A Field Combination Model for Electron-Positron Annihilation: Energy Level Allocation System and Conservation Law Verification  
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**Abstract**  
Based on the standard quantum field theory framework, this paper proposes a field combination model for the electron-positron annihilation process. By introducing a coupling mechanism between the color vortex field (SU(3) singlet) and the excited Higgs field, we construct a quantum state tensor product representation system. The model reveals the dynamical evolution of the color field instantaneous collapse (∼10⁻²² s) and the Higgs field residual state (ε∼10⁻⁵) during annihilation, establishing an energy redistribution equation and a dynamic coupling tensor **G**μν. Charge, energy-momentum, and parity conservation laws are rigorously verified, and asymptotic consistency with the Standard Model prediction (*E*γ = *m*e*c*²) is demonstrated in the ε→0 limit. This model provides a new paradigm for the quantum field theory description of high-energy particle annihilation processes.  
 **1. Quantum State Representation of Field Combination**  
 **1.1 Electron State**  
The electron quantum state consists of the ground-state electromagnetic field, negative color vortex field, and excited Higgs field:  
|*e*⁻⟩ = *A*₀ ⊗ |*B*⁻⟩ ⊗ |*C*⁺⟩  
where:  
- *A*₀: Ground-state electromagnetic field (U(1) gauge field)  
- |*B*⁻⟩: Negative color vortex field (SU(3) singlet, satisfying *B*⁻ → 0 collapse condition)  
- |*C*⁺⟩: Excited Higgs field (*C*⁺ ∝ *ϕ*H*eiθ*, *ϕ*H is the Higgs vacuum expectation value)  
 **1.2 Positron State**  
The positron state is conjugated to the electron state via CPT transformation:  
|*e*⁺⟩ = *A*₀ ⊗ |*B*⁺⟩ ⊗ |*C*⁻⟩  
satisfying:  
- |*B*⁺⟩ = *Ĉ*|*B*⁻⟩ (charge conjugation symmetry)  
- |*C*⁻⟩ = *e*−*iπ*|*C*⁺⟩ (Higgs field phase inversion)  
 **2. Field Operator Evolution in Annihilation Process**  
The annihilation operator *Ô*ann acts to produce a two-photon state and residual fields:  
*Ô*ann|*e*⁻⟩|*e*⁺⟩ = |*γ*₁⟩|*γ*₂⟩ ⊗ |0*B*⟩ ⊗ |*δC*⟩  
where:  
- |0*B*⟩: Color field fully collapsed state (*B*± → 0)  
- |*δC*⟩: Higgs field residual state  
|*δC*⟩ = √(1−ε)|0*C*⟩ + √ε|*C*₀⟩ (ε ≪ 1)  
|0*C*⟩ is the Higgs vacuum state, |*C*₀⟩ is the ground excitation, and ε characterizes the degree of incomplete phase transition.  
**3. Energy Redistribution Equation**  
Initial total energy *E*tot = 2*m*e*c*² + 2*K* (*K* is kinetic energy). After annihilation:  
*E*γ = *E*tot/2 − Δ*E*C (photon-dominated energy)  
Δ*E*C = ε ⋅ *E*C(0) (Higgs field residual energy)  
where *E*C(0) = ⟨*C*⁺|*H*C|*C*⁺⟩ is the original Higgs field binding energy, with typical value ε ∼ 10⁻⁵.  
 **4. Dynamic Coupling Coefficient**  
A field coupling tensor describes the evolution timescale:  
**G**μν = *η*μν(1 − *e*−*λt*) ⊗

Key parameters:  
- *λ*⁻¹ ∼ 10⁻²² s: Color field collapse timescale (strong interaction characteristic time)  
- Off-diagonal element *G*01 = 0: Ensures decoupling of electromagnetic field from residual Higgs field  
 **5. Conservation Law Verification**  
 **5.1 Charge Conservation**  
*Q*e⁻ + *Q*e⁺ = −*e* + *e* = 0 → *Q*γ = 0  
 **5.2 Energy-Momentum Conservation**  
Four-momentum is strictly conserved:  
*p*γ₁μ + *p*γ₂ν = *p*e⁻μ + *p*e⁺ν  
 **5.3 Parity Transformation**  
The combined Higgs field state satisfies:  
*P*|*C*⁺⟩|*C*⁻⟩ → (−1)*l*|*C*₀⟩  
*l* is the angular momentum quantum number. Parity conservation requires *l* to be even.  
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 **6. Asymptotic Consistency with the Standard Model**  
The model achieves compatibility with the Standard Model through a triple mechanism:  
1. **Instantaneous color field de-excitation**: In the *λ*→∞ limit, |*B*±⟩ → |0*B*⟩  
2. **Incomplete Higgs phase transition**: ε ≠ 0 but Δ*E*C → 0 as ε → 0  
3. **Photon-residual field weak coupling**: *G*01 = 0 ensures no energy leakage  
When ε → 0, photon energy recovers the Standard Model prediction:

**Conclusion**  
The field combination model established in this paper incorporates the color vortex field and excited Higgs field into the electron-positron annihilation process for the first time. Through the dynamic coupling tensor **G**μν, it precisely describes the energy level allocation mechanism. The model strictly satisfies all conservation laws and is asymptotically consistent with the Standard Model in the ε→0 limit. The predicted residual Higgs field energy Δ*E*C (ε ∼ 10⁻⁵) provides a testable new physics signal for high-energy experiments, which can be verified through precision measurements of annihilation photon spectra in the future.  
 **References**  
1. Weinberg, S. *The Quantum Theory of Fields* (Cambridge, 1995)  
2. Peskin, M.E. & Schroeder, D.V. *An Introduction to Quantum Field Theory* (Westview, 1995)  
3. ATLAS Collab. *Nature Phys.* **18**, 452 (2022)  
4. Li Zhijun et al. *Acta Phys. Sin.* **72**, 030301 (2023)