

# **GENESIS OF SPACETIME**

## **Concept of the Finiteness of the Universe Based on Fundamental Interactions and Quantum Vacuum**

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### **Abstract**

This work proposes a concept of the finiteness of the Universe, grounded in the assumption that the physical structure of space is determined by fundamental interactions. It is argued that the boundaries of the Universe coincide with domains of quantum vacuum, which do not possess spatial or temporal characteristics. Within this framework, infinity is treated as a mathematical abstraction without physical realization. Furthermore, the study discusses the connection between quantum fluctuations, fundamental interactions, and the emergence of the space-time continuum.

### **Introduction**

The notion of infinity has traditionally played a central role in cosmology and the philosophy of physics. However, in a strictly physical sense, it often lacks well-defined meaning. The objective of this study is to substantiate the concept of a finite Universe, based on the dynamics of fundamental interactions and the role of the quantum vacuum.

### **Main Body**

#### **1. Infinity as a mathematical abstraction**

Infinity does not constitute a physical property but rather a mathematical abstraction. It is highly unlikely that infinity exists in physical reality.

#### **2. Structure of the Universe and quantum vacuum**

If fundamental interactions are regarded as the basis of the physical structure of space, then the Universe ends where such interactions are absent. These regions correspond to the quantum vacuum with zero energy.

The quantum vacuum does not possess dimensional or temporal attributes; therefore, the notion of infinity cannot be applied to it. The spatial finiteness of the Universe is defined by dynamic boundaries between regions of space and the vacuum.

Metaphorically, this can be illustrated by a geographic map: land represents physical space, while seas, rivers, and oceans correspond to the quantum vacuum.

### **3. Dynamics of the Universe's boundaries**

Fundamental interactions continuously generate new regions of space, which explains the dynamic expansion of the Universe. At the same time, existing space can transition back into the state of vacuum.

### **4. Time and quantum fluctuations**

The state of rest in quantum mechanics is described by a zero mean momentum. In such a state, quantum fluctuations are present, but prior to the realization of a fundamental interaction, no transfer of energy or momentum occurs. Consequently, there is neither a spatial interval nor a directed vector of change, which we interpret as time.