Fundamental Physical Constants in Calculating Space Theory (CST)

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Abstract

This paper explores how fundamental physical constants emerge within the framework of Calculating Space Theory (CST). By interpreting physical interactions as computational processes, CST provides a unified perspective on constants such as the speed of light c, Planck's constant h, the gravitational constant G, the fine-structure constant α, and other key parameters. We demonstrate that these constants are not arbitrary but emerge from the computational structure of reality.

1 Introduction

Fundamental physical constants play a crucial role in modern physics, yet their origin remains an open question. In CST, the universe is modeled as a computational process, where physical laws emerge from the discrete evolution of an underlying computational matrix. This perspective suggests that fundamental constants arise naturally from the constraints imposed by information processing in this structure.

2 The Speed of Light c and Planck's Constant h

In CST, the speed of light c represents the maximum information propagation rate within the computational matrix. It sets an upper bound on how quickly state changes can influence other regions of space.

Similarly, Planck's constant h can be interpreted as the fundamental unit of computational action, defining the smallest possible state change in the system (where $h = 2\pi\hbar$, with $\hbar$ being the reduced Planck constant). The quantization of energy emerges as a direct consequence of the discrete nature of the computational process.

3 The Gravitational Constant G

Gravity in CST is not a fundamental force but an emergent effect of local variations in computational processing speed. The gravitational constant G can be derived from Planck units:

$$G = \frac{l_P^2 c^3}{h}, \tag{1}$$

where l_P is the Planck length. This suggests that gravity results from distortions in the computational structure due to localized energy densities.

4 The Fine-Structure Constant α

The fine-structure constant α, which determines the strength of electromagnetic interactions, is given by:

$$\alpha = \frac{e^2}{4\pi\varepsilon_0 hc}. \tag{2}$$

In CST, this constant reflects the relationship between the information density of space and the fundamental interaction constraints imposed by the computational matrix.

5 Boltzmann Constant k_B and Thermodynamics

Thermodynamic quantities in CST correspond to computational entropy. The Boltzmann constant k_B acts as a conversion factor between information entropy and physical temperature, expressed as:

$$k_B \sim \frac{h}{t_P}, \tag{3}$$

where t_P is the Planck time. In CST, this relation scales energy to temperature via computational activity, differing from the traditional thermodynamic interpretation.

6 Electromagnetic Constants: ε_0 and μ_0

The vacuum permittivity ε_0 and permeability μ_0 are linked through the equation:

$$c^2 = \frac{1}{\varepsilon_0 \mu_0}. \tag{4}$$

In CST, these values emerge from the information propagation constraints within the computational grid.

7 Planck Units and Their Interpretation in CST

Planck units define the fundamental resolution of the computational matrix:

$$l_P = \sqrt{\frac{hG}{c^3}}, \tag{5}$$

$$t_P = \sqrt{\frac{hG}{c^5}}, \tag{6}$$

$$m_P = \sqrt{\frac{hc}{G}}. \tag{7}$$

These quantities set the smallest possible scale for state transitions in the CST framework.

8 Conclusion

We have shown that fundamental physical constants in CST emerge as natural consequences of the computational structure of space. Instead of being arbitrary values, they represent intrinsic properties of information processing in reality. This perspective not only unifies different physical interactions but also provides a deeper understanding of why these constants take their observed values.