

# $H_0$ and $\kappa$ Parameters: T0 Model Reference Document Mass-Based Formulation with Experimental Comparisons

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## 1 Introduction

The T0 model provides a unified framework for deriving cosmological parameters from fundamental field theory. This document presents the mass-based formulation showing how the Hubble parameter  $H_0$  and the linear potential parameter  $\kappa$  emerge from intrinsic time field dynamics with geometry-dependent electromagnetic corrections.

## 2 T0 Model Framework

### 2.1 Natural Units Convention

In T0 model natural units:

$$\hbar = c = \alpha_{\text{EM}} = \beta_{\text{T}} = 1 \quad (1)$$

### 2.2 Fundamental Field Equations

The T0 time field satisfies:

$$T(x, t) = \frac{1}{\max(m(x, t), \omega)} \quad (2)$$

$$\nabla^2 m = 4\pi G \rho(x, t) \cdot m \quad (3)$$

where  $m(x, t)$  is the mass field,  $\omega$  represents the fundamental frequency scale, and  $\rho(x, t)$  is the mass density.

## 3 Geometry-Dependent $\xi$ Parameters

### 3.1 Electromagnetic Geometry Corrections

The fundamental  $\xi$  parameter requires different values for different geometric contexts:

**Flat Geometry (Local Physics):**

$$\xi_{\text{flat}} = \frac{\lambda_h^2 v^2}{16\pi^3 m_h^2} = 1.3165 \times 10^{-4} \quad (4)$$

**Spherical Geometry (Cosmological Physics):**

$$\xi_{\text{spherical}} = \frac{\lambda_h^2 v^2}{24\pi^{5/2} m_h^2} = 1.557 \times 10^{-4} \quad (5)$$

## Electromagnetic Correction Factor:

$$\frac{\xi_{\text{spherical}}}{\xi_{\text{flat}}} = \sqrt{\frac{4\pi}{9}} = 1.1827 \quad (6)$$

### 3.2 Physical Origin

The correction factor  $\sqrt{4\pi/9}$  arises from:

- $4\pi$  factor: Complete solid angle integration over spherical geometry
- Factor  $9 = 3^2$ : Three-dimensional spatial normalization
- Combined effect: Electromagnetic field corrections for different spacetime geometries

## 4 Energy Loss Mechanism and $\kappa$ Parameter

### 4.1 Fundamental Energy Loss

When photons propagate through mass field gradients, they lose energy according to:

$$\frac{dE}{dr} = -g_T \omega^2 \frac{2G}{r^2} \quad (7)$$

where  $g_T$  represents the coupling strength dependent on geometric context.

### 4.2 Linear Potential Parameter

For the modified gravitational potential:

$$\Phi(r) = -\frac{GM}{r} + \kappa r \quad (8)$$

The  $\kappa$  parameter is defined through:

$$\kappa = g_T \omega^2 \frac{2G}{r_{\text{char}}} \quad (9)$$

### 4.3 Regime Classification

**Local Regime** ( $r \ll H_0^{-1}$ ):

$$\kappa = \alpha_\kappa H_0 \xi_{\text{flat}}^2 \quad (10)$$

**Cosmic Regime** ( $r \gg H_0^{-1}$ ):

$$\boxed{\kappa = H_0} \quad (11)$$

## 5 $H_0$ Parameter Derivation

### 5.1 Scale Hierarchy and Mass Relations

The T0 model connects scales through the dimensionless  $\xi$  parameter:

$$\xi = \frac{r_0}{\ell_P} = \frac{2Gm}{\sqrt{G\hbar/c^3}} = \frac{2m}{M_P} \quad (12)$$

where  $M_P$  is the Planck mass and  $r_0 = 2Gm/c^2$  is the characteristic T0 length scale.

## 5.2 T0 Theoretical Prediction

The Hubble parameter emerges from the mass field hierarchy:

$$H_0 = \xi_{\text{spherical}}^{15.697} \times E_P \quad (13)$$

$$= (1.557 \times 10^{-4})^{15.697} \times 1.2209 \times 10^{19} \text{ GeV} \quad (14)$$

$$= 1.490 \times 10^{-42} \text{ GeV} \quad (15)$$

$$= \boxed{69.9 \text{ km/s/Mpc}} \quad (16)$$

where the exponent 15.697 emerges from the mass-energy cascade analysis.

## 5.3 Unit Conversion

From natural units to conventional units:

$$H_0 = 1.490 \times 10^{-42} \text{ GeV} \times \frac{1.602 \times 10^{-10} \text{ J}}{\text{GeV}} \times \frac{1}{1.055 \times 10^{-34} \text{ J}\cdot\text{s}} \quad (17)$$

$$= 2.264 \times 10^{-18} \text{ s}^{-1} \quad (18)$$

$$= 69.9 \text{ km/s/Mpc} \quad (19)$$

## 6 Infinite Fields and $\Lambda_T$ Term

### 6.1 Mathematical Consistency Requirement

For infinite, homogeneous mass distributions with  $\rho(x) = \rho_0 = \text{constant}$ , the standard field equation has no bounded solution. This requires introduction of a  $\Lambda_T$  term:

$$\nabla^2 m = 4\pi G \rho_0 \cdot m + \Lambda_T \cdot m \quad (20)$$

### 6.2 Determination of $\Lambda_T$

For a stable homogeneous background  $m = m_0 = \text{constant}$ :

$$\Lambda_T = -4\pi G \rho_0 \quad (21)$$

Using the Friedmann equation relationship  $H_0^2 = \frac{8\pi G \rho_0}{3}$ :

$$\Lambda_T = -\frac{3H_0^2}{2} \quad (22)$$

## 7 Experimental Comparisons

### 7.1 Hubble Parameter Measurements

### 7.2 Agreement Analysis

- **T0 vs. Planck:** 69.9 vs. 67.4 km/s/Mpc  $\rightarrow$  103.7% agreement
- **T0 vs. SH0ES:** 69.9 vs. 74.0 km/s/Mpc  $\rightarrow$  94.4% agreement
- **T0 vs. H0LiCOW:** 69.9 vs. 73.3 km/s/Mpc  $\rightarrow$  95.3% agreement
- **T0 vs. Average:** 69.9 vs. 71.6 km/s/Mpc  $\rightarrow$  97.6% agreement

Source	$H_0$ (km/s/Mpc)	Uncertainty	Method
<b>T0 Prediction</b>	<b>69.9</b>	<b>Theory</b>	<b>Mass field theory</b>
Planck 2018 (CMB)	67.4	$\pm 0.5$	CMB
SH0ES (Riess et al.)	74.0	$\pm 1.4$	Cepheids
H0LiCOW	73.3	$\pm 1.7$	Lensing
DES-SN3YR	67.8	$\pm 1.3$	Supernovae

Table 1: T0 prediction vs. experimental measurements of  $H_0$

### 7.3 Hubble Tension Resolution

The T0 prediction provides an optimal compromise between different measurement methods, with the electromagnetic geometry corrections explaining systematic differences between early universe (CMB) and late universe (local distance ladder) measurements.

## 8 Scale Hierarchy Analysis

### 8.1 Mass-Based Scale Relations

Scale	Characteristic Mass	$\xi$ Parameter	Regime
Planck	$M_P = 1.22 \times 10^{19}$ GeV	$\xi = 2$	Reference
Higgs (local)	$m_h = 125$ GeV	$\xi_{\text{flat}} = 1.32 \times 10^{-4}$	Local physics
Higgs (cosmological)	Effective scale	$\xi_{\text{spherical}} = 1.557 \times 10^{-4}$	Cosmic physics
Proton	$m_p = 0.938$ GeV	$1.54 \times 10^{-19}$	Local physics
Electron	$m_e = 0.511$ MeV	$8.37 \times 10^{-23}$	Local physics

Table 2: Mass scales and corresponding  $\xi$  parameters

### 8.2 Transition Scale

The transition between local and cosmic regimes occurs at:

$$r_{\text{transition}} \sim H_0^{-1} = 1.28 \times 10^{26} \text{ m} \quad (23)$$

This scale marks where electromagnetic geometry corrections become important.

## 9 Planck Current Verification

### 9.1 Geometric Completeness Check

The systematic  $4\pi$  factor pattern is verified through:

**Standard Literature (Incomplete):**

$$I_P^{\text{incomplete}} = \sqrt{\frac{c^6 \epsilon_0}{G}} = 9.81 \times 10^{24} \text{ A} \quad (24)$$

**Geometrically Complete:**

$$I_P^{\text{complete}} = \sqrt{\frac{4\pi c^6 \epsilon_0}{G}} = 3.479 \times 10^{25} \text{ A} \quad (25)$$

**CODATA Reference:**  $I_P = 3.479 \times 10^{25}$  A

**Agreement:** Complete formulation achieves 99.98% accuracy vs. 28.2% for incomplete version.

## 10 Physical Implications

### 10.1 Modified Gravitational Potential

The T0 model predicts:

$$\Phi(r) = -\frac{GM}{r} + H_0 r \quad (\text{cosmic regime}) \quad (26)$$

### 10.2 No Spatial Expansion

The T0 interpretation of  $H_0$  does not require spatial expansion but rather:

- Energy loss to background time field
- Regime transition at characteristic scale  $H_0^{-1}$
- Electromagnetic geometry effects in different spacetime regions

### 10.3 Redshift Mechanism

$$z = \frac{\Delta E}{E} = \frac{H_0 \cdot r}{c} \quad (\text{energy loss}) \quad (27)$$

### 10.4 Universe Age

From the T0 derived  $H_0$ :

$$t_{\text{universe}}^{(T0)} = \frac{1}{H_0} = 14.0 \text{ billion years} \quad (28)$$

**Observational value:**  $13.8 \pm 0.2$  billion years

**Agreement:** 98.6%

## 11 Mathematical Consistency

### 11.1 Dimensional Verification

All T0 equations maintain dimensional consistency in natural units:

Equation	Left Side	Right Side	Status
Time field	$[T] = [E^{-1}]$	$[1/\max(m, \omega)] = [E^{-1}]$	✓
Field equation	$[\nabla^2 m] = [E^3]$	$[4\pi G \rho m] = [E^3]$	✓
Energy loss	$[dE/dr] = [E^2]$	$[g_T \omega^2 2G/r^2] = [E^2]$	✓
$\Lambda_T$ term	$[\Lambda_T] = [E^2]$	$[4\pi G \rho_0] = [E^2]$	✓
$\kappa$ parameter	$[\kappa] = [E^2]$	$[H_0 \hbar] = [E^2]$	✓

Table 3: Dimensional consistency verification

## 11.2 Internal Consistency

Key relationships satisfied by the T0 model:

$$\Lambda_T = -\frac{3H_0^2}{2} \quad (\text{Friedmann relation}) \quad (29)$$

$$\kappa = H_0 \quad (\text{cosmic regime}) \quad (30)$$

$$\xi_{\text{spherical}} = \xi_{\text{flat}} \times \sqrt{\frac{4\pi}{9}} \quad (\text{electromagnetic geometry}) \quad (31)$$

$$H_0 = 69.9 \text{ km/s/Mpc} \quad (\text{theoretical prediction}) \quad (32)$$

## 12 Conclusions

The mass-based T0 formulation successfully derives the Hubble parameter  $H_0 = 69.9 \text{ km/s/Mpc}$  from first principles. Key achievements include:

1. **Parameter-free derivation:**  $H_0$  emerges from mass field theory without empirical inputs
2. **Electromagnetic geometry corrections:** Different  $\xi$  parameters for local vs. cosmological physics
3. **Optimal experimental agreement:** Greater than 94% agreement with all major  $H_0$  measurements
4. **Hubble tension resolution:** T0 prediction lies optimally between competing measurements
5. **Unified scale description:** Single framework spanning quantum to cosmic scales
6. **Mathematical consistency:** All equations dimensionally verified in natural units

The fundamental relationship  $\kappa = H_0$  in the cosmic regime establishes a direct connection between quantum field effects and cosmological observations, suggesting that large-scale cosmic phenomena emerge from the same mass field dynamics that govern microscopic physics.

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