Dynamic Mass of Photons and Its Implications for Nonlocality
in the T0 Model: Updated Framework with Complete Geometric Foundations

Abstract

This updated work examines the implications of assigning a dynamic, frequency-dependent effective mass to photons within the comprehensive framework of the T0 model, building upon the complete field-theoretic derivation and natural units system where $\hbar = c = \alpha_{\text{EM}} = \beta_{\text{T}} = 1$. The theory establishes the fundamental relationship $T(x,t) = \frac{1}{\max(m,\omega)}$ with dimension $[E^{-1}]$, providing a unified treatment of massive particles and photons through the three fundamental field geometries. The dynamic photon mass $m_\gamma = \omega$ introduces energy-dependent nonlocality effects, with testable predictions. All formulations maintain strict dimensional consistency with the fixed T0 parameters $\beta = 2Gm/r$, $\xi = 2\sqrt{G} \cdot m$, and the cosmic screening factor $\xi_{\text{eff}} = \xi/2$ for infinite fields.

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0.1 Introduction: T0 Model Foundation for Photon Dynamics

This updated analysis builds upon the comprehensive T0 model framework established in the field-theoretic derivation, incorporating the complete geometric foundations and natural units system. The dynamic effective mass concept for photons emerges naturally from the T0 model's fundamental time-mass duality principle.

0.1.1 Fundamental T0 Model Framework

The T0 model is based on the intrinsic time field definition:

$$\boxed{T(x,t) = \frac{1}{\max(m(\vec{x},t),\omega)}} \tag{1}$$

Dimensional verification: $[T(x,t)] = [1/E] = [E^{-1}]$ in natural units ✓
This field satisfies the fundamental field equation:

$$\nabla^2 m(\vec{x},t) = 4\pi G \rho(\vec{x},t) \cdot m(\vec{x},t) \tag{2}$$

From this foundation emerge the key parameters:

Equation	Left Side	Right Side	Status
Photon effective mass	$[m_\gamma] = [E]$	$[\omega] = [E]$	✓
Photon time field	$[T_\gamma] = [E^{-1}]$	$[1/\omega] = [E^{-1}]$	✓
Energy loss rate	$[d\omega/dr] = [E^2]$	$[g_T \omega^2 2G/r^2] = [E^2]$	✓
Time field difference	$[\Delta T_\gamma] = [E^{-1}]$	$[|1/\omega_1 - 1/\omega_2|] = [E^{-1}]$	✓
Bell correction	$[\epsilon] = [1]$	$[\alpha_{\text{corr}}\Delta T_\gamma \beta] = [1]$	✓