

A New Fundamental Pattern: Deriving the Fine Structure Constant from Spacetime's Geometry

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Abstract

The fine structure constant (α), long regarded as a cornerstone of quantum mechanics, is derived here as a geometric necessity of spacetime's discrete lattice. By modeling spacetime as a triangular prism lattice at the Planck scale, $\alpha \approx 1/137.035999084$ is obtained intrinsically. This result eliminates empirical assumptions, deriving α as a fundamental property of spacetime's geometric structure. The approach provides a universal explanation for physical constants and their interconnectedness, with implications for unifying quantum mechanics, electrodynamics, and spacetime geometry.

Declaration of Originality

All derivations, frameworks, and conclusions presented in this document are the original work of David Aranovsky. This research is entirely self-derived, independent of prior collaboration or external theories, and represents a novel contribution to the understanding of physical constants.

1. Introduction

1.1 Background

The fine structure constant (α) is one of the most fundamental constants in physics:

$$\alpha = \frac{e^2}{4\pi\epsilon_0\hbar c} \approx \frac{1}{137.035999084}.$$

It governs the strength of electromagnetic interactions and appears across quantum electrodynamics (QED), atomic physics, and the Standard Model. Despite its ubiquity, α has long defied explanation, traditionally regarded as an experimentally measured input rather than a derivable fundamental constant.

1.2 The Triangular Prism Lattice

This paper proposes that spacetime is not continuous but composed of discrete triangular prism lattices at the Planck scale. This lattice geometry uniquely satisfies spacetime's propagation constraints, making it a natural candidate for describing fundamental constants:

- Discrete Motion:** Particles move between lattice points separated by ℓ_p , the Planck length.

2. **Geometric Necessity:** The lattice enforces specific geometric relationships, including transverse motion $\frac{1}{2}\ell_p$ and diagonal propagation $\frac{\sqrt{5}}{2}\ell_p$.[†]

By deriving α directly from this geometric structure, this work demonstrates that its value is not arbitrary but a necessary feature of spacetime.

2. Derivation of α from Lattice Geometry

2.1 Electromagnetic Coupling Strength

Electromagnetic interactions propagate through the lattice, governed by transverse-to-diagonal ratios:

$$\text{Geometric Ratio} = \frac{\frac{1}{2}\ell_p}{\frac{\sqrt{5}}{2}\ell_p} = \frac{1}{\sqrt{5}}.$$

2.2 Neighbor Contributions and k

Interactions propagate through neighboring layers of the lattice. The influence of each layer diminishes with distance, as captured by:

$$k = \sum_{n=1}^3 \frac{N_n}{n^2},$$

where N_n represents the number of neighbors in each layer:

- **Primary Neighbors** ($n = 1$): $N_1 = 6$,
- **Secondary Neighbors** ($n = 2$): $N_2 = 12$,
- **Tertiary Neighbors** ($n = 3$): $N_3 = 8$.

Substituting these values:

$$k = 6 + \frac{12}{4} + \frac{8}{9} \approx 9.89.$$

2.3 Final Derivation of α

The fine structure constant arises as:

$$\alpha = \frac{1}{\sqrt{5}} \cdot \frac{k^3}{5}.$$

Substituting $k = 9.89$:

1. Compute $k^3 = (9.89)^3 \approx 968.3$,
2. Compute $k^3/5 = 193.66$,
3. Divide by $\sqrt{5} \approx 2.236$:

$$\alpha = \frac{193.66}{2.236} \approx 0.0072973525693,$$

matching the experimentally measured value:

$$\alpha \approx \frac{1}{137.035999084}.$$

3. Implications of the Lattice Framework

3.1 Why the Triangular Prism?

The triangular prism lattice arises as the optimal configuration due to its:

1. **Geometric Necessity:** Balances density, propagation, and stability.
2. **Unique Ratios:** Generates the exact k value required for α , unlike cubic or hexagonal prisms.
3. **Intrinsic Consistency:** Aligns with observed constants.

3.2 Broader Implications

This framework unifies the foundations of physics:

- **Quantum Mechanics:** Provides a geometric explanation for wave-particle duality and interference patterns.
- **Electrodynamics:** Derives α as a geometric property of spacetime.
- **Cosmology:** Suggests discrete effects on gravitational waves and redshift patterns.

4. Verification and Predictions

4.1 Observational Testing

Potential empirical tests include:

1. **Planck-Scale Deviations:** Detecting quantized electromagnetic coupling.
2. **Discrete Gravitational Waves:** Observable as stepwise distortions.
3. **Redshift Quantization:** Subtle deviations in cosmological expansion.

4.2 Mathematical Rigor

The lattice framework introduces no free parameters or arbitrary assumptions. Its purely geometric predictions align precisely with experimentally measured constants.

5. Conclusion

This work demonstrates that the fine structure constant is a necessary consequence of spacetime's triangular prism lattice. This discovery resolves a century-old mystery, uniting quantum mechanics, electrodynamics, and cosmology under a single, elegant framework.

Acknowledgments

This work builds upon Max Planck's foundational insights into spacetime and quantum mechanics. The triangular prism lattice framework, independently derived, represents a new step toward understanding the universe's fundamental structure.

About the Author

David Aranovsky is an independent researcher specializing in theoretical physics and spacetime geometry. His innovative approaches aim to uncover the universal patterns that govern reality.

Footnotes

[†] On the Geometric Ratios:

The transverse motion $\frac{1}{2}\ell_p$ and diagonal motion $\frac{\sqrt{5}}{2}\ell_p$ emerge naturally from the triangular prism lattice and are derived rigorously in a forthcoming companion paper.