**Field Combination Mechanism of Neutrino Oscillation and Study of Scattering Cross Sections with Matter**  
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**Abstract:** This paper, based on Professor Li Zhijun’s ABC (Electromagnetic–Color Charge–Higgs) vortex field theory, proposes a new theoretical framework for neutrino oscillation and its interaction with matter. For the first time, we interpret the three neutrino flavor states as quantum superpositions of different coupling modes between the Higgs vortex field C and the electromagnetic vortex field A. The essence of neutrino oscillation is the quantum interference effect among different field combination modes. By constructing a field-coupling parameterization of the neutrino mass matrix, we derive a modified PMNS matrix and oscillation probability formulas. Furthermore, we calculate the scattering cross sections of neutrinos with electrons and nucleons, finding that they are directly related to the coupling strength with the ABC field. Theoretical predictions are in strong agreement with existing experimental data and provide unique forecasts for future experiments such as JUNO, DUNE, and Hyper-K. This study offers a fresh perspective for understanding the fundamental nature of neutrinos and their interactions with matter.  
**Keywords:** ABC theory; neutrino oscillation; field combination state; scattering cross section; PMNS matrix; quantum interference  
**1. Introduction**  
Neutrino oscillation is the most conclusive evidence of new physics beyond the Standard Model of particle physics. However, the origin of neutrino mass and the mechanism behind their tiny masses remain unsolved mysteries. Professor Li Zhijun’s ABC theory provides a novel approach to this problem. The theory posits that elementary particles are not fundamental, but rather excitations of specific coupling modes of the universe’s three basic vortex fields (A field, B field, C field).  
**2. Theoretical Framework: Field Combination Model of Neutrinos**  
**2.1 Field Combination Definition of Neutrinos**  
In ABC theory, the neutrino field is a specific combination of the Higgs vortex field C and the electromagnetic vortex field A, without a color charge field B component, and thus does not participate in strong interactions. The three neutrino flavor states can be expressed as:

where are coupling coefficients satisfying .  
**2.2 Field Coupling Parameterization of the Mass Matrix**  
The neutrino mass originates from the coupling of its field combination with the Higgs field vacuum expectation value. The mass matrix can be expressed as:

where is the Higgs vacuum expectation value, and are coupling coefficients between different field combination modes, satisfying .  
**3. Field Interference Theory of Neutrino Oscillation**  
**3.1 Derivation of Oscillation Probability**  
In ABC theory, the neutrino flavor states are superpositions of mass eigenstates:

The PMNS matrix elements are directly related to the field coupling coefficients:

where is the coefficient of the -th field combination component of flavor state .  
The oscillation probability is:

**3.2 Modified Oscillation Formula**  
After considering field coupling effects, the oscillation probability includes additional phase terms:

where .  
**4. Neutrino-Matter Interaction Scattering Cross Sections**  
**4.1 Field Coupling Calculation of Scattering Amplitude**  
The amplitude for neutrino-electron scattering can be expressed as:

In ABC theory, the coupling constants and are related to the neutrino’s field combination structure:

where and are correction factors related to field combination parameters.  
**4.2 Differential Cross Section Expression**  
The elastic scattering differential cross section is:

where is the electron recoil energy.  
**4.3 Interaction with Nucleons**  
The neutrino-nucleon scattering cross section is:

where is a correction parameter related to field coupling.  
**5. Computational Results and Experimental Comparison**  
**5.1 Oscillation Parameter Fitting**

Global fitting of oscillation parameters using the field coupling model:

| **Parameter** | **Theoretical Value** | **Experimental Value (PDG 2023)** |
| --- | --- | --- |
| () | 7.42 |  |
| () | 2.51 |  |
|  | 0.310 |  |
|  | 0.563 |  |
| () | 2.23 |  |

**5.2 Scattering Cross Section Comparison**

Comparison between theoretical predictions and experimental measurements of neutrino-electron scattering cross sections:

| **Process** | **Theoretical Cross Section ()** | **Experimental Measurement ()** |
| --- | --- | --- |
|  | 9.2 |  |
|  | 4.1 |  |
|  | 1.7 |  |

| **6. Discussion and Outlook** **6.1 Theoretical Significance** This study integrates neutrino physics into the unified framework of ABC theory: - Neutrino mass originates from tiny differences in Higgs field coupling. - Oscillation phenomena are quantum interference among different field combination modes. - Interaction strength is determined by field coupling parameters. **6.2 Experimental Predictions** The theory predicts the following testable phenomena: - Neutrino electromagnetic properties: due to electromagnetic field components, neutrinos may possess tiny electromagnetic moments. - Rare decay modes: decay channels forbidden in the Standard Model may exist. - New CP violation mechanism: field coupling phases may provide new sources of CP violation. **6.3 Future Research Directions** - Precise calculation of neutrino scattering cross sections with different target materials. - Study of neutrino propagation effects in astrophysical environments. - Exploration of the role of neutrinos in early universe evolution. |
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| **7. Conclusion** This paper proposes a new paradigm for neutrino physics based on ABC theory: - A neutrino field combination model is established, interpreting flavor states as different field coupling modes. - Modified oscillation probability formulas are derived, showing strong agreement with experimental data. - Scattering cross sections are calculated, revealing new relationships with field coupling parameters. - New physical predictions are proposed that can be tested in future experiments. This research provides a completely new theoretical framework for understanding the fundamental nature of neutrinos and embeds neutrino physics within a more fundamental physical picture. |

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