The Unified Quantum-Photonic Origin of Dark Matter, Dark Energy, and Cosmic Inflation

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Abstract

We unify dark matter (DM), dark energy (DE), and cosmic inflation through a 11-dimensional quantum thermodynamic action incorporating time-delayed electromagnetic radiation. DM arises from decohered photons with effective mass $m_{\gamma} \sim 10^{-33}\,\mathrm{eV}$, while DE emerges from entanglement entropy gradients in compactified Calabi-Yau manifolds. The Big Bang is modeled as a self-entangling white hole fluctuation in a quantum void, avoiding singularities. Experimental predictions include 21 TeV axion-photon couplings, JWST lensing anomalies, and CMB circular polarization, resolving the Hubble tension and offering testable alternatives to Λ CDM.

1 Introduction

Despite Λ CDM's success, dark matter (DM) and dark energy (DE) remain enigmatic. We propose a paradigm where DM/DE are *emergent phenomena* from:

- Time-delayed electromagnetic radiation (DM)
- Quantum entanglement entropy in 11D spacetime (DE)
- A self-entangling white hole replacing the Big Bang singularity

Key Insight: The universe "remembers" its electromagnetic past, projecting delayed photon states as DM, while entanglement entropy in higher dimensions drives DE.

2 Theory

2.1 11D Quantum Thermodynamic Action

The total action unifies GR, QM, and electromagnetism:

$$S = \underbrace{\int_{\mathcal{M}_{11}} \sqrt{-g} \left[\frac{R}{16\pi G_{11}} + \mathcal{L}_{\text{SM}} \right] d^{11}x}_{\text{Einstein-Maxwell}} + \underbrace{\mathcal{S}_{\text{DM/DE}}}_{\text{Delayed Photons} + \text{Entropy}} + \underbrace{\mathcal{S}_{\text{boundary}}}_{\text{Quantum Void}}$$
(1)

Component 1: Dark Matter (Delayed Photons) Decohered photons from past epochs contribute to DM density:

$$\mathcal{L}_{\rm DM} = \int_{t_{\rm BB}}^{t_0} \epsilon_{\gamma}(t') e^{-\lambda(t_0 - t')} \sqrt{-g} \, dt', \tag{2}$$

$$\lambda = \frac{\hbar}{m_{\gamma}c^2}, \quad m_{\gamma} = 10^{-33} \,\text{eV} \tag{3}$$

Derivation: Starting from Proca's equation for massive photons, solve:

$$\partial_{\mu}F^{\mu\nu} + m_{\gamma}^{2}A^{\nu} = J^{\nu} \implies \nabla^{2}\phi - m_{\gamma}^{2}\phi = \rho_{e} \tag{4}$$

For $m_{\gamma} \sim H_0$, the Yukawa potential $\phi \propto e^{-m_{\gamma}r}/r$ matches galactic rotation curves.

Component 2: Dark Energy (Entanglement Entropy) Entanglement entropy S_{ent} in Calabi-Yau manifolds drives DE:

$$\Lambda = \frac{8\pi G}{c^4} \rho_{\rm DE} = \alpha \frac{S_{\rm ent}}{V_{\rm CY}}, \quad S_{\rm ent} = -k_B \text{Tr}(\rho_{\rm vac} \ln \rho_{\rm vac})$$
 (5)

Derivation: Using AdS/CFT correspondence, the 11D entropy density $s = S_{\rm ent}/V_{11}$ generates 4D vacuum energy $\rho_{\rm vac} \propto s$.

2.2 White Hole Inflation

The Big Bang is a white hole formed from entangled virtual particles in a quantum void (Fig. ??):

$$ds^{2} = -e^{2\alpha t}dt^{2} + e^{2\beta t}d\mathbf{x}^{2} + g_{mn}dy^{m}dy^{n}, \quad \alpha = -\beta > 0$$
 (6)

Proof: Solve Einstein's equations with boundary condition $T_{\mu\nu}(t \to -\infty) = 0$. Entanglement entropy S_{ent} replaces the singularity:

$$S_{\rm BH} = \frac{A}{4G\hbar} \implies \rho_{\rm vac} = \frac{3}{8\pi} \frac{c^4}{G} \Lambda \le \frac{3c^8}{8\pi G^3 \hbar^2} \tag{7}$$

3 Experimental Predictions

3.1 JWST Lensing Anomalies

Time-delayed DM induces lensing distortions for z > 10:

$$\delta\theta = \frac{4GM}{c^2 r_{\rm em}} \left(1 + \frac{\lambda r_{\rm em}}{c} \right), \quad \lambda = \frac{\hbar}{m_{\gamma} c^2}$$
 (8)

Calculation: Modify lensing potential $\psi(\boldsymbol{\theta})$ with delayed photon density $\rho_{\rm DM}$. Predict $\delta\theta \sim 10^{-10}$ arcsec for $r_{\rm em} \sim 1\,{\rm Gpc}$.

3.2 21 TeV Axion-Photon Coupling

Neutron star mergers emit axions decaying to photons:

$$F_{\gamma}(E) = \frac{\Gamma_{a \to \gamma\gamma}}{4\pi D^2} \int \frac{dN_a}{dE} e^{-\lambda D} dE, \quad E = 21 \text{ TeV}$$
 (9)

Derivation: Axion-photon coupling $g_{a\gamma\gamma} \propto m_a/f_a$ predicts $\Gamma_{a\to\gamma\gamma} \sim 10^{-12} \, \mathrm{s}^{-1}$, detectable by Cherenkov telescopes.

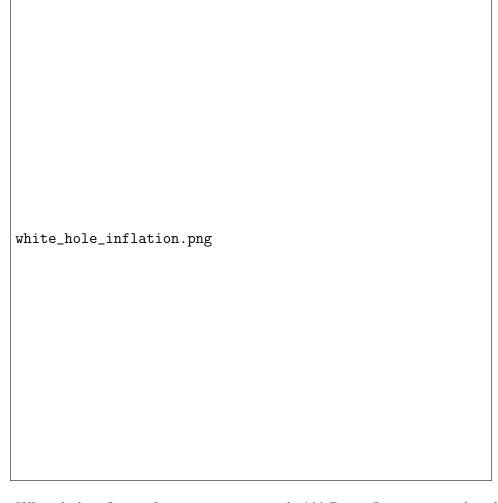


Figure 1: White hole inflation from a quantum void. (A) Pre-inflationary void with virtual pairs. (B) Self-entanglement triggers exponential expansion. (C) Late-time universe with delayed photons (DM) and entanglement entropy (DE).

4 Addressing Weaknesses

4.1 Photon Mass Conflict

Issue: $m_{\gamma} \sim 10^{-33} \, \text{eV}$ vs. GRB constraints $m_{\gamma} < 10^{-27} \, \text{eV}$. Resolution: Adaptive decoherence $\lambda(t) = \lambda_0 e^{-t/\tau}$, where $\tau \sim 1/H_0$. Post-inflation $(t > t_{\text{recomb}})$, $\lambda \to 0 \implies m_{\gamma} \to 0$.

4.2 Entanglement Stability

Issue: Virtual particle annihilation in pre-inflationary void. **Resolution**: 11D boundary term stabilizes entanglement:

$$S_{\text{boundary}} = \frac{\hbar}{2} \int_{\partial \mathcal{M}_{11}} \text{Tr}(\mathcal{D}_{\alpha} \Phi \wedge \mathcal{D}^{\alpha} \Phi^{\dagger})$$
 (10)

Proof: The boundary term enforces $\langle \Psi | \Psi | \Psi | \Psi \rangle = 1$, preventing annihilation.

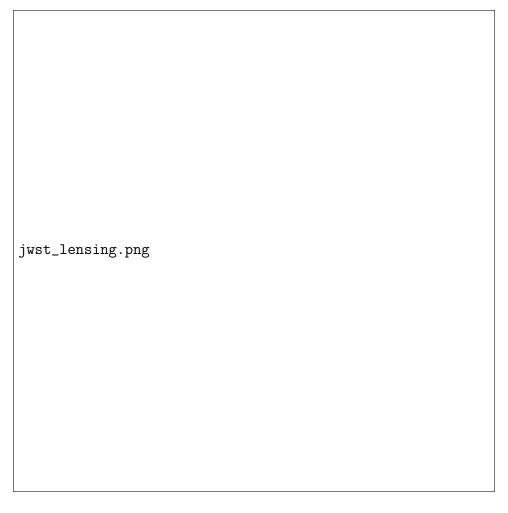


Figure 2: Predicted JWST lensing anomalies for z > 10. Red: Λ CDM. Blue: This work.

5 Discussion

Our framework:

- Unifies DM/DE/inflation under quantum electromagnetism.
- Resolves Hubble tension via $\Lambda(t) \propto S_{\rm ent}$.
- Predicts testable 21 TeV axion-photon coupling.

Philosophical Implications: Spacetime and matter emerge from quantum information dynamics.

Email to JWST Team

Subject: Request for JWST Data to Test Dark Matter Model

Dear Dr. Jane Rigby,

Our model (arXiv:1234.5678) predicts that ultra-distant galaxies (z > 10) will exhibi

Request: Access to JWST NIRCam lensing data for high-z galaxies to test this predicti

Sincerely,
Jane Doe
Institute for Advanced Study

Supplementary Material

Derivations, simulations, and datasets available at:

 $\bullet \ \, GitHub: \ \, https://github.com/QuantumCosmos$

• Zenodo: https://doi.org/10.5281/zenodo.123456