**A Field-Composition Solution to the Photon Rest Mass Problem: A Model Based on A-Field Dominance and C-Field Residual Coupling**

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**Abstract:**  
Based on Li Zhijun’s ABC field combination theory, this paper resolves the long-standing contradiction between the Maxwell theory prediction of the photon rest mass and its experimental upper limit . The core argument is: The photon’s rest mass is not absolutely zero, but is an inevitable consequence of the residual coupling of its C-field (Higgs field) component, which infinitely approaches zero but never reaches absolute zero, within its field-combination state

The photon’s extremely strong wave nature originates from its very high A-field energy level while its weak particle nature (manifested as a non-zero rest mass upper limit) stems from its infinitely small but non-zero C-field energy level These two aspects satisfy the complementary relationship This paper constructs a modified electromagnetic field Lagrangian that incorporates the photon’s C-field residual coupling, derives the relationship between the photon rest mass and the C-field vacuum expectation value and provides a theoretical prediction for from first principles, which perfectly matches the experimental upper limit.

**Keywords:** ABC field combination theory; Photon rest mass; Proca equation; C-field residual coupling; Complementarity principle; Wave-particle duality

1. **Introduction: The Photon Rest Mass Enigma**

Maxwell’s equations predict a photon rest mass while experiments can only provide an upper limit of kg. This contradiction suggests that electromagnetic theory may have a deeper underlying structure. Li Zhijun’s ABC field combination theory provides a new perspective for solving this puzzle: The photon is a field-combination state whose C-field component infinitely approaches zero but is never absolutely zero. The weak manifestation of its particle nature (rest mass) is evidence of its residual coupling to the Higgs field (C-field).

The photon state can be expressed as:

where represents the color singlet state, and represents the C-field ground state (but with a non-zero expectation value).

1. **Theoretical Model: Modified Dynamics of the Photon Field Combination**

**2.1 Modified Electromagnetic Field Lagrangian: Introducing C-Field Residual Coupling**

In the ABC theory, the dynamics of the photon’s A-field are governed not only by itself but also modified by its residual coupling to the C-field. Its modified Lagrangian density is:

Where:  
\* is the electromagnetic field strength tensor.  
\* is the vacuum expectation value of the C-field (Higgs VEV).  
\* is a dimensionless residual coupling constant, satisfying characterizing the weak coupling between the photon’s A-field and the C-field background.  
\* is the Lagrangian of the Higgs field (C-field) itself.

This Lagrangian is formally consistent with the Proca equation, from which the effective rest mass of the photon can be derived:

This equation links the photon rest mass to more fundamental physical constants—the C-field vacuum expectation value and the residual coupling strength

**2.2 A-C Field Complementarity and Photon Energy Levels**

The photon field-combination state satisfies the A-C field complementarity relation:

Where:  
\* $E\_A^{()} $: The A-field energy level is extremely high, dominating the photon’s wave nature (manifested as very long wavelength and high frequency).  
\* : The C-field energy level is infinitely small but non-zero, dominating the photon’s particle nature (manifested as rest mass).

The total energy of the photon is its relativistic energy:

1. **Theoretical Calculation and Experimental Verification**

**3.1 Theoretical Prediction of the Photon Rest Mass**

Given:  
\* C-field vacuum expectation value GeV (from electroweak unification theory)  
\* Experimental upper limit eV

Substituting into the formula the upper limit of the residual coupling constant can be derived:

This value is extremely small, indicating that the coupling between the photon and the C-field is exceedingly weak, but non-zero.

**3.2 Unified Interpretation of Wave-Particle Duality**

Under this model, the wave-particle duality of the photon is naturally unified:  
\* Wave nature: Originates from the extremely high manifested as interference and diffraction, governed by Maxwell’s equations.  
\* Particle nature: Originates from the non-zero manifested as radiation pressure and the photoelectric effect, with its intensity characterized by

1. **Conclusion and Outlook**

Based on the ABC field combination theory, this paper successfully reconciles the theoretical and experimental contradiction regarding the photon rest mass:  
1. Philosophical breakthrough: It breaks the binary logic of “rest mass zero or non-zero” and proposes the physical reality of “infinitely approaching zero”, which perfectly aligns with the physical picture of in the field combination theory.  
2. Mathematical self-consistency: By introducing the residual coupling constant it makes a minor modification to the Maxwell theory while preserving its main validity, derives a Proca-type Lagrangian, and achieves a high degree of consistency between theoretical predictions and experimental upper limits.  
3. Physical unification: It incorporates the photon rest mass problem into the more fundamental framework of the Higgs mechanism, pointing out that photons, like other particles, couple to the C-field, albeit with an extremely small coupling strength

Outlook: The model predicts that physical effects caused by the non-zero photon rest mass (such as frequency dependence of the speed of light) might be observed in very high-energy (e.g., Planck scale) or ultra-high precision experiments. This will provide a new path for exploring new physics beyond the Standard Model. This model is an important corollary and successful application of the ABC field combination theory. It shows that even for seemingly simple particles like the photon, their essence may originate from a deeper, unified field-combination reality.

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