The Field Combination Principle of the Physical Realm: A Unified Theory Based on Information Localization and Branch Coupling

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Abstract:  
Based on Li Zhijun’s ABC theory, this paper proposes a novel unified framework describing the properties of fundamental particles and their interactions within the physical realm. The core thesis is that the physical realm is constituted by three fundamental vortex fields: the electromagnetic field the color charge field and the Higgs field All observable phenomena originate from specific combination patterns of these fields.  
We demonstrate:  
(1) Particle charge and color charge properties are determined by the number of couplings to positive/negative field branches, satisfying ;  
(2) The essence of quark confinement is the quantum information localization of color charge field branches, with hadrons as color singlets satisfying ;  
(3) The non-utilizability of dark energy stems from its nature as the vacuum ground state lacking a reconstructable field combination structure, with its energy density conserved within a comoving volume;  
(4) The speed of light limit is the ultimate speed for information transfer within the physical realm, guaranteed by the Lorentz invariance of field combinations. This theory unifies particle physics, cosmology, and information theory within a single framework for the first time, providing a theoretical basis for exploring the boundaries of the physical realm.

Keywords: ABC theory; Field combination; Information localization; Branch coupling; Color singlet; Cosmological constant; Physical realm

1. Introduction: Field-Theoretic Foundation of the Physical Realm

The boundaries of the physical realm are defined by observable, operable entities. Based on the ABC theory, we propose that the fundamental building blocks of the physical realm are three vortex fields:

Fundamental Field Definitions:  
\* Electromagnetic Field: (responsible for wave nature)  
\* Color Charge Field: (color charge branches)  
\* Higgs Field: (mass branches)

Field Combination Principle: Any physical entity is a specific combination of these fields:

1. Branch Coupling Mechanism for Particle Properties

2.1 Origin of Charge and Color Charge

Particle properties are determined by their coupling patterns to field branches:

Charge Operator:

where denotes the number of couplings to positive/negative field branches.

Specific Particle Constituents:  
\* Up Quark (u):   
\* Down Quark (d):   
\* Electron ():   
\* Gluon (g):

2.2 Mass and Higgs Coupling

Mass originates from coupling to the Higgs field:

where is the coupling constant; the branch provides mass, while the branch may be related to dark matter.

1. Strong Interaction and Information Localization

3.1 Color Singlet Constraint

Observable hadrons must satisfy the color singlet condition:

where is the color charge operator.

Proton Wavefunction:

3.2 Information-Theoretic Interpretation of Confinement

The essence of confinement is quantum information localization:

where is the reduced density matrix of the color charge field; the finiteness of the entanglement entropy ensures color information cannot propagate to infinity.

Flux Tube Potential

The linear term originates from the energy cost of information localization.

1. Cosmology and Dark Energy

4.1 Field-Theoretic Description of Dark Energy

Dark energy corresponds to the vacuum ground state:

Its energy density is constant:

4.2 Proof of Non-Utilizability

Reasons dark energy cannot be utilized:  
1. Lack of field gradient:   
2. No local excitations: for   
3. Conservation in comoving volume:

1. Boundaries of the Physical Realm

5.1 Speed of Light Limit

The speed of information transfer is limited by field combination stability:

is the ultimate speed for field disturbance propagation within the physical realm.

5.2 Superluminal Entities

Any entity with necessarily:  
1. Decouples from the physical realm:   
2. Is undetectable:   
3. Is unusable:

1. Mathematical Framework

6.1 Field Operator Algebra

The fundamental fields satisfy commutation relations:

where

6.2 Combined State Hilbert Space

Physical states reside in the tensor product space:

6.3 Symmetry Constraints

Physical states must satisfy:  
1. Color singlet:   
2. Finite energy:   
3. Localization:

1. Theoretical Predictions and Verification

7.1 Predictions of New Particles

Existence of novel field combinations:  
\* Double-Higgs state:   
\* Mixed excitation state:   
\* Topological defect:

7.2 Experimental Tests

1. Precise measurement of quark charge structure
2. Search for information entropy signatures of confinement
3. Detection of dark energy field excitations
4. Tests for quantum corrections to the speed of light limit
5. Conclusion and Outlook

The field combination theory proposed herein achieves multiple unifications:

1. Unification of Properties: Charge, color charge, and mass all originate from field branch coupling.
2. Unification of Interactions: Strong and electroweak interactions are described within the field combination framework.
3. Particle-Cosmos Unification: Principles common to quark confinement and cosmic expansion.

Future Directions:  
1. Develop quantum computational simulations of field combinations.  
2. Explore possible existences beyond the physical realm.  
3. Establish a theory of quantum gravity based on information localization.

This theory provides a new paradigm for understanding physical reality, pushing physics from the “era of discovery” into the “era of creation”.

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