The T0-Model: The Hubble Parameter in a Static Universe

Energy Loss Through the Universal ξ-Field Johann Pascher January 6, 2026

Abstract

The T0-model reinterprets the Hubble parameter H_0 within a static universe framework where observed redshift arises from photon energy loss during propagation through the omnipresent ξ-field rather than spatial expansion. Using the universal geometric constant $\xi = \frac{4}{3} \times 10^{-4}$ and energy field dynamics, we derive the Hubble parameter as $H_0 = 67.2$ km/s/Mpc without free parameters. This approach eliminates dark energy, resolves the Hubble tension naturally, and provides a unified description based on three-dimensional space geometry in natural units where $\hbar = c = k_B = 1$.

Contents

0.1 Introduction: Rethinking the Hubble Parameter

The conventional interpretation of Hubble's law assumes that galaxies recede due to expanding space, leading to the familiar relationship $v = H_0 d$ where recession velocity increases linearly with distance. However, this expansion paradigm has created numerous theoretical difficulties including the requirement for 69% dark energy, persistent measurement tensions, and fine-tuning problems that suggest our understanding may be fundamentally incomplete.

The T0-model offers a radically different perspective: the universe is static, and what we observe as redshift actually represents energy loss by photons as they propagate through the universal ξ-field that permeates all of space. This reinterpretation transforms the Hubble parameter from a measure of spatial expansion into a characteristic energy loss rate, providing a more elegant and theoretically consistent framework.

In the T0-model, space does not expand. Instead, the Hubble parameter H_0 represents the characteristic rate at which photons lose energy to the universal ξ-field during cosmic propagation.

The fundamental insight is that time-energy duality, expressed through Heisenberg's uncertainty relation $\Delta E \cdot \Delta t \geq \hbar/2$, forbids a temporal beginning of the universe. If everything emerged from a Big Bang singularity, the finite time interval would require infinite energy uncertainty, violating quantum mechanics. Therefore, the universe must have existed eternally, making spatial expansion unnecessary to explain cosmic observations.

0.2 Symbol Definitions and Units

0.2.1 Primary Symbols

0.2.2 Natural Units Convention

Throughout this work, we employ natural units where the fundamental constants are set to unity:

$$\hbar = 1 \quad \text{(reduced Planck constant)} \tag{1}$$
$$c = 1 \quad \text{(speed of light)} \tag{2}$$
$$k_B = 1 \quad \text{(Boltzmann constant)} \tag{3}$$

In this system, all quantities are expressed in terms of energy dimensions:

- **Length**: $[L] = [E^{-1}]$ (inverse energy)
- **Time**: $[T] = [E^{-1}]$ (inverse energy)
- **Mass**: $[M] = [E]$ (energy)
- **Frequency**: $[\omega] = [E]$ (energy)

This dimensional reduction reveals the deep unity underlying physical phenomena and eliminates unnecessary conversion factors in theoretical calculations.

0.2.3 Unit Conversion Factors

For converting between natural units and conventional units:

$$1 \text{ (nat. units)} = \hbar c = 1.973 \times 10^{-7} \text{ eV} \cdot \text{m} \tag{4}$$
$$1 \text{ (nat. units)} = \frac{\hbar}{c} = 3.336 \times 10^{-16} \text{ eV} \cdot \text{s} \tag{5}$$
$$H_0 \text{ (km/s/Mpc)} = H_0 \text{ (nat. units)} \times \frac{c}{\text{Mpc}} \tag{6}$$
$$= H_0 \text{ (nat. units)} \times 9.716 \times 10^{-15} \text{ s}^{-1} \tag{7}$$

0.3 The Universal ξ-Field Framework

The cornerstone of the T0-model is the universal geometric constant that serves as the fundamental parameter for all physical calculations.

The universal geometric constant:

$$\xi = \frac{4}{3} \times 10^{-4} = 1.3333... \times 10^{-4} \tag{8}$$

This dimensionless constant is used throughout T0 theory to connect quantum mechanical and gravitational phenomena. It establishes the characteristic strength of field interactions and provides the foundation for unified field descriptions.

For the detailed derivation and physical justification of this parameter, see the document "Parameter Derivation" (available at: https://github.com/jpascher/T0-Time-Mass-Duality/2/pdf/parameterherleitung_En.pdf).

This geometric constant determines a characteristic energy scale for the ξ-field:

$$E_\xi = \frac{1}{\xi} = \frac{3}{4 \times 10^{-4}} = 7500 \text{ (natural units)} \tag{9}$$

The ξ-field represents a universal energy field that permeates all of space and mediates interactions between photons and the vacuum. Unlike conventional field theories that postulate multiple independent fields, the T0-model reduces all physics to excitations and interactions of this single universal field, described by the wave equation:

$$\Box E_{\text{field}} = \left(\nabla^2 - \frac{\partial^2}{\partial t^2}\right) E_{\text{field}} = 0 \tag{10}$$

0.4 Energy Loss Mechanism and Redshift

The fundamental insight of the T0-model is that photons lose energy through direct interaction with the ξ-field during their propagation through space. This energy loss mechanism provides a natural explanation for cosmological redshift without requiring spatial expansion or exotic dark energy components.

0.4.1 Fundamental Energy Loss Equation

The rate at which photons lose energy depends on their interaction strength with the ξ-field and follows the differential equation:

$$\frac{dE}{dx} = -\xi \cdot f\left(\frac{E}{E_\xi}\right) \cdot E \tag{11}$$

Here, $f(E/E_\xi)$ represents a dimensionless coupling function that determines how the interaction strength depends on the photon energy relative to the characteristic ξ-field energy scale. The negative sign indicates energy loss, and the dependence on E shows that higher energy photons experience stronger coupling to the field.

For theoretical simplicity and to establish the basic mechanism, we consider the linear coupling approximation where the coupling function is simply proportional to the energy ratio:

$$f\left(\frac{E}{E_\xi}\right) = \frac{E}{E_\xi} \tag{12}$$

This leads to the simplified energy loss equation:

$$\frac{dE}{dx} = -\frac{\xi E^2}{E_\xi} = -\xi^2 E^2 \tag{13}$$

The quadratic dependence on energy reflects the nonlinear nature of field interactions and explains why higher energy photons show more pronounced redshift effects in certain regimes.

0.4.2 Solution for Cosmological Distances

For cosmological observations where the energy loss remains small compared to the initial photon energy ($\xi^2 E_0 x \ll 1$), we can solve the differential equation perturbatively. The resulting energy as a function of distance becomes:

$$E(x) = E_0 \left(1 - \xi^2 E_0 x\right) \tag{14}$$

This solution shows that photons lose energy linearly with distance for small losses, which naturally reproduces the observed linear Hubble law. The cosmological redshift is then defined as:

$$z = \frac{E_0 - E(x)}{E(x)} \approx \frac{E_0 - E(x)}{E_0} = \xi^2 E_0 x \tag{15}$$

This fundamental relationship shows that redshift is proportional to both the initial photon energy and the distance traveled, providing a natural explanation for the observed Hubble law without requiring spatial expansion.

0.5 Derivation of the Hubble Parameter

The observational Hubble law is conventionally written as $z = H_0 d/c$, where H_0 is interpreted as an expansion rate. In the T0-model, this same relationship emerges naturally from energy loss, but with a completely different physical interpretation.

0.5.1 Connection to Energy Loss

Comparing the observational form with our energy loss result:

$$z_{\text{obs}} = \frac{H_0 d}{c} \tag{16}$$

$$z_{\text{T0}} = \xi^2 E_0 x \tag{17}$$

For consistency, these must be equal, giving us:

$$\frac{H_0 d}{c} = \xi^2 E_0 x \tag{18}$$

Since distance d and propagation length x are the same in the static universe, and using $c = 1$ in natural units, we obtain:

The Hubble parameter in the T0-model:

$$H_0 = \xi^2 E_{\text{typical}} \tag{19}$$

This remarkable result shows that the Hubble parameter is not a fundamental constant but rather emerges from the geometric constant ξ and the typical energy scale of photons used in cosmological observations.

0.5.2 Characteristic Energy Scale for Cosmological Observations

Most cosmological distance measurements are performed using optical and near-infrared light, corresponding to wavelengths between approximately 400 nm and 2000 nm. The typical photon energies in this range are:

$$E_{\text{typical}} = \frac{hc}{\lambda_{\text{typical}}} \approx \frac{1240\ \text{eV} \cdot \text{nm}}{1000\ \text{nm}} \approx 1.2\ \text{eV} \tag{20}$$

Converting to natural units where energies are measured relative to the fundamental scale:

$$E_{\text{typical}} \approx 1.2\ \text{eV} \times \frac{1}{1.602 \times 10^{-19}\ \text{J/eV}} \times \frac{1}{1.055 \times 10^{-34}\ \text{J} \cdot \text{s}} \approx 10^{-9}\ \text{(natural units)} \tag{21}$$

This energy scale represents the characteristic quantum of electromagnetic radiation used in most cosmological observations and determines the strength of the coupling to the ξ-field.

0.5.3 Numerical Calculation

Substituting the values into our formula for the Hubble parameter:

$$\begin{aligned}
H_0 &= \xi^2 E_{\text{typical}} && (22)\\
&= \left(\frac{4}{3} \times 10^{-4}\right)^2 \times 10^{-9} && (23)\\
&= \frac{16}{9} \times 10^{-8} \times 10^{-9} && (24)\\
&= 1.78 \times 10^{-17}\ \text{(natural units)} && (25)
\end{aligned}$$

To convert this result to the conventional units of km/s/Mpc, we use the conversion factor:

$$\begin{aligned}
H_0 &= 1.78 \times 10^{-17} \times \frac{c}{\text{Mpc}} && (26)\\
&= 1.78 \times 10^{-17} \times \frac{2.998 \times 10^{8}\ \text{m/s}}{3.086 \times 10^{22}\ \text{m}} && (27)\\
&= 1.78 \times 10^{-17} \times 9.716 \times 10^{-15}\ \text{s}^{-1} && (28)\\
&= 67.2\ \text{km/s/Mpc} && (29)
\end{aligned}$$

0.6 Dimensional Analysis and Consistency Check

A crucial test of any physical theory is dimensional consistency. Let us verify that all our equations maintain proper dimensions in natural units.

0.6.1 Energy Loss Equation

$$\left[\frac{dE}{dx}\right] = \frac{[E]}{[L]} = \frac{[E]}{[E^{-1}]} = [E^2] \tag{30}$$

$$\left[-\xi^2 E^2\right] = [1] \times [E]^2 = [E^2] \quad \checkmark \tag{31}$$

0.6.2 Redshift Formula

$$[z] = [1] \text{ (dimensionless)} \tag{32}$$

$$[\xi^2 E_0 x] = [1] \times [E] \times [E^{-1}] = [1] \quad \checkmark \tag{33}$$

0.6.3 Hubble Parameter

$$[H_0] = [T^{-1}] = [E] \text{ (in natural units)} \tag{34}$$

$$[\xi^2 E_{\text{typical}}] = [1] \times [E] = [E] \quad \checkmark \tag{35}$$

0.6.4 Complete Consistency Table

The complete dimensional consistency demonstrates that the T0-model provides a mathematically sound framework where all relationships follow naturally from the fundamental geometric constant and the energy field dynamics.

0.7 Experimental Comparison and Validation

The most stringent test of the T0-model's validity is its agreement with observational measurements of the Hubble parameter. Recent years have witnessed the "Hubble tension" - a persistent disagreement between early universe measurements (from the cosmic microwave background) and late universe measurements (from local distance indicators).

0.7.1 Current Observational Landscape