**The Unification and Separation of Cosmic Forces: A Sequence of Gauge Symmetry Breaking Based on ABC Field Combinations**

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Abstract:  
Based on Li Zhijun’s ABC theory, this paper proposes a complete dynamical model of the unified origin and hierarchical separation of the four fundamental interactions (strong, weak, electromagnetic, and gravitational forces). The core thesis is that all fundamental forces originate from the action of a unified parent gauge group at ultra-high energy scales, which acts on the ABC field combinations As the universe expands and cools, undergoes a sequence of spontaneous symmetry breaking (SSB) steps, breaking down to its subgroups corresponding to the differentiation of the various interactions. We construct a unified gauge field action and derive the energy scale sequence of symmetry breaking: . This model, for the first time, incorporates gravity and the other three forces within the same field combination framework and provides the precise energy scales and cosmological times of their separation. Finally, we present a cosmological timeline of force separation, thoroughly unifying the history of force evolution with particle generation and structure formation.

Keywords: ABC theory; Gauge unification; Symmetry breaking; Force separation; Field combination; Cosmological timeline

1. **Introduction: The Problem of Force Unification**

The Standard Model successfully unifies the electromagnetic, weak, and strong forces, but gravity remains excluded. Li Zhijun’s ABC theory offers a new perspective: all forces are manifestations of interactions between different components of the ABC field combinations, and their unification and separation are determined by the symmetry breaking of the gauge group acting on these field combinations.

1. **Theoretical Framework: The Unified Parent Gauge Group and Field Combinations**

2.1 Field Combinations and Gauge Transformations

In Li’s theory, the state of a fundamental particle is determined by its excitation mode within the ABC fields:

We postulate the existence of a unified gauge group whose elements simultaneously perform joint gauge transformations on the ABC fields:

2.2 Unified Action

The most compact form of the unified action is:

where contains the gauge field kinetic terms, is the Yukawa coupling term, and are the symmetry-breaking scalar fields whose vacuum expectation values determine the energy scales of symmetry breaking.

1. **The Chain of Symmetry Breaking and Force Separation**

We propose the following chain of symmetry breaking, along with its corresponding energy scales and cosmological times:

Table 1: Timeline of Gauge Symmetry Breaking and Force Separation

| Evolutionary Stage | Gauge Group | Residual Symmetry | Breaking Scale (GeV) | Cosmic Time | Separated Interaction | Corresponding Field Component |
| --- | --- | --- | --- | --- | --- | --- |
| Unification Era |  |  |  |  | Unified Force |  |
| Gravitational Sep. |  |  |  |  | Gravity | (Metric Field) |
| Strong Force Sep. |  |  |  |  | Strong Force | (Color Charge Field) |
| Electroweak SB |  |  |  |  | Weak & EM Forces | (EM Field) |
| EM Separation |  |  | 0 |  | Electromagnetic Force | (EM Field) |

3.1 Gravitational Separation ()

Mechanism: At the Planck scale the metric field decouples from the unified field background. Its dynamics are described by the Einstein-Hilbert action:

Residual Symmetry: General coordinate invariance. breaks to where describes non-gravitational interactions.

3.2 Strong Force Separation ()

Mechanism: At the Grand Unification scale the gauge group corresponding to the color charge field separates from Its action is:

where and are the generators of .

3.3 Electroweak Separation and Electromagnetic Force Generation ()

Mechanism: At the electroweak scale the Higgs field acquires a vacuum expectation value, breaking down to .

After breaking, the electromagnetic field emerges as a mass eigenstate:

Its corresponding gauge group acts on the branch of the electromagnetic field determining the electric charge Q.

1. **The Unified Equation of Forces**

Above the unification energy scale ( the interactions are described by a unified gauge field whose field strength is:

The kinetic term in the unified action is:

This term contains the unified description of all interactions.

As symmetry breaking occurs, decomposes into:

where is the graviton field and is its corresponding generator. Thus, we obtain the unified origin equation for the four fundamental forces.

1. **Integration with Particle Generation and Cosmic Evolution**

Force separation and particle generation are two sides of the same process:

1. Gravitational Separation: Generation of the spacetime background
2. Strong Force Separation: The color charge field emerges as an independent degree of freedom, laying the foundation for quark generation.
3. Electroweak Breaking: The Higgs field acquires a VEV, giving mass to W, Z bosons, and enabling leptons and quarks to acquire mass, laying the foundation for the generation of atomic nuclei and atoms.

The Revised Panorama of Cosmic Evolution:

* : Unified force acts on a unified field background.
* : Gravity separates; spacetime forms.
* : Strong force separates; quarks and gluons are the primary degrees of freedom.
* : Electroweak symmetry breaking; weak and electromagnetic forces separate; W, Z bosons, leptons, and quarks gain mass.
* : QCD phase transition; strong force confines; protons and neutrons are generated.
* : Primordial nucleosynthesis; atomic nuclei are generated.
* : Recombination era; atoms are generated.
* : Gravity-dominated structure formation; stars and galaxies are generated.

1. **Conclusion and Outlook**

Based on the ABC theory, this paper proposes a complete framework that unifies the four fundamental forces and describes their history of separation:

1. Unification: All forces originate from a single parent gauge group which acts on the ABC field combinations.
2. Separation Mechanism: Through a sequence of spontaneous symmetry breakings, breaks down step by step, and the forces separate sequentially.
3. Integration with Cosmic History: The separation of forces shares the same timeline with particle generation and structure formation, constituting a coherent history of cosmic evolution.

**Future Work:**

1. Determine the specific form of the parent group (e.g., ,
2. Investigate how the graviton is concretely embedded into the unified gauge field
3. Explore the predictions of this model for ultra-high-energy physics (e.g., cosmic rays, black hole physics).

This model provides a promising new paradigm for ultimately achieving a unified theory of forces.

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