically, the PDG have misinterpreted [$\Lambda = 0$] as [$q = 0$] at [7.7 (Gyr)]. The significance of PDG-Frieman reconciliation is that the EGM Construct *simultaneously* determines the history of [Λ], [Ω_Λ], [Ω_M], [q]. Thus, it follows that if the EGM Solutions for [Λ, q] are experimentally validated by the PDG & Frieman (*as discussed*), then the EGM Solution for [Ω_Λ] is indirectly validated by implication. Therefore, a Present-Epoch value of [$\Omega_\Lambda = ½$] appears to be a radical, but valid EGM prediction. Numerous potential explanations for this exist, all requiring substantive theoretical research & experimental investigation; for example:

- Dark Matter decaying to Dark Energy: *see* [Fig. 10]:
  - *i.e.* Dark Matter is misidentified as being Dark Energy.
- Dark Matter is distributed throughout the Observable Universe in a manner assisting Cosmological Acceleration.
- Dark Matter is distributed throughout the Observable Universe in a manner corrupting the experimental determination of Cosmological Acceleration.

At this juncture, it should be emphasized that the EGM Construct shows on [Tab. IV] that Cosmological Acceleration commenced at [$t_1 \cong 2.2 \bullet 10^{-42}$ (s)]; the instant of Maximum Cosmological Temperature [$T_{Max} \cong 3.2 \bullet 10^{31}$ (K)]. The *actual* commencement of Cosmological Acceleration is not related to [$q = 0$]. Instead, it is related to *the rate of change of the Hubble Constant in the time domain* being permanently positively valued; [$dH_{\alpha dt} > 0$ when $t > t_1$]; see [Fig. 5, 11, A3].



[Fig. 11] 1st Derivative of Hubble Constant displaying the instant when Cosmological Acceleration commences; *i.e.* when the curve crosses the X-Axis & becomes permanently positive; [$dH_{\alpha dt} > 0$ when $t > t_1$]

The 'Flatness Problem'

A number of significant 'problems' exist in contemporary Cosmology; one of them is termed the 'Flatness Problem'. **S**winburne **U**niversity of **T**echnology (SUT) states [18]:

- "The 'problem' is that for the Universe to be so close to critical density after ~ 14 billion years of expansion and evolution, it must have been even closer at earlier times. For instance, it requires the density at Planck time (*within 10^{-43} seconds of the Big Bang*) to be within 1 part in 10^{57} of the critical density. *i.e.* Ω_0 initially must have been almost *exactly*:

1.000000000000000000000000000000000000000000000000000000000000

- There is no known reason for the density of the Universe

to be so close to the critical density, and this appears to be an unacceptably strange coincidence in the view of most astronomers. Hence the origin of the 'Flatness Problem'. Many attempts have been made to explain the 'Flatness Problem', and modern theories now include the idea of inflation which predicts the observed flatness of the Universe".

As demonstrated in preceding sections, the EGM Construct solves the 'Flatness Problem' by revealing that the Universe was 'Barely Open' at the Big-Bang, 'Barely Open' (*Apparently Flat*) in the Present-Epoch & 'Asymptotically Open' in the Far-Distant Future; hence, the 'Flatness Problem' does not exist:

- The SMoC's erroneous conclusion that a 'Flatness Problem' exists, originates from the *unfounded* assumption that Cosmological Curvature is constant. The SMoC executes a similar error with Cosmological Acceleration, [Λ], [Ω_Λ], [Ω_M], [q] & [H].

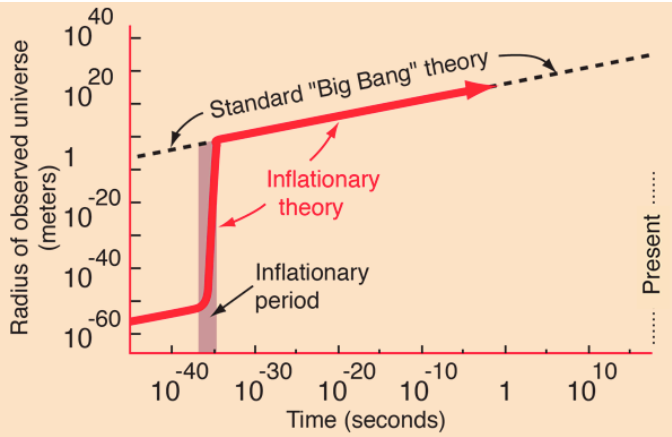
The reality of existence, as the EGM Construct concludes, is that the majority of significant Cosmological metrics (if not all), vary with time. This begs the obvious question:

- How far back in time may we approximate Cosmological Curvature as being 'Flat'?

The answer to this question was indirectly addressed in [Tab. XVII]. If we specify the PDG Value [$\Omega_K = 0.0007$] [6] as the Cosmological Curvature limit, then the 'Flat' look-back period is confined to [~ 9.5 (Myr)] ago [14]: [pg. 72, 75].

Cosmological Inflation

Another significant problem in Cosmology involves Inflation. Although Cosmological Inflation is widely accepted & forms part of the SMoC, it is not universally embraced as undeniable fact by all Physicists. Moreover, the sequence of events is also disputed. The historical position is that Cosmological Inflation followed the Big-Bang as illustrated in [Fig. 12] [21].



[Fig. 12] Historical representation of the Primordial-Era; the Big-Bang precedes Cosmological Inflation [21]

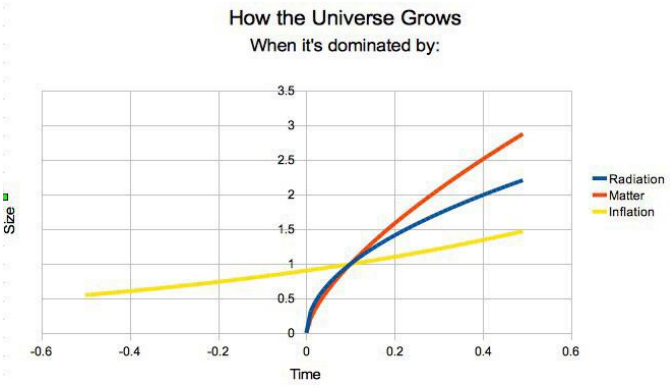
However, a problem exists. From [Fig. 12], we can infer that the radius of the Universe at the instant of the Big-Bang was [~ 10^{-57}(m)]; hence, Cosmological Mass Density [ρ_r] is:

$$\rho_r(r) = \frac{3M_\Phi}{4\pi r^3} \quad (22)$$

Thus, [$\rho_r(r)$ = 2.21538077021697 •10^{223} (kg/m^3)]. This is a problem because Planck Mass Density [ρ_h] is considerably lower [$\rho_h = c^5/(hG^2)$ = 8.20419620181289 •10^{95} (kg/m^3)] [22]. If we accept that [ρ_h] represents the maximum permissible theoretical value, then [ρ_r] is *many* orders of magnitude larger than [ρ_h]; [ρ_r/ρ_h = 2.70030203535044 •10^{127}]. Notably, [10^{127}] is so far above the Planck limit, it appears ridiculous. In contrast, the EGM Construct calculates the radius of the Universe at the instant of the Big-Bang, termed 'singularity radius', to be [r_S = 11.8108462500471 (fm)]. This produces a value of Mass Density [ρ_S] in compliance with the Planck limit; [ρ_S = 1.3446378548865 •10^{94} (kg/m^3)]. Hence, we see that [ρ_S/ρ_h = 0.016389635520776 ≅ 1.64 (%)] is a more favorable result. If we work in reverse & determine the minimum permissible Big-Bang radius [r_{Min}] based upon [ρ_h], we calculate [r_{Min} = 3.00011186077362 (fm)]; ~ the Classical Electron Radius [r_e = 2.81794034635391 (fm)].

Nowadays, the dominant position concerning Inflationary Sequence is that the Big-Bang occurred *after* Cosmological Inflation [23]. Hence, the Universe inflated from [t = 0] to 'some instant', then 'exploded' in a Space-Time ball of existence. This 'explosion' expanded until [t = 7.7 (Gyr)] [6], then the Universe miraculously, for no apparent reason, began accelerating; this is the SMoC today:

- However, if the SMoC cannot explain the observed event at [t = 7.7 (Gyr)], how can it be expected to explain an unobservable event farther back in time such as Cosmological Inflation?



[Fig. 13] Cosmological growth dominated by Radiation, Matter & Inflation

The author of [Fig. 13] writes [23]; "two of the curves, red and blue, represent a Universe dominated by either matter or radiation. If you extrapolate to the past, you get an infinitely small size at a finite time [t = 0], which is a singularity. But if at some early time, the Universe isn't dominated by matter or radiation, but by a form of energy inherent to space itself, you get the yellow curve":

1. "Note how this yellow curve, since it's an exponential curve, never reaches zero in size, but only approaches it, even if you go infinitely back in time."
   - **EGM-Reply**: Negative time [t < 0], as per [Fig. 13], is non-physical. The yellow line can *only* start at [t = 0]; thus, asymptotic properties are irrelevant.

2. "An inflating Universe does not begin in a singularity"
   - **EGM-Reply**: We show this position to be explicitly incorrect; see [Tab. IV], [Fig. 5]. The position that Cosmological Inflation occurred & *ceased* before the Big-Bang is untenable. However, a viable explanation is given by the EGM Construct; *i.e*. the Big-Bang, Cosmological Inflation & Cosmological Expansion occurred concurrently.
3. "All we can state with certainty is that the state we call the hot Big-Bang only came about after the end of inflation. It says nothing about inflation's origins."
   - **EGM-Reply**: The EGM Big-Bang Temperature is *derived*, being exactly [T = 0(K)]; the EGM version of the Big-Bang is cold, *not* hot. It does not become 'hot' until after [t_α], reaching its maximum value at [t_1]; [$T_{Max} \cong 3.2 \bullet 10^{31}$ (K)]. The EGM Construct shows that Cosmological Inflation, Expansion & the Big-Bang occur concurrently.

The author continues: "There are a lot of people who mean 'the initial singularity' when they say The-Big-Bang":

4. "The hot Big-Bang cannot be extrapolated back to a singularity, but only to the end of an inflationary state that preceded it."
   - **EGM-Reply**: this position has been conclusively overturned by the EGM Construct; *i.e*. a cold Big-Bang Singularity of Space-Time inflating, heating & expanding concurrently. All Physics attempting to describe [t < 0] is imaginary & may be discarded; this includes Cosmological Inflation as appears with the yellow line in [Fig. 13].

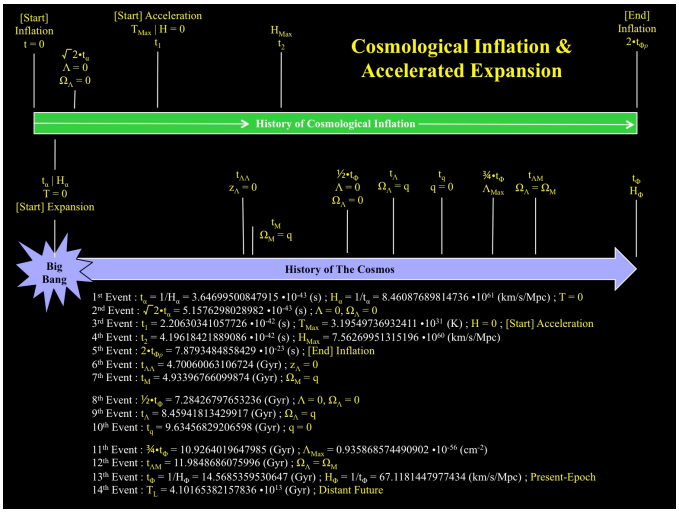
The author concludes by claiming that "*Inflation came first*, and its end heralded the arrival of the Big-Bang."

   - **EGM-Reply**: Cosmological Inflation & the Big-Bang were parallel processes, not serial processes.

The SMoC position with respect to inflation, expresses significant failings. However, the EGM Construct avoids them by establishing an initial *cold* singularity experiencing inflation, heating & expansion concurrently. The articulation & precision of the EGM Construct overturns all SMoC arguments denying the existence of the Big-Bang singularity due to some important characteristic differences; as follows[16]:

❖ $M_\Phi = 4.66692747982406 \bullet 10^{22}$ ($M_\odot$) [14], [24].

1. [t = 0]: **C**osmological **I**nflation **C**ommences (CIC).
2. [t = t_α]: **C**osmological **E**xpansion **C**ommences (CEC):
   - Big-Bang occurs; *not* at [t = 0].
   - [$t_\alpha = 3.64699500847915 \bullet 10^{-43}$ (s)]
   - [$H_\alpha = 1/t_\alpha = 8.46087689814736 \bullet 10^{61}$ (km/s/Mpc)]
   - [$r_S = 11.8108462500471$ (fm)].
   - [T = 0(K)]; the Big-Bang was cold, *not* hot.
   - Universe is 'Barely Open':
     - [$\Omega_\phi = -8.32667268468867 \bullet 10^{-15}$] or;
     - [$\Omega_{\phi\phi} = -8.54871728961378 \bullet 10^{-15}$].
3. [t = $\sqrt{2} \bullet t_\alpha$]:
   - [$\sqrt{2} \bullet t_\alpha = 5.1576298028982 \bullet 10^{-43}$ (s)].
   - Sign of Cosmological Constant changes from positive (+ve) to negative (-ve); [$\Lambda = 0$].
4. [t = t_1]: **C**osmological **A**cceleration **C**ommences (CAC):
   - [$t_1 = 2.20630341057726 \bullet 10^{-42}$ (s)].
   - [$T_{Max} = 3.19549736932411 \bullet 10^{31}$ (K)].
   - [H = 0 (km/s/Mpc)].
5. [t = t_2]:
   - [$t_2 = 4.19618421889086 \bullet 10^{-42}$ (s)].
   - Maximum Hubble Constant *after* [t_1].
   - [$H_{Max} = 7.56269951315196 \bullet 10^{60}$ (km/s/Mpc)].
6. [t = $2 \bullet t_{\Phi\rho}$]: **C**osmological **I**nflation **T**erminates (CIT):
   - [$2 \bullet t_{\Phi\rho} = 7.8793484858429 \bullet 10^{-23}$ (s)].
7. [t = $\frac{1}{2} \bullet t_\Phi$]:
   - [$\frac{1}{2} \bullet t_\Phi = 7.28426797653236$ (Gyr)].
   - Sign of Cosmological Constant changes from negative (-ve) to positive (+ve); [$\Lambda = 0$].
8. [t = t_q]:
   - [$t_q = 9.63456829206598$ (Gyr)]; [q = 0].
9. [t = $\frac{3}{4} \bullet t_\Phi$]:
   - [$\frac{3}{4} \bullet t_\Phi = 10.9264019647985$ (Gyr)].
   - [$\Lambda_{Max} = 0.935868574490902 \bullet 10^{-56}$ (cm^{-2})].
10. Cosmological Age [t = t_Φ] [1]:
    - [$t_\Phi = 14.5685359530647$ (Gyr)].
    - [$H_\Phi = 1/t_\Phi = 67.1181447977434$ (km/s/Mpc)].
    - [$\Lambda_\Phi = 0.789639109726698 \bullet 10^{-56}$ (cm^{-2})]
    - Universe is 'Barely Open' at [t_Φ].
    - [Ω_ϕ] in the Present-Epoch [t_Φ] is so 'slight' that the Universe appears 'Apparently Flat':
      - [$\Omega_\phi = -2.59792187762287 \bullet 10^{-14}$] or [$\Omega_{\phi\phi} = 0$].
11. Distant Future [t = T_L]:
    - [$T_L = 4.10165382157836 \bullet 10^{13}$ (Gyr)]:
    - [$\Lambda = 1.99238131202798 \bullet 10^{-81}$ (cm^{-2})].
    - Universe is 'Open':
      - [$\Omega_\phi = -0.999999999999648$] or;
      - [$\Omega_{\phi\phi} = -0.999999999999653$].
12. Far-Distant Future [t = ∞]:
    - Universe is 'Asymptotically Open': [$\Omega_\phi = \Omega_{\phi\phi} = -1$].



[Fig. 14] Cosmological Inflation Process

[16] Refer to [Tab. III, IV] for more information.

Cosmological Curvature

A significant contributor to the SMoC failures described previously, is the erroneous assumption that Cosmological Curvature is constant; hence, the 'Flatness Problem'. The EGM Construct demonstrates that 'Flatness' is an approximation limited by Look-Back period. The father backwards in time one gazes, the less valid the approximation of 'Flatness' becomes [14] [pg. 72, 75, 80]. Hence, utilizing a Cosmological Curvature Parameter of [~ 0.0007] as a measure of 'Flatness' yields:

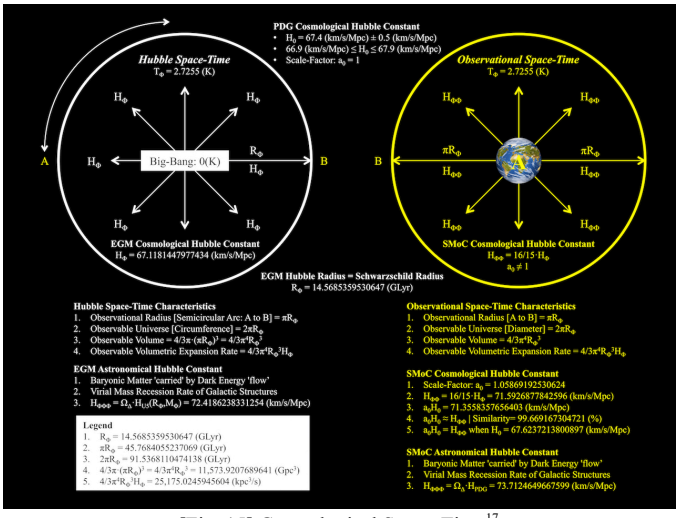
13. Approximate Look-Back Period with [$10 \bullet \Omega_K$] Curvature Resolution: [-94.7009226954225 (Myr)].
14. Approximate Look-Back Period with [$100 \bullet \Omega_K$] Curvature Resolution: [-894.668134931388 (Myr)].

Therefore, even with a relaxation of two orders of magnitude in the determination of Cosmological Curvature by the PDG [$100 \bullet \Omega_K$], the 'Flatness' approximation Look-Back period is limited to [$1 <$ (Gyr)]. This provides the final tranche of evidence that the SMoC understanding of the Primordial Universe & Cosmological Evolution is presently incomplete.

XI. Conclusion

This research article describes **The History of The Cosmos;** From The Big-Bang to The Present-Epoch. In delivering this outcome, numerous important resolutions have been achieved en-route:

1. **C**osmological **I**nflation (CI):
   - The CI process is expressed via a table of Cosmological Phases, demonstrating that CI envelopes several parallel processes.
   - Consequently, it is shown that the present SMoC interpretation of CI is incomplete; supplanted by the EGM Construct; refer to [Fig. 14].
2. **Ap**parent **C**osmological **A**cceleration (ApCA):
   - It is shown that the **P**article **D**ata **G**roup (PDG) misidentify ($\Lambda = 0$) as ($q = 0$).
   - It is demonstrated that Frieman *correctly* identifies the instant when ($q = 0$).
   - The ($q = 0$) conflict between Frieman & the PDG is reconciled.
3. **Ac**tual **C**osmological **A**cceleration (AcCA):
   - It is shown that AcCA commenced at [t_1]; during the Inflationary-Epoch.
   - By way of reason:
     - Any interpretation of experimental observations requiring all points in Space-Time to commence accelerating simultaneously (such as ApCA), are non-physical outside of the CI-Epoch.
     - Hence, ($q = 0$) indicates 'a' Cosmological Event within the **S**tandard **M**odel **o**f **C**osmology (SMoC) has occurred, but not AcCA.
4. Cosmological Calendar:
   - Cosmological History may be characterized by a calendar of fourteen (14) key Cosmological Events.
5. Present-Epoch comparison between the EGM Construct & the SMoC:
   - It is shown that the EGM Construct offers corrections to greater than 23% of the data published by the PDG.
6. The 'Flatness Problem':
   - It is resolved that the problem does not exist. Moreover, it is demonstrated that the actual state of Cosmological Curvature is 'Barely Open'.
7. Dark Energy:
   - The EGM Construct predicts that the **J**ames **W**ebb **S**pace **T**elescope (JWST), or other apparatus, will experimentally validate [$\Omega_\Lambda = ½$] in the Present-Epoch.
8. Detailed History:
   - The EGM Construct presents a detailed historical account of [Λ], [Ω_Λ], [Ω_M], [q], [H], [T], [ρ_m], [$\rho_{\Phi c}$], [Ω_ϕ] & [$\Omega_{\phi\phi}$].
9. Cyclic Cosmology:
   - The EGM Construct proposes the existence of Cyclic Cosmology; in support of Conformal Cyclic Cosmology as propositioned by Sir Roger Penrose.
10. The Nature of The Universe:
    - The EGM Construct supports the conjecture that our Universe 'may' be the product of a Black-Hole (or White-Hole); as illustrated in [Fig. 15]:
      - Black-Hole: https://youtu.be/jeRgFqbBM5E
      - White-Hole: https://youtu.be/S4aqGI1mSqo
    - The Hubble Radius (Hubble Length) is equal to the Schwarzschild Radius of a Black-Hole; [$M = M_\Phi$].

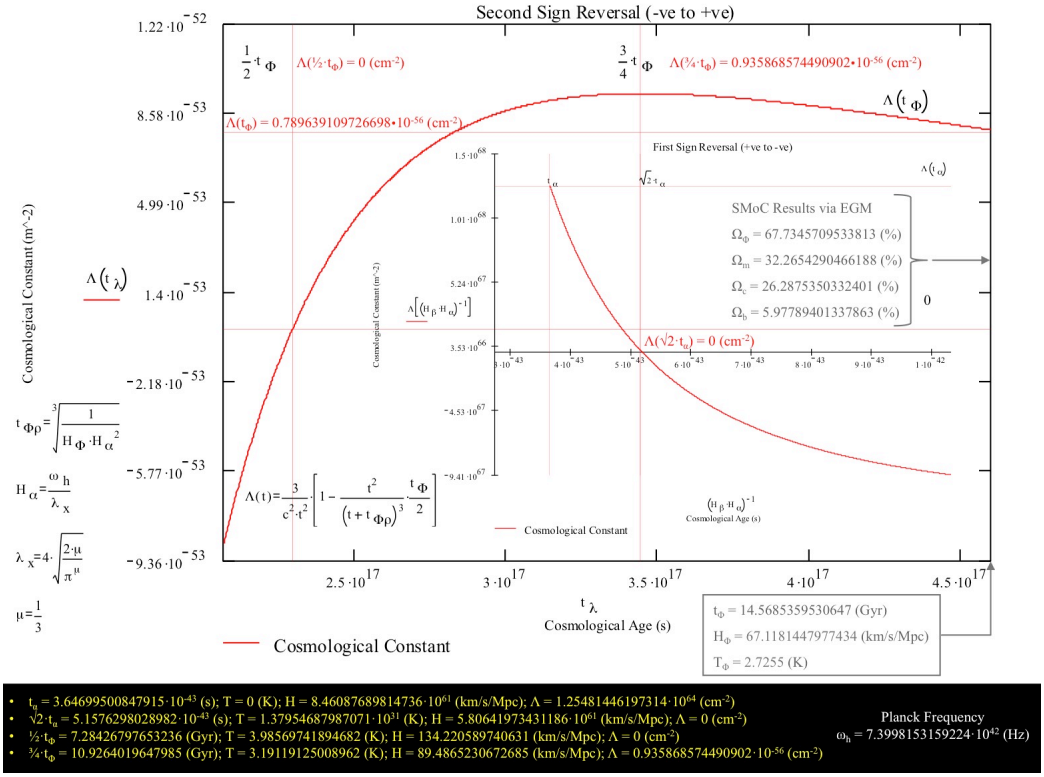


[Fig. 15] Cosmological Space-Time[17]

[17] See Appendix; also review the supplementary material listed in the references for High & Ultra-High resolution imagery in multiple formats.

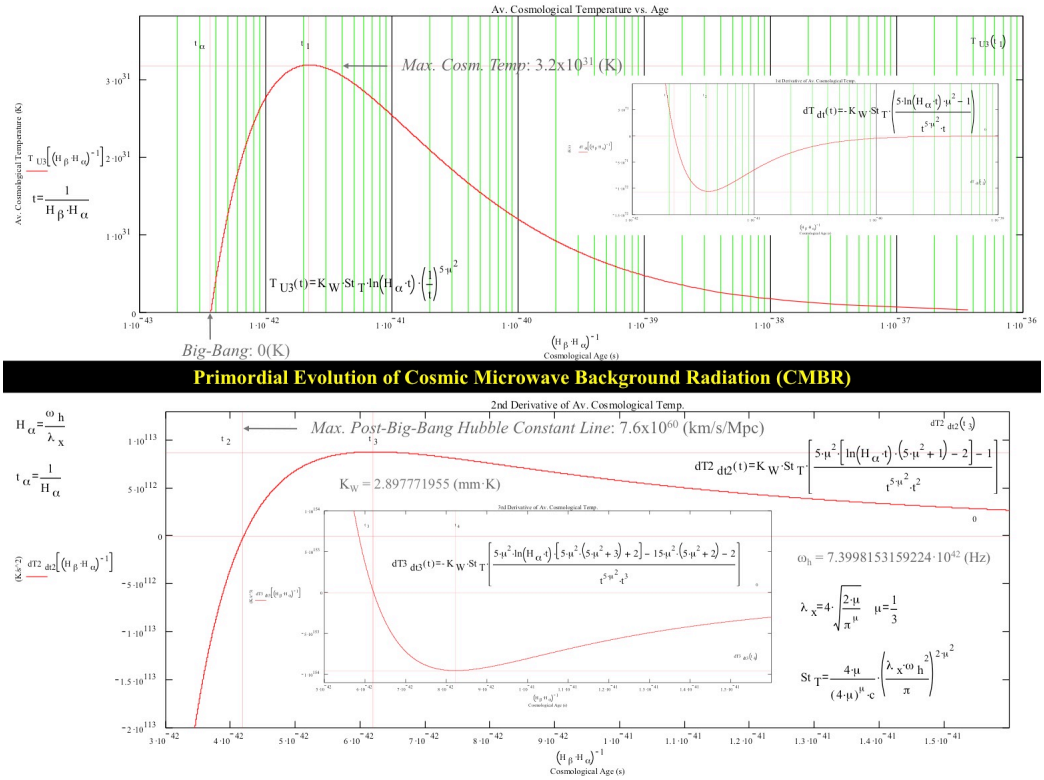
APPENDIX

1. History of The Cosmological Constant



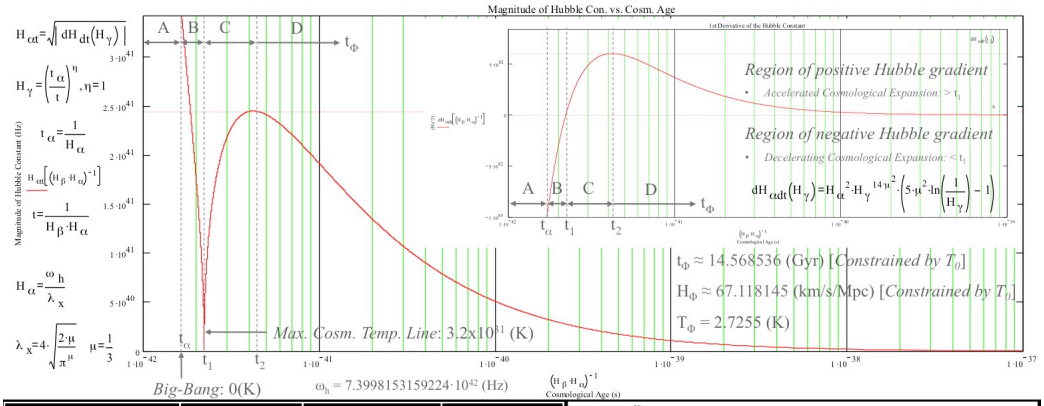
[Fig. A1]: Cosmological Constant

2. Primordial Evolution of The CMBR



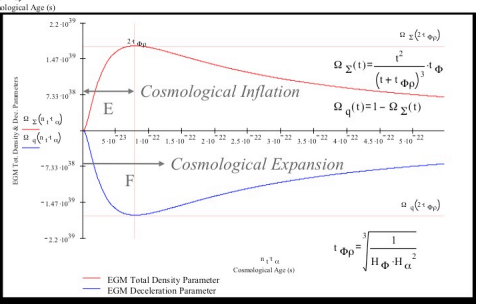
[Fig. A2]: **P**rimordial **C**osmic **M**icrowave **B**ackground **R**adiation (P-CMBR)

3. Primordial Evolution of The Hubble Constant



Phase	Region	Start	End
Planck Inflation	A	0	t_α
Thermal Inflation	B	t_α	t_1
Hubble Inflation	C	t_1	t_2
Hubble Expansion	D	t_2	t_Φ
Cosmological Inflation	E	0	$2 \cdot t_{\Phi\rho}$
Cosmological Expansion	F	t_α	t_Φ

Time	T (K)	dH/dt (km/s/Mpc)²	H (km/s/Mpc)
0	-∞	-∞	+∞
$t_\alpha \approx 3.646995 \cdot 10^{-43}$(s)	0	$\approx -7.158644 \cdot 10^{123}$	$\approx 8.460877 \cdot 10^{61}$
$t_1 \approx 2.206303 \cdot 10^{-42}$(s)	$\approx 3.195497 \cdot 10^{31}$	0	0
$t_2 \approx 4.196184 \cdot 10^{-42}$(s)	$\approx 3.034302 \cdot 10^{31}$	$\approx 5.719442 \cdot 10^{121}$	$\approx 7.5627 \cdot 10^{60}$
$2 \cdot t_{\Phi\rho} \approx 7.879348 \cdot 10^{-23}$(s)	$\approx 1.140344 \cdot 10^{22}$	$\approx 1.455322 \cdot 10^{83}$	$\approx 3.814868 \cdot 10^{41}$

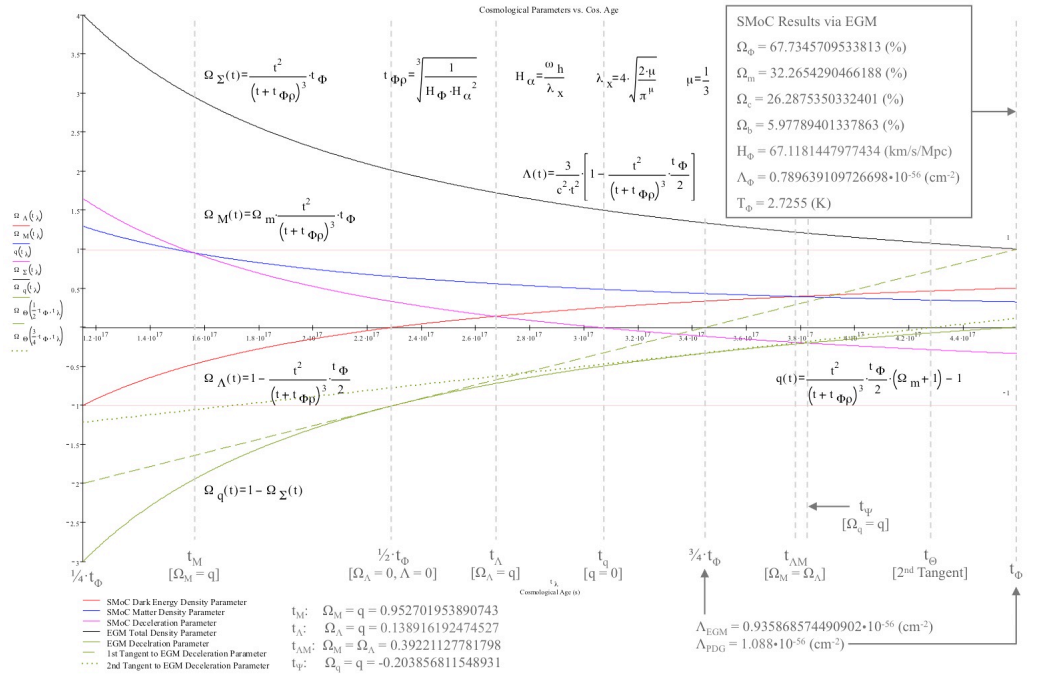


Cosmological Evolution of The Primordial Universe

- Decelerating Cosmological Expansion [dH/dt = negative]: $0 \le t < t_1$
- Accelerated Cosmological Expansion [dH/dt = positive]: $> t_1$
- Cosmological Inflation ceases at $2 \cdot t_{\Phi\rho}$

[Fig. A3]: **P**rimordial **H**ubble **C**onstant (PHC)

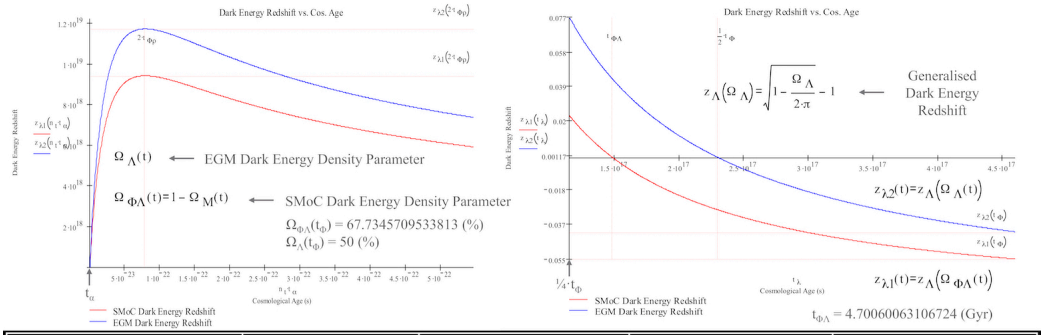
4. History of The Cosmological Parameters



$\frac{1}{4} \cdot t_\Phi$ = 3.642133988266 18 (Gyr) t_M = 4.93396766099874 (Gyr) $\frac{1}{2} \cdot t_\Phi$ = 7.28426797653236 (Gyr) t_Λ = 8.45941813429917 (Gyr)
t_q = 9.63456829206598 (Gyr) $\frac{3}{4} \cdot t_\Phi$ = 10.9264019647985 (Gyr) $t_{\Lambda M}$ = 11.9848686075996 (Gyr) t_Ψ = 12.1015521225654 (Gyr)
t_Θ = 13.6580024559982 (Gyr) t_Φ = 14.5685359530647 (Gyr) ω_h = 7.3998153159224·10^42 (Hz)

[Fig. A4]: Cosmological Parameters [Ω_Λ, Ω_M, q]

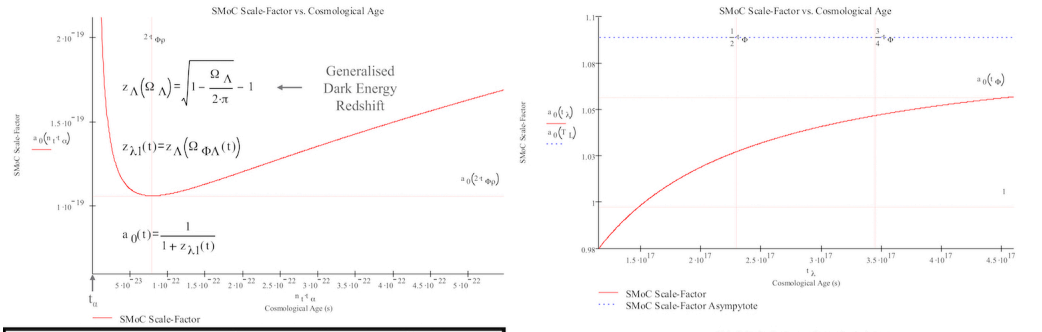
5. Cosmological History of Dark Energy Redshift



Cosmological Age	SMoC Scale-Factor	SMoC Dark Energy Redshift	EGM Dark Energy Redshift	Cosmological Temperature
$t_\alpha = 3.646995008479 15 \cdot 10^{-43}$ (s)	1.05869192530624	-0.055438153350663	-0.0406134624386	0 (K)
$\sqrt{2} \cdot t_\alpha = 5.1576298028982 \cdot 10^{-43}$ (s)	1.02947960192369	-0.028635440535785	0	$1.37954687987071 \cdot 10^{31}$ (K)
$t_1 = 2.20630341057726 \cdot 10^{-42}$ (s)	0.606312479524644	0.649314559357266	0.937328061269383	$3.19549736932411 \cdot 10^{31}$ (K)
$t_2 = 4.19618421889086 \cdot 10^{-42}$ (s)	0.361809027905898	1.76388902119957	2.37278935202517	$3.03430237848861 \cdot 10^{31}$ (K)
$t_3 = 6.20577270831829 \cdot 10^{-42}$ (s)	0.252298908024466	2.96355262823027	3.8869608604435	$2.83252359340709 \cdot 10^{31}$ (K)
$t_4 = 8.22131310011563 \cdot 10^{-42}$ (s)	0.192676492983364	4.19004671777132	5.42495210760686	$2.66321266739522 \cdot 10^{31}$ (K)
$t_{11} = 2.4265 \cdot 10^{-35}$ (s)	$6.63248207917287 \cdot 10^{-8}$	$1.50773107524157 \cdot 10^{7}$	$1.87689583938909 \cdot 10^{7}$	$3.91756114639671 \cdot 10^{28}$ (K)
$2 \cdot t_{\phi p} = 7.8793484858429 \cdot 10^{-23}$ (s)	$1.06132392425242 \cdot 10^{-19}$	$9.42219408371845 \cdot 10^{18}$	$1.17291982193269 \cdot 10^{19}$	$1.14034359584969 \cdot 10^{22}$ (K)
$t_{Op} = 372.9$ (kyr)	0.022321247224749	43.8003639729974	54.7654938958417	895.245381249395 (K)
$¼ \cdot t_\Phi = 3.64213398826618$ (Gyr)	0.977645958080281	0.022865170908714	0.07664058213124	5.82842830809797 (K)
$½ \cdot t_\Phi = 7.28426797653236$ (Gyr)	1.02947960192369	-0.028635440535785	0	3.98569741894682 (K)
$¾ \cdot t_\Phi = 10.9264019647985$ (Gyr)	1.04867993857528	-0.046420205807904	-0.026887286948371	3.19119125008962 (K)
$t_\Phi = 14.5685359530647$ (Gyr)	**1.05869192530624**	**-0.055438153350662**	**-0.0406134624386**	**2.7255 (K)**
$T_L = 4.10165382157836 \cdot 10^{13}$ (Gyr)	1.09054103595779	-0.083023960559425	-0.08302396055942	$3.98834623345483 \cdot 10^{-7}$ (K)
Note: Cosmological Temperature $\neq T_0 \cdot (1 + z_\Lambda)$				

[Fig. A5]: **D**ark **E**nergy **R**edshift (DER)

6. Cosmological History of The Scale-Factor

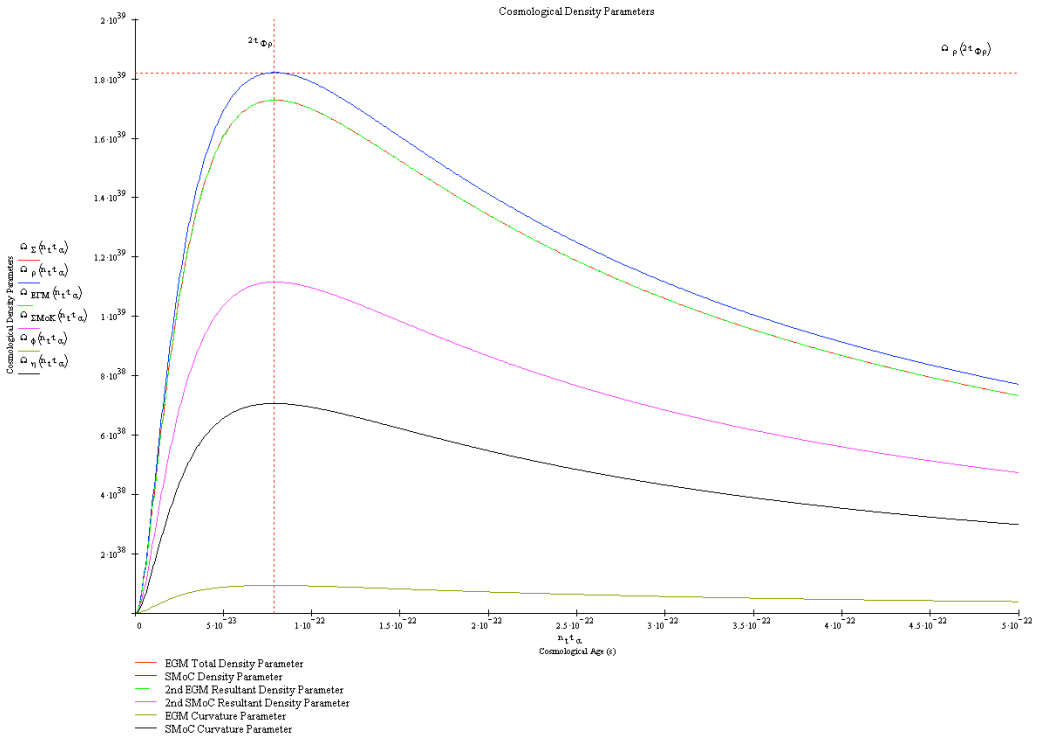


Cosmological Age	SMoC Scale-Factor	Comments
0 (s)	1.09054103595781	Asymptote
$t_\alpha = 3.646995008479 15 \cdot 10^{-43}$ (s)	1.05869192530624	Big-Bang
$\sqrt{2} \cdot t_\alpha = 5.1576298028982 \cdot 10^{-43}$ (s)	1.02947960192369	$\Lambda = 0$
$t_1 = 2.20630341057726 \cdot 10^{-42}$ (s)	0.606312479524644	Max. Temp.
$t_2 = 4.19618421889086 \cdot 10^{-42}$ (s)	0.361809027905898	Max. Hub'l
$t_3 = 6.20577270831829 \cdot 10^{-42}$ (s)	0.252298908024466	–
$t_4 = 8.22131310011563 \cdot 10^{-42}$ (s)	0.192676492983364	–
$t_{11} = 2.4265 \cdot 10^{-35}$ (s)	$6.63248207917287 \cdot 10^{-8}$	Max. PRD
$2 \cdot t_{\phi p} = 7.8793484858429 \cdot 10^{-23}$ (s)	$1.06132392425242 \cdot 10^{-19}$	End Infl'n
$t_{Op} = 372.9$ (kyr)	0.022321247224749	–
$¼ \cdot t_\Phi = 3.64213398826618$ (Gyr)	0.977645958080281	–
$½ \cdot t_\Phi = 7.28426797653236$ (Gyr)	1.02947960192369	$\Lambda = 0$
$¾ \cdot t_\Phi = 10.9264019647985$ (Gyr)	1.04867993857528	Max. Λ
$t_\Phi = 14.5685359530647$ (Gyr)	**1.05869192530624**	**Today**
$T_L = 4.10165382157836 \cdot 10^{13}$ (Gyr)	1.09054103595779	Asymptote

- Max. Temp. = Instant of Maximum Cosmological Temperature
- Max. Hub'l = Instant of Maximum Hubble Constant
- Max. PRD = Instant of Maximum Photon Radiation Density
- End Infl'n = End of Inflationary Period

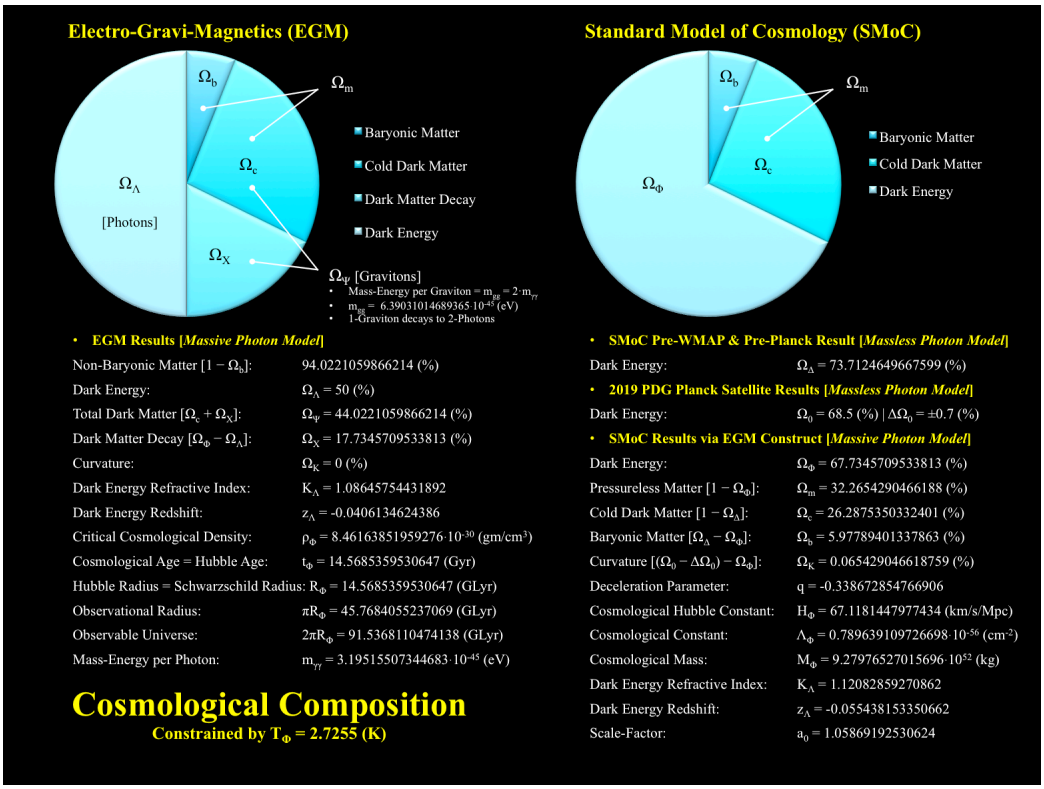
[Fig. A6]: **S**cale-**F**actor (SF)

7. Primordial Evolution of Cosmological Density Parameters



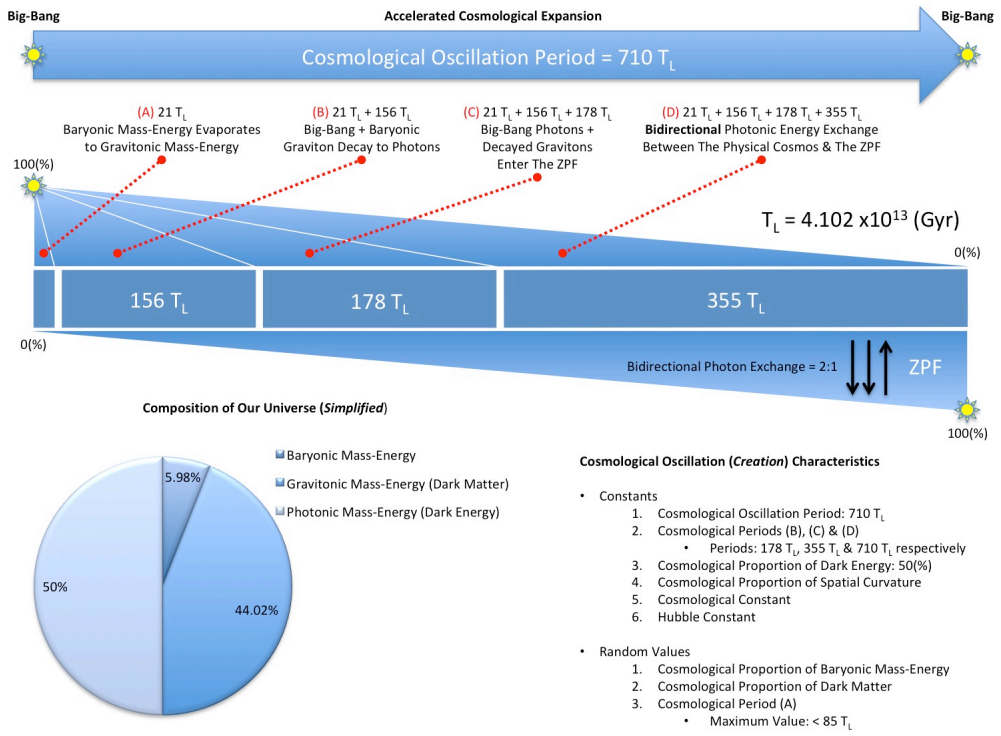
[Fig. A7]: Primordial Evolution of Cosmological Density Parameters

8. Cosmological Composition



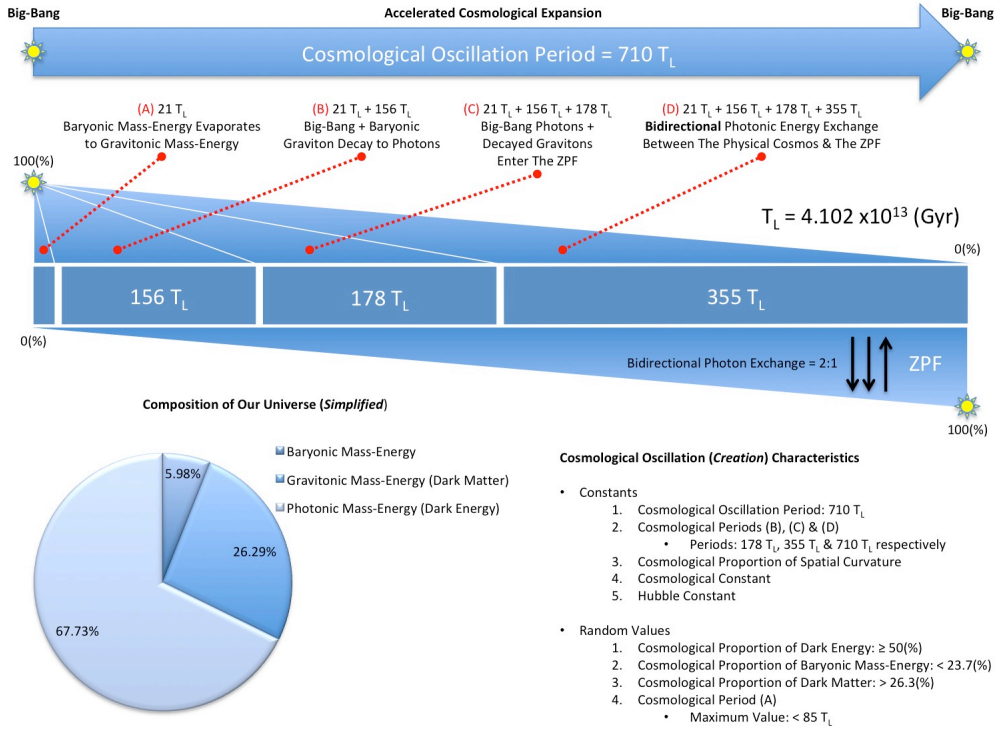
[Fig. A8]: **C**osmological **C**omposition (CC)

9. **Cosmological Bi-Directional Processes: EGM Domain**



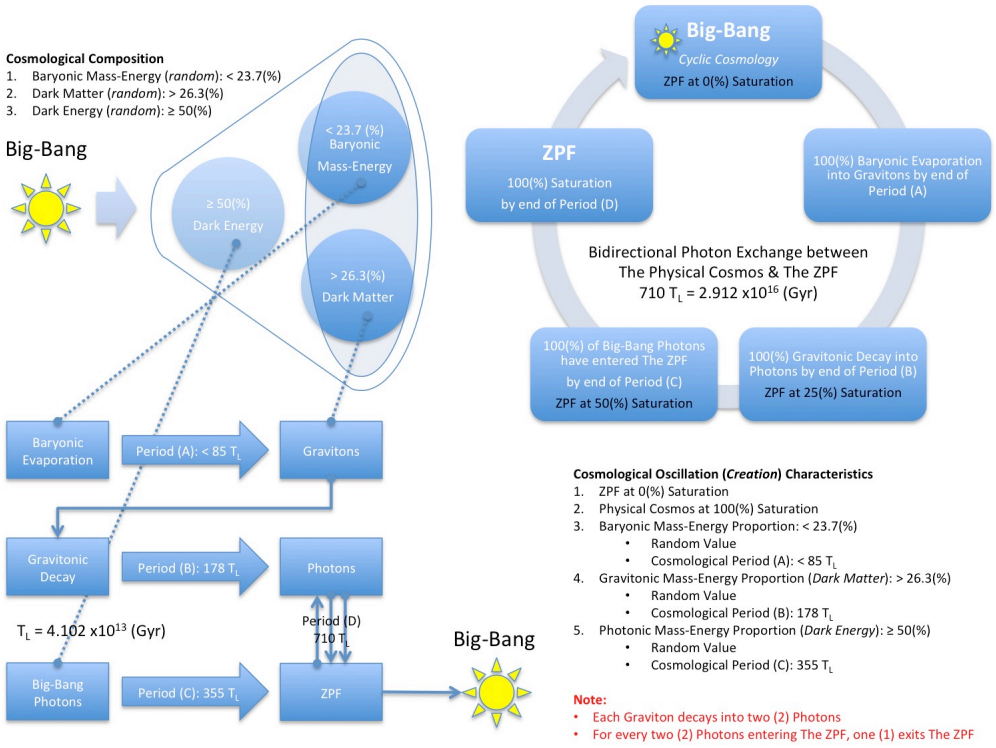
[Fig. A9]: Cosmological Matter-Energy Evaporation Process: EGM Domain

10. **Cosmological Bi-Directional Processes: SMoC Domain**



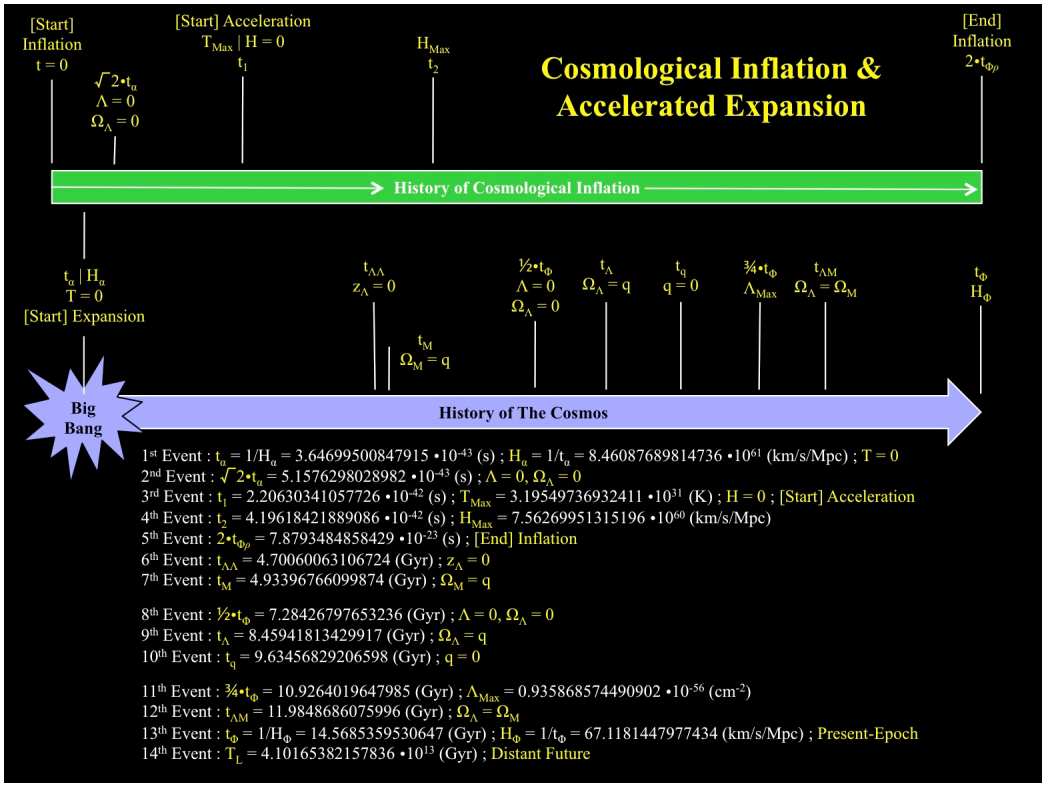
[Fig. A10]: Cosmological Matter-Energy Evaporation Process: SMoC Domain

11. **Common Cosmological Bi-Directional Process**



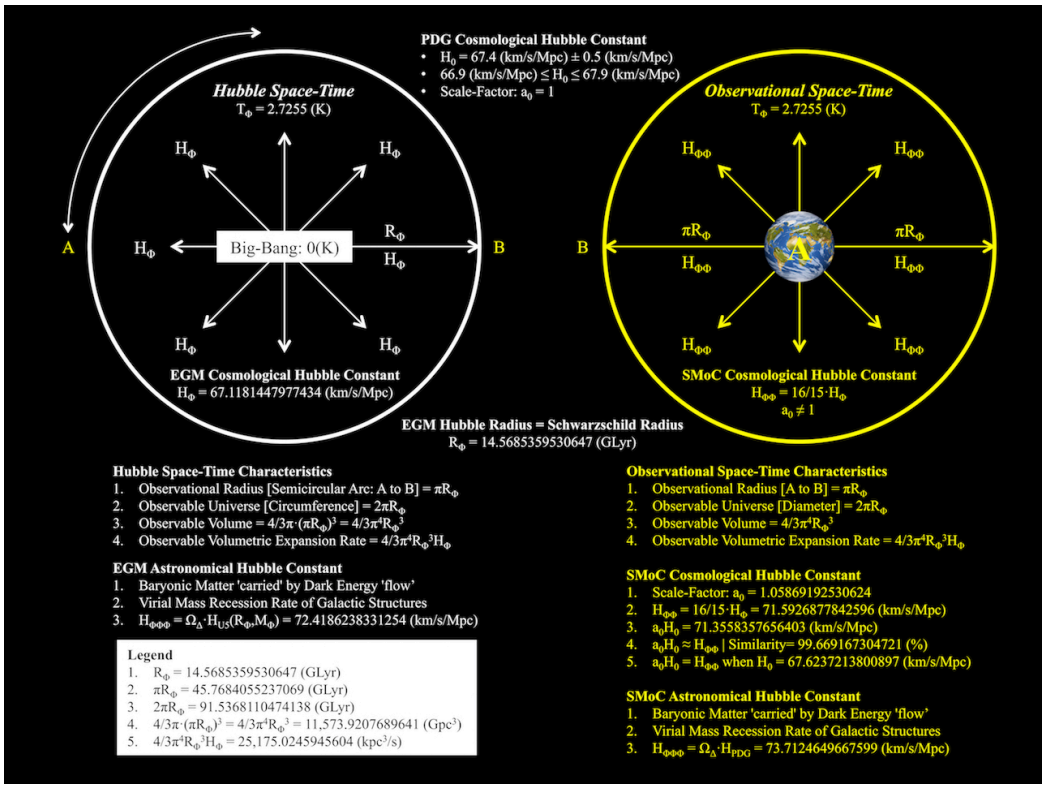
[Fig. A11] Cosmological Matter-Energy Evaporation Process:
[EGM Domain: $\Omega_\Lambda = ½$], [SMoC Domain: $\Omega_\Lambda = 0.677345709533812$ [1]]

12. **Cosmological Inflation Process**



[Fig. A12] **C**osmological **I**nflation **P**rocess (CIP)

13. **Cosmological Space-Time**



[Fig. A13]: **C**osmological **S**pace-**T**ime (CST)

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