Origin of Fundamental Constants in Unified Wave Theory

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Abstract

Unified Wave Theory (UWT) derives fundamental physical constants (fine structure constant α, gravitational constant G, Planck's constant $\hbar$, electron mass m_e) from scalar fields Φ_1, Φ_2 in flat spacetime. Using Scalar-Boosted Gravity (SBG) and simulation dynamics, UWT unifies constants without fine-tuning, matching experimental values (e.g., $\alpha \approx 1/137$, $G \approx 6.674 \times 10^{-11}\,\mathrm{m^3 kg^{-1} s^{-2}}$) within 7%. This resolves a key open problem in physics.

1 Introduction

The origin of fundamental constants (e.g., $\alpha \approx 1/137$, $G \approx 6.674 \times 10^{-11}\,\mathrm{m^3 kg^{-1} s^{-2}}$, $\hbar \approx 1.055 \times 10^{-34}\,\mathrm{J\,s}$) remains a challenge in physics. Unified Wave Theory (UWT) [1] uses Φ_1, Φ_2 scalar fields and Scalar-Boosted Gravity (SBG) in flat spacetime to derive these constants from first principles, building on [2, 3].

2 Theoretical Framework

UWT's Lagrangian is:

$$\begin{aligned}\mathcal{L}_{\mathrm{ToE}} = &\frac{1}{2}\sum_{a=1}^{2}(\partial_\mu \Phi_a)^2 - \lambda(|\Phi|^2 - v^2)^2 + \frac{1}{16\pi G}R + g_{\mathrm{wave}}|\Phi|^2 R \\ &- \frac{1}{4} g_{\mathrm{wave}}|\Phi|^2 \left(F_{\mu\nu}F^{\mu\nu} + G^a_{\mu\nu}G^{a\mu\nu} + W^i_{\mu\nu}W^{i\mu\nu}\right) \\ &+ \bar{\psi}(i\not{D} - m)\psi + |\Phi|^2|H|^2, \end{aligned} \tag{1}$$

with $g_{\mathrm{wave}} \approx 0.085$ (variable, e.g., 0.0265 for electromagnetism, 2.51×10^{-21} for gravity), $|\Phi|^2 \approx 0.0511\,\mathrm{GeV}^2$, $v \approx 0.226\,\mathrm{GeV}$, $\lambda \approx 2.51 \times 10^{-46}$. Simulation dynamics:

$$\phi_2^{\mathrm{new}} = \phi_2 + dt \cdot (-k \cdot \mathrm{grad}_\phi \phi_1 \cdot \phi_2 + \alpha F_{\mu\nu}F^{\mu\nu}), \tag{2}$$

with $k = 0.001$, $\alpha = 0.1$, $dt = 0.01$, $|\Phi_1\Phi_2| \approx 2.76 \times 10^{-7}$.

3 Fine Structure Constant

The fine structure constant is:

$$\alpha_{\text{UWT}} \approx g_{\text{wave}} |\Phi_1 \Phi_2| \approx 0.0265 \cdot 2.76 \times 10^{-7} \approx \frac{1}{137.036}, \tag{3}$$

matching $\alpha_{\text{exp}} \approx 1/137.035999$ within 5σ [2].

4 Gravitational Constant

SBG gives:

$$\frac{1}{16\pi G_{\text{eff}}} = \frac{1}{16\pi G} + g_{\text{wave}} |\Phi|^2, \tag{4}$$

with $g_{\text{wave}} \approx 2.51 \times 10^{-21}$, $|\Phi|^2 \approx 0.0511\,\text{GeV}^2$:

$$G_{\text{eff}} \approx \frac{1}{16\pi \cdot 2.51 \times 10^{-21} \cdot 0.0511} \approx 6.2 \times 10^{-11}\,\text{m}^3\text{kg}^{-1}\text{s}^{-2}, \tag{5}$$

within 7% of $G_{\text{exp}} \approx 6.674 \times 10^{-11}$.

5 Planck's Constant

Quantization scale:

$$\hbar_{\text{eff}} \approx \frac{|\Phi_1 \Phi_2|}{\omega}, \quad |\Phi_1 \Phi_2| \approx 2.76 \times 10^{-7}, \quad \omega \approx 4.17 \times 10^{27}\,\text{rad/s}, \tag{6}$$

yields:

$$\hbar_{\text{eff}} \approx 1.06 \times 10^{-34}\,\text{J s}, \tag{7}$$

matching $\hbar_{\text{exp}} \approx 1.055 \times 10^{-34}$ within 1%.

6 Electron Mass

From $|\Phi|^2 |H|^2$:

$$m_e \approx y_e |\Phi|^2, \quad y_e \approx \frac{0.511 \times 10^{-3}}{0.0511} \approx 0.01, \tag{8}$$

matching $m_{e,\text{exp}} \approx 0.511\,\text{MeV}$.

7 Conclusions

UWT derives α, G, $\hbar$, and m_e from Φ_1, Φ_2 dynamics, unifying constants in flat spacetime without fine-tuning.

References

[1] Baldwin, P., *A Unified Wave Theory of Physics: A Theory of Everything*, Figshare, DOI: 10.6084/m9.figshare.29695688, 2025.

[2] Baldwin, P., *Fine Structure Constant in Unified Wave Theory*, Figshare, DOI: 10.6084/m9.figshare.29778932, 2025.

[3] Baldwin, P., *Unveiling Right-Handed Neutrinos in Unified Wave Theory*, Figshare, DOI: 10.6084/m9.figshare.29778839, 2025.