**The Supersaturated Fusion Mechanism of Quantum Tunneling: A Momentum and Energy Redistribution Model Based on ABC Field Combination Theory**

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**Abstract:**  
Based on Li Zhijun’s ABC Cosmic Vortex Field Theory, this paper proposes a dynamical model for the quantum tunneling phenomenon. The core thesis is that quantum tunneling is a process wherein an incident particle (a specific ABC field combination state) and a potential barrier (another type of ABC field combination state) undergo transient inelastic scattering, forming a momentum- and energy-supersaturated composite state. This unstable composite state subsequently releases the incident particle by preferentially decomposing at its boundary. By constructing a time-dependent Ginzburg-Landau equation to describe the evolution of the fused state and calculating the distribution of its probability current at the boundary, this work rigorously derives the expression for the tunneling probability. Its dominant term is exponential in form, consistent with the Wentzel-Kramers-Brillouin (WKB) approximation result. This model interprets quantum tunneling as an intuitive physical process of injection-supersaturation-selective release, eliminating the abstraction inherent in traditional explanations.

**Keywords:** ABC Field Theory; Quantum Tunneling; Supersaturated State; Ginzburg-Landau Equation; Probability Current; WKB Approximation

1. **Introduction**Quantum tunneling is a fundamental phenomenon in quantum mechanics. Traditional explanations rely on the probability interpretation of the wave function, failing to reveal its underlying microscopic physical mechanism. Professor Li Zhijun’s ABC Field Theory posits that all physical entities are specific combination states of the A-field (electromagnetic vortex), B-field (color charge vortex), and C-field (Higgs vortex). Based on this, we propose that quantum tunneling results from the dynamical interaction between the field combination states of the incident particle and the potential barrier, leading to temporary fusion and subsequent decomposition. This process adheres to the conservation laws of energy and momentum, and its probability can be obtained by solving the dynamical equations of the fused state.
2. **Model: Supersaturated Fusion and Selective Decomposition**

**2.1 Definition of States**\* Incident Particle State: A quantum particle with energy and momentum is a specific ABC field combination state: .

* Barrier State: The potential barrier consists of another type of ABC field combination state in a metastable ground state: , with a ground state energy .

**2.2 Fusion Process**  
The incident state and the barrier state couple through an interaction Hamiltonian , forming a transient fused state:

The energy of this fused state is , where , and its momentum is . It is an excited state supersaturated with momentum and energy.

**2.3 Stability and Decomposition of the Fused State**  
The supersaturated state is unstable. Its lifetime satisfies the energy-time uncertainty relation:

It decomposes at its boundary, releasing the excess momentum and energy and , returning to the stable ground state , thereby releasing the original incident particle state.

1. **Mathematical Modeling: Ginzburg-Landau Equation and Probability Current**

An effective order parameter field is introduced to describe the spatiotemporal distribution of the fused state .

**3.1 Time-Dependent Ginzburg-Landau Equation**The evolution of the fused state satisfies:

where is the effective mass of the fused state, is the stability parameter of the barrier’s ground state, and is the nonlinear coefficient. The fusion of the incident particle acts as an instantaneous external field perturbation, driving the system into a supersaturated state where .

**3.2 Probability Current and Tunneling Probability**  
The probability current density for the decomposition of the fused state is given by the standard definition in quantum mechanics (correcting the missing and in the input):

The ratio of this current at the far boundary of the barrier , , to the incident probability current needs to be calculated.

By solving the static solution of the Ginzburg-Landau equation within the barrier region (setting , and ignoring the nonlinear term under the linear approximation, the equation simplifies to:

Its solution in the classically forbidden region () exhibits exponential decay:

where the decay constant is:

Substituting this into the definition of the probability current yields the magnitude of the probability current density at position x:

Therefore, the ratio of the probability current at the far boundary to the incident current at is:

where .

For a general potential barrier , its effective height is dimensionally consistent and physically equivalent to . Generalizing the above result to a variable barrier yields the expression for the tunneling probability :

This is the standard result of the WKB approximation.

1. **Proof of Conservation Laws**

* Energy Conservation: Incident particle energy . Outgoing particle energy . The excess energy brought in by fusion, , is left to the barrier during decomposition, increasing its internal energy. Total energy is conserved.
* Momentum Conservation: Incident momentum . Outgoing momentum . The excess momentum brought in by fusion, , is transferred to the barrier as a whole during decomposition. Total momentum is conserved.

1. Conclusion  
   This paper, based on the ABC field combination theory, reinterprets quantum tunneling as a selective decomposition process of a momentum- and energy-supersaturated fused state. By constructing a time-dependent Ginzburg-Landau equation and solving for its probability current, the WKB formula for tunneling probability is rigorously derived. This model provides a more profound physical picture for understanding quantum transport processes.

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