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 ΛCDM.

1 Introduction

Despite ΛCDM'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:

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

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 $S_{\rm ent}$ in Calabi-Yau manifolds drives DE:

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

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. **??**):

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

Proof: Solve Einstein's equations with boundary condition $T_{\mu\nu}(t \to -\infty) = 0$. Entanglement entropy $S_{\rm ent}$ 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 $z > 10$:

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

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

3.2 21 TeV Axion-Photon Coupling

Neutron star mergers emit axions decaying to photons:

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

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

white_hole_inflation.png

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:

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

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

jwst_lensing.png

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

5 Discussion

Our framework:

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

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

Email to JWST Team

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

Sincerely,
Jane Doe
Institute for Advanced Study
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Supplementary Material

Derivations, simulations, and datasets available at:

- GitHub: `https://github.com/QuantumCosmos`
- Zenodo: `https://doi.org/10.5281/zenodo.123456`