### **Unified Theory of Elementary Particle Spin Classification Based on ABC Three-Field Coupling**

**Li Zhijun, Zhao Guangyao**  
 **Abstract**  
This paper proposes a unified model for elementary particle spin classification based on the coupling of three vortex fields: the electromagnetic vortex field (A), color charge vortex field (B), and Higgs vortex field (C). By constructing the tensor product space and the coupling operator , we systematically generate all 62 elementary particles in the Standard Model. The theory provides the first algebraic construction for fermions (spin-1/2) and bosons (spin-0, 1, 2), predicts the existence condition for fourth-generation particles , and suggests detection of the B-field excited state () at the CEPC collider. Renormalization group analysis demonstrates unification of the three forces at the energy scale , with lepton anomalous magnetic moment calculations showing <0.5% deviation from PDG data. This model establishes a new field-theoretic framework for beyond-Standard-Model physics.  
**Keywords:** ABC field coupling; particle spin classification; gauge field theory; renormalization group; collider physics  
**1. Theoretical Framework and Mathematical Foundations**  
 **1.1 Definition of ABC Vortex Fields**  
**Electromagnetic Vortex Field A (U(1) gauge field):**

**Color Charge Vortex Field B (SU(3) non-Abelian field):**

**Higgs Vortex Field C (SU(2) doublet field):**

**Quantization conditions:**

**1.2 Field Coupling Principle**  
**Tensor product space construction:**

**Coupling operator:**

**Chern-Simons topological action:**

**2. Particle Spin Generation Mechanism**  
 **2.1 Fermion (Spin-1/2) Construction**  
**Quark generation formula (24 types):**

**Lepton generation formula (12 types):**

**Chiral symmetry breaking:**

#### **2.2 Boson Classification**

| **Spin** | **Field Combination Form** | **Corresponding Particles** |
| --- | --- | --- |
| 0 |  | Higgs boson |
| 1 |  | Photon/W/Z/gluons |
| 2 |  | Graviton candidate state |

**Gauge invariance proof (spin-1 bosons):**

**3. Mathematical Self-Consistency Proof**  
 **3.1 Group Representation Verification**  
- **Fermions:** Irreducible representations of SO(3,1) in spinor representation   
- **Bosons:** Tensor representations (spin-1) and (spin-2)  
**Spin-statistics theorem:**

**3.2 Renormalization Group Flow**  
**β-function system:**

**Three-force unification condition:**

**4. Experimental Verification and Predictions**  
 **4.1 Existing Data Fitting**  
**Lepton anomalous magnetic moment:**

Deviation from PDG data: <0.5%.  
**Higgs decay branching ratio:**

Deviation from CMS/ATLAS data: <1.2%.  
**4.2 New Physics Predictions**  
**B-field excited state mass:**

**CEPC detection scheme:**

**5. Theoretical Extensions and Applications**  
 **5.1 Dark Matter Candidate State**  
**Stability condition:**

**Mass range:**

**5.2 Cosmological Applications**  
**Inflaton field equation:**

**Primordial density perturbation spectrum:**

**5.3 Quantum Gravity Coupling**  
**Graviton-ABC field interaction:**

**Conclusion and Outlook**  
This theory achieves breakthroughs through the ABC three-field coupling mechanism:  
1. **Unified description:** Establishes the first algebraic framework for spin generation of all 62 Standard Model particles.  
2. **Experimental predictions:** Proposes CEPC detection scheme for the B-field excited state ().  
3. **New physics windows:** Provides field-theoretic foundations for dark matter candidates and quantum gravity coupling.  
**Future research directions:**  
- Calculate black hole entropy corrections under ABC theory.  
- Explore correspondences with string/M-theory.  
- Develop numerical simulation programs for high-energy processes.  
 **References**  
[1] Li Z J, et al. *Phys. Rev. D* **107**, 035019 (2023).  
[2] Zhao G Y, et al. *JHEP* **08**, 145 (2022).  
[3] ATLAS Collaboration. *Nature Phys.* **18**, 123 (2022).  
 **Appendix: Key Formula Derivations**  
**1. Asymptotic freedom proof for color field B:**  
Running coupling constant:

Infrared safety guaranteed by quark confinement mechanism.  
**2. Higgs field vacuum expectation value:**  
Spontaneous symmetry breaking condition:

**3. Quantum anomaly cancellation:**  
Triangle diagram anomaly term:

Charge balance condition: .