

Research Article

The Existence and Effect of Dark Energy Redshift on Cosmological Age

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A derivation of Cosmological Age explicitly constrained by Cosmic Microwave Background Radiation (CMBR) is presented, demonstrating that the correct value of Cosmological Age is equal to the Hubble Age. It is shown that utilizing “ $z=0$ ” for Cosmological Redshift in the Present Epoch introduces a fundamental flaw into Cosmological Age calculations. However, this flaw is captured and corrected by the Polarizable-Vacuum (PV) Model of Gravity developed by Puthoff, suggesting that the Dark Energy Field exists as a massive photonic field. Consequently, it is demonstrated that for a Dark Energy Driven description of Accelerated Cosmological Expansion, Cosmological Redshift takes a negative value in the Present Epoch.

1. Dilemma

1.1. Introduction. The Standard Model of Cosmology (SMoC) utilizes Cosmic Microwave Background Radiation (CMBR) data to determine the age of the Universe, defined by [1] as $13.797 \text{ (Gyr)} \pm 23 \text{ (Myr)}$. However, notably in contrast, the age of star HD-140283 is defined in [2] as $14.46 \text{ (Gyr)} \pm 800 \text{ (Myr)}$. Although no emphatic contradiction exists between these two observations, due to the associated experimental tolerances, it provokes scrutiny as the HD-140283 lower observational limit is 13.66 (Gyr) . Since the lower CMBR limit is 13.774 (Gyr) , an arguably narrow 114 (Myr) congruence window exists between CMBR and HD-140283 measurements. Cognizant of the exponential rate of technological growth, one may well expect that the tolerance commonality between these two experimental sources might instantly vanish. For such an event to occur, the SMoC may require significant revision.

It seems improbable that the physical measurements gathered by the instrumentation utilized in the Planck Satellite [3] are flawed; the Science and Engineering underlying the technology is well-understood, and significant instrumentation defects would have become rapidly evident and subsequently corrected prior to deployment. It is equally improbable that the software associated with the

observation and data collection processes might lead to incorrect results as the computational output is broadly peer-reviewed prior to publication. Thus, by elimination, the remaining candidate for scrutiny is the theoretical basis from which the final age determination is executed according to the SMoC relationship

$$\frac{1}{H_0} \int_{\infty}^z \frac{1}{(1+z)\sqrt{(1-\Omega_{\Lambda})(1+z)^3 + \Omega_{\Lambda}}} dz = 13.797 \text{Gyr}, \quad (1)$$

where [1] H_0 = Hubble Constant = $67.4 \text{ (km/s/Mpc)} \pm 0.5 \text{ (km/s/Mpc)}$ and Ω_{Λ} = Dark Energy Density Parameter = 0.685 ± 0.007 .

If the Cosmological Redshift for the Present Epoch is assigned the value “ $z=0$,” (1) simplifies to

$$\frac{2}{3H_0 \cdot \sqrt{\Omega_{\Lambda}}} \cdot \ln\left(\frac{1 + \sqrt{\Omega_{\Lambda}}}{\sqrt{1 - \Omega_{\Lambda}}}\right) = 13.797 \text{Gyr}. \quad (2)$$

It is important to note that “ $z=0$ ” for the Present Epoch is an *assigned* value, not an assumed value. An assigned value is a man-made contrivance, whilst an assumed value can have natural origins. The assigned value for the Present Epoch seems reasonable, benign, and convenient, but what

are the implications associated with this? To address this question and validate (2), we require an alternative representation of Cosmological Redshift. Fortunately, Puthoff [4] developed an alternative representation of General Relativity (GR) termed The Polarizable-Vacuum (PV) Model of Gravity. Since then, Depp et al. [5, 6] and Desiato [7] have shown the PV Model of Gravity to be isomorphic to GR by satisfying the Schwarzschild and Reissner–Nordstrom solutions.

1.2. The PV Model. The PV Model of Gravity is an optical derivative, utilizing a Refractive Index value “ K_{PV} .” For an observer at the bottom of a gravity well, gazing upwards and backwards in time (e.g., at the surface of the Earth), the relationship between Cosmological Redshift “ z ” and “ K_{PV} ” utilizing Puthoff relationships [4] is given by

$$1 + z = \frac{1}{\sqrt{K_{PV}}}. \quad (3)$$

Hence, (1) expressed in PV form is given by

$$\frac{1}{2H_0} \int_0^1 \frac{1}{K_{PV} \sqrt{\left(\frac{1}{\sqrt{K_{PV}^3}}\right)(1 - \Omega_\Lambda) + \Omega_\Lambda}} dK_{PV} = 13.797 \text{Gyr}. \quad (4)$$

(1)=(4); therefore, the PV Model of Gravity aligns precisely to the SMOc (as expected). However, (4) reveals an important fact regarding the assigned value of Cosmological Redshift “ $z=0$,” utilized to formulate (2). That is, the Refractive Index value “ $K_{PV} = 1$ ” can *only* occur when the observer possesses the power of infinite gaze in our Universe

or resides at infinity outside our Universe (e.g., in a *Multiverse Cosmological Model*). This means that the assigned value of Cosmological Redshift “ $z=0$ ” represents a non-physical situation, thereby denoting an invalid procedural step. Utilizing “ $z=0$ ” requires The Observable Universe to be infinitely large, yet CMBR observations are seeking to measure a finite size. Hence, (2) is in conflict with CMBR experimental objectives, demonstrated by the Gravitational Refractive Index as implicitly asserted by Desiato [7], such that the value “ $K_{PV} = 1$ ” occurs as “ $r \rightarrow \infty$ ” according to

$$K_{PV} = \frac{1}{(1 - (2G \cdot M/r \cdot c^2))} = \frac{r \cdot c^2}{r \cdot c^2 - 2G \cdot M}. \quad (5)$$

Note: equation (5) represents the Metric Coefficient of the Schwarzschild Solution of Einstein’s equations of GR.

2. Resolution

Equation (5) invokes the question if “ $r \rightarrow \infty$ ” should not be applied, what should be? To address this question, we shall conduct the following thought experiment: consider an Observable Universe of Hubble Radius “ R_H .” For an observer to circumnavigate this Universe, he/she must travel a distance of “ $2\pi R_H = 2\pi c/H_0$ ”; hence, from the perspective of the observer, (5) is required to metabolize the condition “ $r = 2\pi c/H_0$.” Moreover, it follows that if the Universe is of Hubble Radius, then “ M ” relates to Hubble Volume; hence, “ M ” is equal to the Dark Energy Density Parameter multiplied by the Hubble Volume multiplied by the Critical Density, such that a Dark Energy Refractive Index “ K_Λ ” may be formulated according to

$$K_\Lambda = \frac{(2\pi c/H_0)c^2}{(2\pi c/H_0)c^2 - 2G(\Omega_\Lambda [(4/3)\pi (c/H_0)^3] (3H_0^2/8\pi G))} = \frac{2\pi}{2\pi - \Omega_\Lambda}. \quad (6)$$

Substituting (6) into (3) yields the Dark Energy Redshift “ z_Λ ” as follows:

$$z_\Lambda = \sqrt{1 - \frac{\Omega_\Lambda}{2\pi}} - 1. \quad (7)$$

Combining (6) with PV Time Dilation of the form “ $\Delta t_0 = \Delta t \cdot \sqrt{K_{PV}}$ ” as defined by Puthoff [4] yields a revised expression for Cosmological Age “ t_0 ” as follows:

$$t_0 = \frac{2}{3H_0 \sqrt{\Omega_\Lambda}} \ln \left[\frac{1 + \sqrt{\Omega_\Lambda}}{\sqrt{1 - \Omega_\Lambda}} \right] \cdot \sqrt{\frac{2\pi}{2\pi - \Omega_\Lambda}}. \quad (8)$$

3. Results

3.1. Theoretical Solution. Equation (6) was formulated for a Theoretical Universe of Hubble Radius; hence, for the Hubble Time configuration $t_0 = 1/H_0$, we obtain the following outputs:

- (i) $\Omega_\Lambda = 0.677345709533812$
- (ii) $\Omega_m = 0.322654290466188$
- (iii) $K_\Lambda = 1.12082859270862$
- (iv) $z_\Lambda = -0.055438153350662$

The following are the key points:

- (i) Our Theoretical Universe is a useful representation of physical reality
- (ii) Our Ω_Λ lies less than “0.1 (%)” outside SMOc limits
 - (a) The SMOc range of Ω_Λ is “ 0.685 ± 0.007 ” [1].
- (iii) The proximity of our Ω_Λ to SMOc results denotes initial evidence that the Hubble Age (8) is the correct Cosmological Age; not (2)
- (iv) K_Λ is greater than unity, denoting Accelerated Cosmological Expansion

- (v) z_Λ is negative, denoting Accelerated Cosmological Expansion
- (vi) Calculations utilizing an *assigned* Cosmological Redshift of $z=0$ may require revision

3.2. *Constrained Theoretical Solution.* For the Hubble Time configuration $t_0 = 1/H_0$ constrained to CMBR Temperature in accordance with the relationship formulated by Storti [8–11],

$$T_0 = K_W St_T \cdot \ln\left(\frac{H_\alpha}{H_0}\right) H_0^{5\mu^2}, \quad (9)$$

where $H_\alpha = \text{Big-Bang Hubble Constant} = 8.46087689814736 \times 10^{61}$ (km/s/Mpc), the derivation of H_α can be found on pg. 12, Equation (24); [10], $St_T = \text{Physical Constant} = 6.35538654769188 \times 10^{95}$ (s⁵/m⁹), the derivation of St_T can be found on pg. 14, Equation (42); [10], $K_W = \text{Wien Displacement Constant} = 2.897771955$ (mm·K), $\mu = \text{Mathematical Constant} = 1/3$, $T_0 = 2.7255$ (K) $\pm \Delta T_0$ [1], and $\Delta T_0 = 0.0006$ (K).

Note: H_α and St_T are forwardly derived from first principles; they are not reverse-engineered, ad hoc, or tailored constants; refer to [10] for the derivation.

The calculated permissible range values for “ Ω_Λ , Ω_m , K_Λ , z_Λ , H_0 and t_0 ” are displayed in Table 1.

The following are the key points:

- (i) Our CMBR Temperature-constrained Theoretical Universe remains a useful representation of physical reality
- (ii) Ω_Λ , Ω_m , K_Λ , and z_Λ remain constant across the CMBR observational range
- (iii) Ω_Λ lies less than “0.1 (%)” outside SMOc limits
- (iv) $H_0 = 67.1181$ (km/s/Mpc) ± 0.0269 (km/s/Mpc)
 - (a) H_0 lies within SMOc observational limits
 - (b) H_0 resolution is improved by one order-of-magnitude
 - (c) Our value of H_0 validates the SMOc-expected (*unproven*) dependency between the Hubble constant and CMBR Temperature
 - (d) Our value of H_0 denotes supporting evidence for the Hubble Age (8) being the correct Cosmological Age; not (2)
- (v) $t_0 = 14.5685$ (Gyr) ± 5.849 (Myr)
 - (a) Our value denotes unprecedented resolution of Cosmological Age
 - (b) We show synergy with HD-140283: 14.46 (Gyr) ± 114.39 (Myr)
 - (c) Our value reduces the potential for a “*Crisis in Cosmology*”

3.3. *Heuristic Solution.* For the Hubble Time configuration $t_0 = 1/H_0$ utilizing key SMOc data ranges [1], we calculate the outputs as displayed in Table 2.

The following are the key points:

- (i) The SMOc determination of Cosmological Age [1] does *not* concur with CMBR Temperature observations (*i.e.*, t_0 is in conflict with T_0)
 - (a) The use of (9) provides supporting evidence for the Hubble Age (8) being the correct Cosmological Age, not (2)
- (ii) SMOc Hubble Constant observations are consistent with CMBR Temperature observations, *validating* (9)
- (iii) SMOc Dark Energy Density values are consistent with CMBR Temperature observations, *validating* (9)
- (iv) Our CMBR Temperature-constrained Theoretical Universe remains a useful representation of physical reality

3.4. *Constrained Heuristic Solution.* For the Hubble time configuration $t_0 = 1/H_0$ constrained by SMOc Ω_Λ and T_0 values [1], we calculate the outputs as displayed in Table 3.

The following are the key points:

- (i) Many SMOc combinations of Ω_Λ and H_0 exist to satisfy observational CMBR Temperature requirements, *validating* (9)
- (ii) The SMOc “ $\Omega_\Lambda + \Delta\Omega_\Lambda$ ” limit violates the SMOc “ $H_0 + \Delta H_0$ ” limit
- (iii) Our dark energy *plus* CMBR Temperature-constrained Theoretical Universe is a useful representation of physical reality

4. Discussion

The preceding analysis clearly demonstrates the correlation between physical reality and our Theoretical Universe of Hubble Radius, offering a persuasive argument supporting the contention that the Hubble Age is the true Cosmological Age, not the present value as calculated by the SMOc [1]. So, why is the SMOc determination of Cosmological Age inaccurate? Primarily, it is because the method of calculation does not include a direct and clear relationship to CMBR Temperature. Cosmological Age, Hubble Constant, Dark Energy and CMBR Temperature must be related, yet The SMOc solution only embraces three of the four critical elements for physical meaningfulness. This is the first clue as to why the SMOc determination of Cosmological Age is inaccurate. The second clue is in the fact that the SMOc value is 663 (Myr) less than the value for HD-140283. Although observational tolerances ensure that the results are not in conflict in this case, it is prudent for us to emphasize the meaning of error bars. Error bars provide no guarantee that the central value is not incorrect to begin with, only that the central value lies between certain limits. The assertion of experimental consistency between two data sets based solely upon tolerance overlap is not a robust defence. If either

TABLE 1: H_0 (km/s/Mpc) and t_0 (Gyr).

	$T_0 - \Delta T_0$	T_0	$T_0 + \Delta T_0$
Ω_Λ	0.677345709533813	0.677345709533812	0.677345709533812
Ω_m	0.322654290466187	0.322654290466188	0.322654290466188
K_Λ	1.12082859270862	1.12082859270862	1.12082859270862
z_Λ	-0.055438153350662	-0.055438153350662	-0.055438153350662
H_0	67.0912006738519	67.1181447977434	67.1450938090621
t_0	14.5743867417478	14.5685359530647	14.5626888000112

TABLE 2: T_0 (K).

	T_0	Configuration	Methodology
$t_0 - \Delta t_0$	2.81061377079329		
t_0	2.80804368741903	$t_0 = 13.797$ (Gyr) $\pm \Delta t_0$, $\Delta t_0 = 23$ (Myr)	Direct injection into (9): T_0 ($1/t_0$)
$t_0 + \Delta t_0$	2.80548022874534		
$H_0 - \Delta H_0$	2.72063915377994		
H_0	2.73176992769907	$H_0 = 67.4$ (km/s/Mpc) $\pm \Delta H_0$, $\Delta H_0 = 0.5$ (km/s/Mpc)	Direct injection into (9): T_0 (H_0)
$H_0 + \Delta H_0$	2.74286346018614		
$\Omega_\Lambda - \Delta\Omega_\Lambda$	2.73082285014193		
Ω_Λ	2.7206171322242	$H_0 = 67.4$ (km/s/Mpc), $\Omega_\Lambda = 0.685 \pm \Delta\Omega_\Lambda$, $\Delta\Omega_\Lambda = 0.007$	Injection into (8), and then into (9): T_0 ($1/t_0$)
$\Omega_\Lambda + \Delta\Omega_\Lambda$	2.71027372079337		

central value evolves from a fundamentally incorrect approach, the tolerance overlap is valueless.

Our significant deviation from SMoC doctrine warrants explanation, satisfying the question as to how this oversight occurred. Herein, we have identified the cause ($z=0$), proposed a resolution z_Λ , and quantified the outcome Ω_Λ . The next logical question to investigate is why an assigned value of $z=0$ is inappropriate to apply, that is, why is (2) inaccurate? Considering the synergy between our

Theoretical Universe and physical reality, we propose that (2) is incomplete because it does not adequately consider the time dilation effects of a Massive Photonic Field.

We propose that the Dark Energy Field is a massive photonic field

Evidence for this claim arose in 2008, where Storti [8] accurately calculated CMBR Temperature utilizing (9) and predicted the value of the Hubble Constant in advance of experimental measurement:

$$H_0 = \frac{m_{\gamma\gamma}}{h} \cdot \ln \left(\frac{\sqrt{(3\pi)^{7\mu} \cdot 32^{\mu^2}}}{256} \cdot \ln \left(\frac{(3\pi)^\mu}{4} \cdot \left(\frac{m_h}{M_G} \right)^{\mu^2} \left(\frac{R_0}{\lambda_h} \right)^{7\mu^2} \right)^{7\mu} \cdot \left(\frac{m_h}{M_G} \right)^{5\mu^2} \left(\frac{R_0}{\lambda_h} \right)^{26\mu^2} \right)^5, \quad (10)$$

where $m_{\gamma\gamma}$ =Photon Mass-Energy = $3.19515507344683 \times 10^{-45}$ (eV) [12], h = Planck's Constant = $6.62607015 \times 10^{-34}$ (J/Hz), m_h = Planck Mass = $5.45551186133462 \times 10^{-8}$ (kg), λ_h = Planck Length = $4.05135054323488 \times 10^{-35}$ (m), M_G = Galactic Mass (2008: predicted) = 6.3142×10^{11} (M_\odot), and μ = Mathematical Constant = $1/3$.

The yielded predictions are displayed in Table 4.

The following are the key points:

- (i) Equations (9) and (10) have been experimentally verified
- (ii) Equation (10) utilizes a derived value of *nonzero* Photonic Mass-Energy
- (iii) The existence of a Massive Photonic Dark Energy Field is implied
- (iv) The Massive Photonic Dark Energy Field is responsible for Accelerated Cosmological Expansion

(v) The effect of Accelerated Cosmological Expansion is to “pull” time dilation in the “opposite direction,” acting to “stretch time”

(vi) Cosmological Inflation and Accelerated Cosmological Expansion are derived naturally and without “fine tuning” or “retro-fitting” in [8–11].

(vii) The true value of Cosmological Age equals the Hubble Age

Upon consideration of all results presented herein, we predict that future experimental observations will tend to yield values of Dark Energy Density Parameter increasingly approaching the present SMoC lower limit “ $\Omega_\Lambda - \Delta\Omega_\Lambda$ ”. Moreover, we propose that the difference between our theoretical Ω_Λ value and the present SMoC lower limit *may* represent a possible candidate for spatial curvature Ω_K , as follows:

- (i) The present SMoC Ω_Λ lower limit = $0.685 - 0.007 = 0.678$

TABLE 3: H_0 (km/s/Mpc) and t_0 (Gyr).

	$T_0 - \Delta T_0$	$\Omega_\Lambda - \Delta\Omega_\Lambda$ T_0	$T_0 + \Delta T_0$
H_0	67.1336409514318	67.160602119527	67.1875681781412
t_0	14.5651731640227	14.5593260740679	14.5534826174442
	$T_0 - \Delta T_0$	Ω_Λ T_0	$T_0 + \Delta T_0$
H_0	67.593627468596	67.6207733693176	67.6479241940671
t_0	14.4660546002391	14.4602473007592	14.4544436098851
	$T_0 - \Delta T_0$	$\Omega_\Lambda + \Delta\Omega_\Lambda$ T_0	$T_0 + \Delta T_0$
H_0	68.0648179486208	68.09215308153	68.1194931727921
t_0	14.365910834097	14.3601437366527	14.3543802228329

TABLE 4: Experimental validation of predictions.

PDG (2008) [13] <i>Measurement</i>	Storti (2008) [8, 9] <i>Prediction</i>	PDG (2019) [1] <i>Measurement</i>
$H_0 = 73$ (km/s/Mpc)	$H_0 = 67.0843$ (km/s/Mpc)	$H_0 = 67.4$ (km/s/Mpc)
$R_0 = 8.0$ (kpc)	$R_0 = 8.1072$ (kpc)	$R_0 = 8.178$ (kpc)
$T_0 = 2.725$ (K)	$T_0 = 2.7248$ (K)	$T_0 = 2.7255$ (K)

- (ii) The present SMOc value of spatial curvature $\Omega_K = 0.0007$ [1]
- (iii) Our value for Ω_Λ in the theoretical solution = 0.677345709533812
- (iv) Our value for $\Omega_K = 0.678 - 0.677345709533812 = 0.000654290466188$

The following are the key points:

- (i) Our value for Ω_K is quasi-identical to the SMOc value

5. Conclusions

The Polarizable-Vacuum Model of Gravity developed by Puthoff [4], the isomorphic work presented by Dep et al. [5, 6], and the form of the Gravitational Refractive Index implicitly asserted by Desiato [7] have enabled us to refine the estimate for Cosmological Age in the Standard Model of Cosmology.

The following are the key points:

- (i) The true value of Cosmological Age equals the Hubble Age
- (ii) Calculations utilizing an *assigned* Cosmological Redshift of “ $z=0$ ” may require revision
- (iii) The value of the Cosmological Refractive Index is greater than unity for the Present Epoch, denoting Accelerated Cosmological Expansion
- (iv) The value of Cosmological Redshift is negative for the Present Epoch, denoting Accelerated Cosmological Expansion
- (v) The SMOc determination of Cosmological Age does *not* concur with CMBR Temperature observations (*i.e.*, t_0 is in conflict with T_0)

- (vi) SMOc Hubble Constant observations are consistent with CMBR Temperature observations
- (vii) SMOc Dark Energy Density values are consistent with CMBR Temperature observations
- (viii) The SMOc “ $\Omega_\Lambda + \Delta\Omega_\Lambda$ ” limit violates the SMOc “ $H_0 + \Delta H_0$ ” limit
- (ix) The existence of a Massive Photonic Dark Energy Field is implied
- (x) The Massive Photonic Dark Energy Field is responsible for Accelerated Cosmological Expansion
- (xi) The effect of Accelerated Cosmological Expansion is to “pull” time dilation in the “opposite direction,” acting to “stretch time”
- (xii) $H_0 = 67.1181$ (km/s/Mpc) ± 0.0269 (km/s/Mpc)
- (xiii) $t_0 = 14.5685$ (Gyr) ± 5.849 (Myr)

Data Availability

Full calculations are supplied via a solution algorithm; all data sources are referenced and available within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Supplementary Materials

The supplementary materials contain the calculation of the Existence and Effect of Dark Energy Redshift on the Cosmological Age and Minimised Solution Algorithm (cosmology). (*Supplementary Materials*)

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