

# Dynamic Mass of Photons and Its Implications for Nonlocality in the T0 Model

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## Zusammenfassung

This work examines the implications of assigning a dynamic, frequency-dependent effective mass to photons within the framework of the T0 model of time-mass duality, which postulates absolute time and variable mass. By assuming  $m_\gamma = \omega$  in natural units, an energy-dependent intrinsic time is introduced, influencing nonlocality and causality. The theory builds on the T0 model's framework and is supported by experimental predictions consistent with its principles.

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# 1 Introduction

This work analyzes the implications of a dynamic, frequency-dependent effective mass for photons within the T0 model of quantum mechanics, which assumes absolute time and variable mass [1]. The concept extends the model's intrinsic time framework to explore nonlocality and causality.

## 2 Natural Units as the Foundation

### 2.1 Definition of Natural Units

**Theorem 2.1** (Natural Units). *With  $\hbar = c = G = 1$ :*

$$[L] = [E^{-1}] \quad (1)$$

$$[T] = [E^{-1}] \quad (2)$$

$$[M] = [E] \quad (3)$$

### 2.2 Significance for Mass-Energy Equivalence

In the T0 model, mass is dynamic ( $T(x) = \frac{\hbar}{mc^2}$ ). For photons, an effective mass is proposed:

$$m_\gamma = \omega \quad (4)$$

where  $\omega$  is the angular frequency, consistent with  $E = \hbar\omega$  in natural units ( $\hbar = 1$ ).

## 3 Time Models in Quantum Mechanics

### 3.1 Limitations of the Standard Model

The standard Schrödinger equation assumes a universal time:

$$i\hbar \frac{\partial \psi}{\partial t} = H\psi \quad (5)$$

### 3.2 The T0 Model with Absolute Time

In the T0 model, energy is linked to a constant intrinsic time  $T_0$ :

$$E = \frac{\hbar}{T_0} \quad (6)$$

For massive particles,  $T(x) = \frac{\hbar}{mc^2}$ .

### 3.3 Extension for Photons

For photons, this extends to an energy-dependent intrinsic time:

$$T(x) = \frac{\hbar}{m_\gamma c^2} = \frac{1}{\omega} \quad (7)$$

This remains consistent with  $m_\gamma = \omega$  (since  $\hbar = c = 1$ ).

## 4 Unification in the T0 Model

To unify massive particles and photons:

$$T(x) = \frac{\hbar}{\max(mc^2, \omega)} \quad (8)$$

For massive particles,  $mc^2$  dominates; for photons,  $\omega$ .

## 5 Implications for Nonlocality and Entanglement

### 5.1 Energy-Dependent Correlations

The energy-dependent  $T(x)$  leads to time delays in entangled systems:

- Delay:  $\left| \frac{1}{\omega_1} - \frac{1}{\omega_2} \right|$

This suggests that nonlocality emerges from intrinsic time differences, akin to the energy loss mechanism of redshift in the T0 model [2].

### 5.2 $\beta_T$ in the T0 Model

In the T0 model, wavelength-dependent redshift is described by the parameter  $\beta_T$ , with  $\beta_T^{\text{SI}} \approx 0.008$  in SI units and  $\beta_T^{\text{nat}} = 1$  in natural units [3]. These values are equivalent, reflecting the same physical reality, with conversion via the characteristic length scale  $r_0$  [4]. The derivation of  $\beta_T$  is well-established in the T0 model, and the choice between  $\beta_T^{\text{SI}}$  and  $\beta_T^{\text{nat}}$  depends solely on the unit system, without uncertainty in the theoretical foundation.

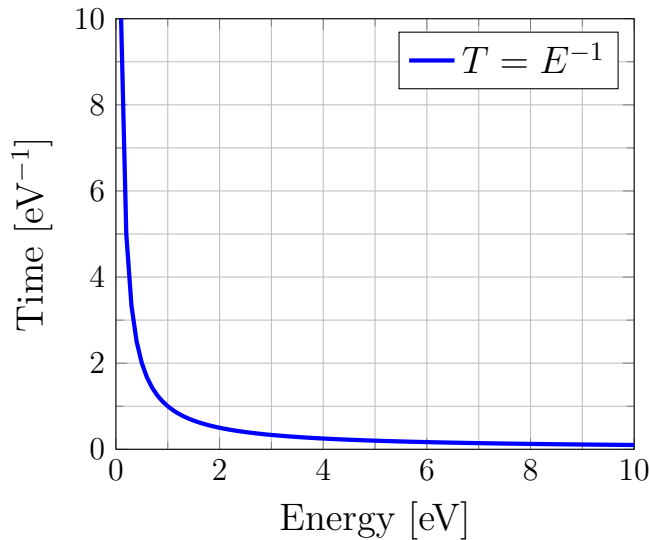


Abbildung 1: Energy-dependent intrinsic time for photons in the T0 model.

## 6 Experimental Verification

- Frequency-dependent Bell tests to measure time delays in entanglement.
- Spectroscopic redshift measurements to validate wavelength-dependent redshift with  $\beta_T$ .

## 7 Physics Beyond the Speed of Light

A hypothetical modified dispersion relation in the T0 model:

$$E^2 = (m_\gamma c^2)^2 + (pc)^2 + \alpha_c p^4 c^2 / E_P^2 \quad (9)$$

where  $\alpha_c$  is a coupling constant and  $E_P$  is the Planck energy, could explain the behavior of high-energy photons and be tested via cosmic ray measurements.

## 8 Conclusion

The dynamic effective mass of photons in the T0 model offers a novel view of nonlocality as an emergent phenomenon driven by energy-dependent intrinsic time, enhancing the explanatory power of the model.

## Literatur

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