## Rigorous Mathematical Formulation of Field Recombination and Energy Redistribution in Electron-Positron Annihilation **Authors:** Li Zhijun, Zhao Guangyao

### **Abstract**

## This paper establishes a rigorous quantum field theory framework for electron-positron annihilation processes, defining composite field operators to describe field recombination mechanisms and energy redistribution. Based on the unitary evolution operator, we derive dynamical equations revealing the coupling dynamics of electromagnetic vortex fields, color charge fields, and Higgs fields. The model incorporates non-perturbative instantaneous color charge field de-excitation, non-adiabatic Higgs field transitions, and energy-momentum conservation corrections. In the limit ε → 0, the theory strictly converges to QED predictions while maintaining intrinsic consistency with Li Zhijun's theoretical framework. The experimentally verifiable parameter ε must satisfy ε < 10⁻⁵ (current experimental precision limit), providing a new paradigm for high-energy physics and dark matter research.

### **1. Fundamental Field Structure Definition**

#### **1.1 Field Operator System**

**Electron field operator:**  
Ψₑ = Aₑ ⊗ B⁻ ⊗ C  
Where:

* Aₑ: Electron electromagnetic vortex field (dimension [E])
* B⁻: Negative color charge vortex field (SU(3) singlet)
* C: Positive Higgs vortex field (dimension [E])  
  **Positron field operator:**  
  Ψₚ = Aₚ ⊗ B ⊗ C⁻  
  Satisfying charge conjugation symmetry:  
  𝒞Ψₑ = Ψₚ  
  **Photon field operator:**  
  Γ = Aᵧ ⊗ C⁰  
  Where C⁰ denotes the residual Higgs field.

**2. Dynamical Evolution Equation**

The annihilation process is governed by the unitary evolution operator:  
  
The coupled field dynamics satisfy:

## Hamiltonian matrix elements satisfy Hermitian constraints:

### **3. Key Coupling Mechanisms**

#### **3.1 Non-Adiabatic Higgs Field Transition**

Higgs field component evolution:  
  
Where:

* - : Electron-photon coupling constant
* - ： Higgs field decay width

#### **3.2 Color Charge Field De-Excitation**

## SU(3) singlet constraint: Non-perturbative de-excitation rate:

## Where is the final-state density.

### **4. Energy Conservation and Branching Ratios**

#### **4.1 Energy Allocation Relation**

Photon energy distribution satisfies:

* Λ: UV cutoff scale ()
* - ： Deviation parameter from QED

#### **4.2 Annihilation Branching Ratios**

## Two-photon channel branching ratio: Total width correction:

### **5. Theoretical Limits and Experimental Verification**

#### **5.1 QED Recovery**

When :

* Higgs field decouples   
  Color charge field freezes:   
  Strictly recovers standard QED:

#### **5.2 Experimental Constraints**

Current experimental limit on   
  
Future verification schemes:

1. High-precision e⁻ colliders (e.g., FCC-ee)
2. Quantum interferometry for angular distribution deviations
3. Higgs field residual signals in dark matter detectors

### **Conclusion**

Through the ABC vortex field coupling mechanism, this model achieves the first unified dynamical description of electromagnetic, color charge, and Higgs fields in electron-positron annihilation. Key innovations include:

1. Establishment of the composite field operator system
2. Derivation of unitary evolution equations with non-perturbative de-excitation
3. Revelation of the scaling law for energy redistribution via parameter
4. The framework maintains consistency with Li Zhijun's dark matter-gravity theory while providing testable predictions for new physics beyond the Standard Model.

### **References**

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