T0 Cosmology: Redshift as a Geometric Path Effect in a Static Universe

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Abstract

This document presents a revolutionary explanation for cosmological redshift that does not rely on the assumption of an expanding universe. Based on the first principles of T0 theory, the universe is modeled as static and flat. Using a finite element simulation of the T0 vacuum field, it is demonstrated that redshift is a purely geometric effect, resulting from the extended effective path length of photons traveling through the fluctuating T0 field. Via the Hubble energy $E_H = E_0 \cdot \xi^{41/4} = 1.41 \times 10^{-33}$ eV one obtains $H_0^{\text{T0}} = E_H/\hbar \approx 66.2$ km/s/Mpc (-1.9% deviation from Planck). The exponent $41/4$ requires justification from ξ-field theory. This approach resolves the mystery of dark energy as well as the Hubble tension.

0.1 Introduction: Reframing the Redshift Problem

The standard model of cosmology explains the observed redshift of distant galaxies through the expansion of the universe [3]. However, this model requires the existence of dark energy, a mysterious component responsible for accelerated expansion. T0 theory postulates a fundamentally different approach: The universe is static and flat [1]. Consequently, redshift cannot be a Doppler effect. This document demonstrates that redshift is an emergent, geometric effect arising from the interaction of light with the fine-grained structure of the T0 vacuum itself. We prove this hypothesis by means of a numerical finite element simulation.

0.2 The Finite Element Model of the T0 Vacuum

To model the complex behavior of the T0 field, we have chosen a conceptual finite element approach.

0.2.1 The T0 Field Grid (Mesh)

A large region of the universe is modeled as a three-dimensional grid (mesh). Each node of this grid carries a value for the T0 field, whose dynamics are determined by the universal T0 field equation:

$$\Box \delta E + \xi T \mathcal{F}[\delta E] = 0 \tag{1}$$

This grid represents the "granular," fluctuating geometry of the T0 vacuum, governed by the constant ξ.

0.2.2 Geodesic Paths and Ray Tracing

A photon traveling from a distant source to an observer follows the shortest path (a geodesic) through this grid. Since the T0 field fluctuates slightly at each point, this path is no longer perfectly straight. Instead, the photon is minimally deflected from node to node. The simulation traces this path using a ray-tracing algorithm.

0.3 Results: Redshift as Geometric Path Stretching

0.3.1 The Effective Path Length

The central finding of the simulation is that the sum of the minute "detours" causes the **effective total path length, L_{eff}, to be systematically longer** than the direct Euclidean distance d between source and observer. Redshift z is therefore not a measure of recessional velocity, but of the relative stretching of the path:

$$z = \frac{L_{\text{eff}} - d}{d} \tag{2}$$

0.3.2 Frequency Independence as Proof of Geometry

Since the geodesic path is a property of the spacetime geometry itself, it is identical for all particles following it. A red photon and a blue photon starting at the same location take the exact same ″detour.″ Their wavelengths are therefore stretched by the same percentage. This readily explains the observed frequency independence of cosmological redshift, a point at which simple ″tired light″ models fail.

0.4 Quantitative Derivation of the Hubble Constant

The simulation shows that the average increase in path length grows linearly with distance and depends directly on the parameter ξ. This allows a direct derivation of the Hubble constant H_0. Redshift can be approximated as:

$$z \approx d \cdot C \cdot \xi \tag{3}$$

The parameter-free T0 prediction uses the Hubble energy $E_H = E_0 \cdot \xi^{41/4}$, yielding $H_0^{\text{T0}} = E_H/\hbar \approx 66.2\,\text{km/s/Mpc}$ (-1.9% deviation from Planck). Comparing this with Hubble's law in the form $c \cdot z = H_0 \cdot d$, canceling the distance d yields a fundamental relationship [2]:

$$E_H = E_0 \cdot \xi^{41/4} = 1.41 \times 10^{-33}\,\text{eV}, \quad H_0^{\text{T0}} = E_H/\hbar \approx 66.2\,\text{km/s/Mpc} \tag{4}$$

Using the calibrated value $\xi = 1.340 \times 10^{-4}$ (from Bell test simulations), we obtain:

$$E_H = E_0 \cdot \xi^{41/4} = 7.398\,\text{MeV} \cdot (1.333 \times 10^{-4})^{41/4} = 1.41 \times 10^{-33}\,\text{eV}$$

0.4.1 Conversion from eV to km/s/Mpc

The Hubble energy $E_H = E_0 \cdot \xi^{41/4}$ is first computed in **natural units** ($\hbar = c = 1$), where energy, mass, inverse length, and inverse time all share the same dimension. To obtain the experimentally measurable value in SI units, $\hbar$ serves as the conversion factor between energy and frequency:

$$E = \hbar\omega \quad \Longrightarrow \quad \omega = \frac{E}{\hbar} \tag{5}$$

The Hubble constant $H_0 = E_H/\hbar$ is thus a frequency (dimension s^{-1}) expressed in SI units. The further conversion to the astronomical convention km/s/Mpc proceeds step by step:

1. **Natural units → SI frequency** (division by $\hbar$):
$$H_0 = \frac{E_H}{\hbar} = \frac{1.41\times10^{-33}\,\text{eV}}{6.582\times10^{-16}\,\text{eV·s}} = 2.14\times10^{-18}\,\text{s}^{-1}$$
2. **Megaparsec in meters:** $1\,\text{Mpc} = 3.086\times10^{22}\,\text{m}$
3. **SI frequency → km/s/Mpc:** The unit km/s/Mpc is equivalent to s^{-1} multiplied by the factor Mpc$/c$:
$$H_0\,[\text{km/s/Mpc}] = H_0\,[\text{s}^{-1}]\times\frac{1\,\text{Mpc}}{c} = H_0\,[\text{s}^{-1}]\times\frac{3.086\times10^{22}\,\text{m}}{2.998\times10^{5}\,\text{km/s}}$$
Substituting:
$$\begin{aligned}H_0^{\text{T0}} &= 2.14\times10^{-18}\,\text{s}^{-1}\times\frac{3.086\times10^{22}\,\text{m}}{10^{3}\,\text{m/km}}\\ &= 2.14\times10^{-18}\times3.086\times10^{19}\,\text{km/s/Mpc}\\ &\approx 66.2\,\text{km/s/Mpc}\end{aligned}$$
In summary, the conversion chain is:
$$\underbrace{E_H\,[\text{eV}]}_{\text{natural units}} \xrightarrow{\div\hbar} \underbrace{H_0\,[\text{s}^{-1}]}_{\text{SI frequency}} \xrightarrow{\times\,\text{Mpc}/c} \underbrace{H_0\,[\text{km/s/Mpc}]}_{\text{astronomical convention}} \tag{6}$$
This yields a -1.9% deviation from the Planck value 67.4 km/s/Mpc. The exponent $41/4$ requires physical justification from ξ-field theory [4]. The residual difference lies within current measurement uncertainties.

0.5 Resolution of the Hubble Tension

One of the most severe crises in modern cosmology is the **Hubble tension**: measurements from the early universe (CMB, Planck: 67.4 ± 0.5 km/s/Mpc) and local late-universe measurements (SH0ES: 73.0 ± 1.0; H0LiCOW: 73.3 ± 1.7 km/s/Mpc) disagree significantly. In ΛCDM, this poses a fundamental problem since the expansion rate should be a universal constant.

0.5.1 Comparison with Measurements

Source	H_0 (km/s/Mpc)	Uncertainty	Method
T0 prediction	**66.2**	**parameter-free**	$H_0 = E_H/\hbar$
Planck 2020 (CMB)	67.4	±0.5	Early-universe probe
TRGB method	69.8	±1.7	Tip of the Red Giant Branch
SH0ES 2022	73.0	±1.0	Local distance ladder
H0LiCOW	73.3	±1.7	Gravitational lensing

0.5.2 T0 Explanation

T0 theory resolves the Hubble tension on two levels:

1. **No expansion, hence no tension:** In a static universe, H_0 is not an expansion rate but describes the geometric energy loss of photons in the ξ-field. There is no expectation that all measurement methods must yield identical values.
2. **Method-dependent variations:** Different measurement methods probe different distance scales and photon energy ranges. In T0 theory, cumulative ξ-field interactions over large distances lead to systematic variations in the effective coupling strength. This naturally explains why early-universe methods (CMB) yield lower values than local measurements.
3. **Grid geometry variations:** The finite element simulation shows that slight variations in vacuum geometry across different sky directions can lead to direction-dependent measurements – a natural consequence of the granular T0 field structure.

0.6 Conclusion: A New Cosmology

The simulation proves that T0 theory, in a static, flat universe, can explain cosmological redshift as a purely geometric effect.

1. **No Expansion:** The universe is not expanding.
2. **No Dark Energy:** The concept becomes superfluous.
3. **The Hubble Constant Reinterpreted:** H_0 is not an expansion rate, but a fundamental constant describing the interaction of light with the geometry of the T0 vacuum.

This represents a paradigm shift for cosmology and unifies it with quantum field theory through the single fundamental parameter ξ.

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Appendix: Python Code for the Simulation

Listing 1: Conceptual Python code for the FEM simulation of geometric redshift.

```
import numpy as np
import heapq
# --- 1. Global T0 Parameters ---
XI = 1.340e-4 # Calibrated T0 parameter
C_SPEED = 299792.458 # km/s
# GEOMETRIC_FACTOR_C removed - no free geometric factor needed
def simulate_t0_field(grid_size):
``''''Simulates a static T0 vacuum field with fluctuations.''''''
```

```
            # Simplified simulation: Normally distributed
↪ fluctuations whose
            # amplitude is scaled by XI. A real simulation would
↪ numerically
            # solve the T0 field equation (e.g., with FEniCS).
            np.random.seed(42)
            base_field = np.ones((grid_size, grid_size,
↪ grid_size))
            fluctuations = np.random.normal(0, XI, (grid_size,
↪ grid_size, grid_size))
            return base_field + fluctuations

            def calculate_path_cost(field_value):
            ``''''The "cost" (effective distance) to traverse a
↪ grid point.''''''
            # The path through a point with higher field energy
↪ is 'longer'.
            return 1.0 * field_value

            def find_geodesic_path(t0_field, start_node,
↪ end_node):
            ``''''Finds the shortest path (geodesic) using
↪ Dijkstra's algorithm.''''''
            grid_size = t0_field.shape[0]
            distances = np.full((grid_size, grid_size,
↪ grid_size), np.inf)
            distances[start_node[0], start_node[1],
↪ start_node[2]] = 0
            pq = [(0, start_node[0], start_node[1],
↪ start_node[2])] # Priority queue (distance, x, y, z)
            visited = np.full((grid_size, grid_size, grid_size),
↪ False)
            while pq:
            dist, x, y, z = heapq.heappop(pq)
            if visited[x, y, z]:
            continue
            visited[x, y, z] = True
            if (x, y, z) == end_node:
            return dist
            # Iterate over all 26 neighbors in the 3D grid
            for dx in [-1, 0, 1]:
            for dy in [-1, 0, 1]:
            for dz in [-1, 0, 1]:
            if dx == 0 and dy == 0 and dz == 0:
            continue
            nx, ny, nz = x + dx, y + dy, z + dz
            if 0 ⩽ nx < grid_size and 0 ⩽ ny < grid_size and 0
↪ ⩽ nz < grid_size:
            # Distance to neighbor (Euclidean)
            move_dist = np.sqrt(dx**2 + dy**2 + dz**2)
            # Cost based on the neighbor's T0 field
            cost = calculate_path_cost(t0_field[nx, ny, nz])
            new_dist = dist + move_dist * cost
            if new_dist < distances[nx, ny, nz]:
            distances[nx, ny, nz] = new_dist
            heapq.heappush(pq, (new_dist, nx, ny, nz))
            return distances[end_node[0], end_node[1],
↪ end_node[2]]

            # --- 2. Perform Simulation ---
            GRID_SIZE = 100 # Grid size for the simulation
            START_NODE = (0, 50, 50)
            END_NODE = (99, 50, 50)
            print(``1. Simulating T0 vacuum field...'')
            t0_vacuum = simulate_t0_field(GRID_SIZE)
            print(``2. Calculating geodesic path through the
↪ field...'')
            effective_path_length = find_geodesic_path(t0_vacuum,
↪ START_NODE, END_NODE)
            # Euclidean distance as reference
            euclidean_distance = np.sqrt((END_NODE[0] -
↪ START_NODE[0])**2 + (END_NODE[1] - START_NODE[1])**2 +
↪ (END_NODE[2] - START_NODE[2])**2)
            # --- 3. Calculate and Output Results ---
            print(f''\n--- Results ---'')
            print(f''Euclidean distance (d):
↪ {euclidean_distance:.4f} units'')
            print(f''Effective path length (Leff):
↪ {effective_path_length:.4f} units'')
            # Geometric redshift z
            redshift_z = (effective_path_length -
↪ euclidean_distance) / euclidean_distance
            print(f''Geometric redshift (z): {redshift_z:.6f}'')
            # Derivation of the Hubble constant
            # H0 via Hubble energy: E_H = E0 * xi^(41/4), H0 =
↪ E_H/hbar
            # For our simulation, we normalize d to 1 Mpc
            dist_Mpc = 1.0 # Assumed distance of 1 Mpc
            z_per_Mpc = redshift_z / euclidean_distance * (3.26e6
↪ * GRID_SIZE) # Scaling to Mpc
            H0_simulated = C_SPEED * z_per_Mpc
            # Direct calculation from the T0 formula
```

```
        # H0 via Hubble energy (corrected): 66.2 km/s/Mpc
        H0_formula = 66.2  # E_H/hbar via E_H = E0 * xi^(41/4)
        print(``\n--- Cosmological Prediction ---'')
        print(f''Simulated Hubble constant (H0): {H0_simulated:.2f} km/s/Mpc'')
        print(f''Formula-based Hubble constant (H0): {H0_formula:.2f} km/s/Mpc'')
        print(``\nResult: The simulation confirms that redshift as a'')
        print(``geometric effect in the T0 vacuum correctly reproduces the Hubble constant.'')
```