

The Global Energy Equivalence: Bridging the $R_H = ct$ and Standard Cosmological Models Through the Indistinguishability of Energy Components

Stéphane Wojnow
Chercheur Indépendant, Limoges, France
Email : wojnow.stephane@gmail.com
<https://orcid.org/0000-0001-8851-3895>

June 17, 2026

Abstract

In this paper, we propose a novel unifying framework that resolves the conceptual tension between the standard cosmological model (Lambda-CDM) and the linear expansion model ($R_H = ct$). Recent data from the Dark Energy Spectroscopic Instrument (DESI) DR2 indicates a complex, potentially dynamical evolution of dark energy. We demonstrate that if the cosmic horizon behaves as a holistic system that is fundamentally agnostic to the internal partitioning of its energy—thereby treating the strict sum of matter density $\Omega_m(1+z)^3$ and dark energy density $\Omega_{DE}(z)$ as a single unsegregated global fluid—the empirical 'quasi-linear' trajectory observed in expansion data is strictly proportional to the cosmic age. We show that the total critical mass-energy contained within the Hubble sphere is analytically equivalent to $E(t) = \frac{1}{2} \frac{c^4}{G} \cdot ct$. This global approach provides an elegant mathematical bridge, showing that Lambda-CDM and $R_H = ct$ can be viewed as two distinct coordinate interpretations of the same underlying total energy evolution.

1. Introduction

The publication of the Dark Energy Spectroscopic Instrument Second Data Release (DESI DR2) has introduced intriguing hints of dynamics within the dark energy sector, diverging from the strict cosmological constant of the standard Λ CDM paradigm. Concurrently, alternative models such as the linear expansion cosmology, defined by a Hubble radius $R_H = ct$, offer compelling simplicity but often clash with standard interpretative frameworks that strictly partition the universe into individual components like baryonic matter, cold dark matter, and dark energy.

This work presents a foundational shift in perspective. Instead of forcing the $R_H = ct$ model to perform a granular segregation between $\Omega_m(1+z)^3$ and $\Omega_{DE}(z)$, we assert that the gravitational horizon reacts purely to the strict addition of these parameters. By examining the unsegregated total density, we uncover a direct, rigorous proportionality between the global energy state and the cosmic age, transforming the empirically observed 'quasi-straight line' of expansion histories into a mandatory consequence of horizon equilibrium.

2. Total Energy in the $R_H = ct$ Universe

Let us define the linear cosmic model where the Hubble radius expands exactly at the speed of light: $R_H = ct$. The corresponding Hubble parameter is inherently defined as $H(t) = \frac{c}{R_H} = \frac{1}{t}$. In a flat Friedmann universe, the critical density required to maintain flat spatial geometry is given by:

$$\rho_{c(t)} = \frac{3 H_t^2}{8 \pi G} = \frac{3}{8 \pi G t^2} \quad (1)$$

The total mass-energy content contained inside the volume of the Hubble sphere $V_{H(t)} = \frac{4}{3} \pi R_H^3 = \frac{4}{3} \pi (ct)^3$ can be derived by multiplying the critical mass-density by the volume and converting to energy via $E = m c^2$:

$$E(t) = \rho_{c(t)} \cdot c^2 \cdot V_{H(t)} = \frac{3}{8 \pi G t^2} c^2 \frac{4}{3} \pi (ct)^3 = \frac{1}{2} \frac{c^4}{G} \cdot ct \quad (2)$$

Equation (2) proves that the total critical energy $E(t)$ is strictly proportional to the age of the universe t . The term $\frac{c^4}{G}$ is the Planck force, acting here as the fundamental tension scaling the spacetime envelope. Through the standard cosmological definition of redshift, where $\frac{dt}{dz} = \frac{-1}{[(1+z)H(z)]}$ substituting $H(z) = 1/t$ yields the exact scaling relation: $t(z) = t_0 / (1+z)$. Consequently, the global energy transforms with redshift as $E(z) \propto (1+z)^{-1}$.

3. The Global Sum Hypothesis and DESI DR2 Interpretation

The core of our proposal is that the physical universe does not possess an innate mechanism to isolate the individual behaviors of pressureless matter $\Omega_m(1+z)^3$ and dark energy $\Omega_{DE}(z)$ establishing global expansion constraints. For a meaningful comparison between the standard model and the $R_H = ct$ framework, one must exclusively look at the unsegregated sum of the energy densities:

$$\Omega_{tot}(z) = \Omega_m(1+z)^3 + \Omega_{DE}(z) \quad (3)$$

In the standard framework, this sum drives the Friedmann equation via $H^2(z) = H_0^2 \Omega_{tot}(z)$. In the $R_H = ct$ framework, a strictly linear evolution requires $H(z) = H_0(1+z)$ which mathematically implies that $\Omega_{tot}(z)$ is proportional to $(1+z)^2$.

Cosmological Era / Metric	Standard Segregated View (\Lambda-CDM)	Global Unsegregated View (This Work)
High Redshift ($z > 1$)	Matter Dominated: $\sim (1+z)^3$	Approaching Matter Limit
Low Redshift ($z < 0.3$)	Dark Energy Dominated: \sim Constant	Approaching Horizon Limit
Transition Zone ($0.3 < z < 1.0$)	Complex interplay of separate curves	Quasi-linear proportional to $(1+z)^2$

When examining Figure 1 of the DESI DR2 publication, the empirical data points for $H(z)$ sketch a 'quasi-straight line' across the median redshift range ($0.3 < z < 1.0$). Under the standard paradigm, this linearity is interpreted as an accidental, temporary numerical coincidence born from the crossover of two drastically different mathematical curves: the cubic decay of matter and the constant/slowly shifting dark energy density.

Under our global sum hypothesis, this quasi-straight line is recognized as a physical manifestation of the universe preserving its total energy proportionality. The nature of the cosmic fluid compensates for the dilution of matter density by modulating the emergence of dark energy. The strict sum dynamically tracks the quadratic evolution $(1 + z)^2$ over a vast observational window, establishing that the total energy is fundamentally proportional to the cosmic age.

4. Conclusion

By refraining from distinguishing between internal components and analyzing the strict sum of $\Omega_m(1 + z)^3$ and $\Omega_{DE}(z)$, the apparent conflict between Λ CDM and $R_H = ct$ cosmologies vanishes. The 'quasi-straight line' highlighted by the latest DESI DR2 data is not a temporary statistical artifact, but rather the elegant signature of a global energy state $E(t) = \frac{1}{2} \frac{c^4}{G} \cdot ct$ that is strictly proportional to the age of the universe. This conceptual synthesis opens up a new avenue for interpreting baryon acoustic oscillations and horizon-scale thermodynamics.

References :

DESI Collaboration. (2025). *DESI DR2 Results II: Measurements of BAO*. <https://doi.org/10.1103/tr6y-kpc6>. <https://arxiv.org/abs/2503.14738> (page 6)