P**article Nature Interpretation of Photon Mirror Reflection: A Revised Field Combination Theory Model Based on the Upper Limit of Photon Rest Mass**

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**Abstract:**  
Based on Li Zhijun’s Field Combination Wavefunction Theory and closely integrating the key experimental fact of the upper limit of the photon rest mass determined by Chinese scientists, this paper provides a more precise particle nature interpretation of the photon mirror reflection process. We revise the photon’s field combination identifier to , where characterizes a non-zero but infinitesimally approaching zero rest mass field excitation. This revision indicates that the mirror reflection of a photon is a quantum process of incompletely elastic scattering between its field combination wavefunction and the collective excitation of the mirror lattice, involving an extremely minute transfer of energy-momentum to the lattice. We construct a photon-phonon scattering model incorporating the photon rest mass correction, demonstrating that even considering the effect of , the equality of the reflection angle and the incidence angle remains an extremely high-precision approximation of momentum conservation under current measurement accuracy. This model unifies the particle nature, wave nature of light, and the physical picture of the possible existence of an extremely small photon rest mass within the evolutionary framework of the field combination wavefunction.

**Keywords:** Field Combination Theory; Photon Rest Mass; Mirror Reflection; Particle Nature; Incompletely Elastic Scattering; Phonon

**1. Introduction: Paradigm Deepening from “Zero Mass” to “Approaching Zero Mass”**

The determination of the upper limit of the photon rest mass by Chinese scientists advances the essence of the photon from an ideal “zero-mass particle” to the more precise category of a “particle whose rest mass infinitely approaches zero.” This paradigm shift necessitates corresponding refinement in the Field Combination Theory’s description of the photon and its interaction dynamics, thereby providing a new perspective for understanding its particle nature.

**2. Theoretical Framework: Photon Field Combination Identifier Incorporating Rest Mass Correction**

## 2.1 Revised Field Combination Wavefunction of the Photon

Considering the experimental upper limit, the photon’s field combination wavefunction should be revised to:

* : Electromagnetic vortex field excitation, with energy and momentum
* : Electrically neutral, color neutral, the B-field is in its ground state.
* : Key revision. Indicates that the photon’s Higgs vortex field is in an excited state where its energy is infinitesimally higher than the ground state. Its rest mass is a non-zero infinitesimal quantity satisfying (photon energy). The symbol emphasizes its limiting nature.

## 2.2 Physical Implications of the Rest Mass Correction

The existence of carries two profound implications:

1. Theoretical Completeness: It implies that the photon may couple with the Higgs field in an extremely weak manner, leaving room for exploring new physics beyond the Standard Model.
2. Dynamical Correction: It revises the mirror reflection of the photon from an ideal completely elastic scattering to an incompletely elastic scattering. Because the photon possesses rest mass, the square of the norm of its four-momentum is no longer strictly zero: In the scattering process, this means there could be an extremely tiny deposition of energy into the medium.

**3. Dynamical Model of Photon Mirror Reflection Incorporating Rest Mass Correction**

## 3.1 Essence of the Interaction: Incompletely Elastic Scattering

The reflection process remains the scattering between the photon’s field combination and the phonon field of the mirror lattice. However, due to the presence of , this scattering process theoretically allows for energy exchange.

## 3.2 Revised Momentum-Energy Conservation Equations

Let the four-momentum of the incident photon be , that of the reflected photon be , and the four-momentum absorbed by the mirror be

The conservation equation is written as:

where represents the energy-momentum transferred to the lattice (phonons).

## 3.3 Extremely High-Precision Approximation of the Reflection Law

Since is extremely small (), its effect is exceedingly weak. We perform an order-of-magnitude estimation:

* For a visible light photon (), the ratio of its rest energy to the photon energy is less than
* In scattering, the maximum possible energy transfer Therefore, the energy change rate of the reflected photon is
* Derived from energy-momentum conservation, the deviation between the reflection angle and the incidence angle is also related to the order of , i.e., .

Conclusion: This deviation angle is far smaller than the precision limit of any existing or foreseeable future measuring instruments. Therefore, in all practical observations, the law stating that the angle of reflection equals the angle of incidence still holds strictly. The corrective effect of is phenomenologically unobservable, but its theoretical existence profoundly changes our understanding of the process’s essence: namely, that reflection is an incompletely elastic scattering that infinitely approaches complete elasticity.

**4. Conclusion and Discussion**

By introducing the revised field combination identifier based on the upper limit of the photon rest mass, this paper provides a more precise and profound interpretation of the particle nature of photon mirror reflection.

1. Deepening of the Particle Nature Interpretation: The particle nature of the photon is manifested not only in its indivisibility as an energy-momentum carrier but also in its behavior as a quantum object with a definite, non-zero (albeit extremely small) rest mass, strictly adhering to the constraints of energy-momentum conservation laws during the scattering process.
2. Self-Consistency between Theory and Experiment: The model shows that there is no contradiction between the extremely small upper limit of the rest mass measured by Chinese scientists and the macroscopically perfectly valid reflection law; they are highly self-consistent. The fact that the theoretically predicted tiny deviation is currently unobservable instead reflects the rigor of the theory.
3. Unification of the Physical Picture: This model successfully unifies the particle nature of light, its wave nature, and the frontier understanding that photons may possess an extremely small rest mass within the quantum dynamical framework of the field combination wavefunction. Reflection is no longer merely the collision of classical particles nor the phase-continuous variation of pure waves, but rather a more refined quantum scattering image that considers the most advanced experimental limitations.

This revision ensures that the theory not only retains its original explanatory power but also aligns with the most precise experimental measurements, demonstrating its strong inclusiveness and foresight as a fundamental theoretical framework.

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