A Physical Origin of the Fine-Structure Constant

The geometric derivation of electromagnetic coupling from substrate condensation topology.

$$\alpha = \omega_c^2 \frac{r_q^2}{c^2}$$

Vijay Shankar Sharma | Independent Researcher | DOI: 10.5281/zenodo.21303201

> One of the greatest damn mysteries of physics: a magic number that comes to us with no understanding by man.
>
> — **Richard Feynman**

The Primitive Input

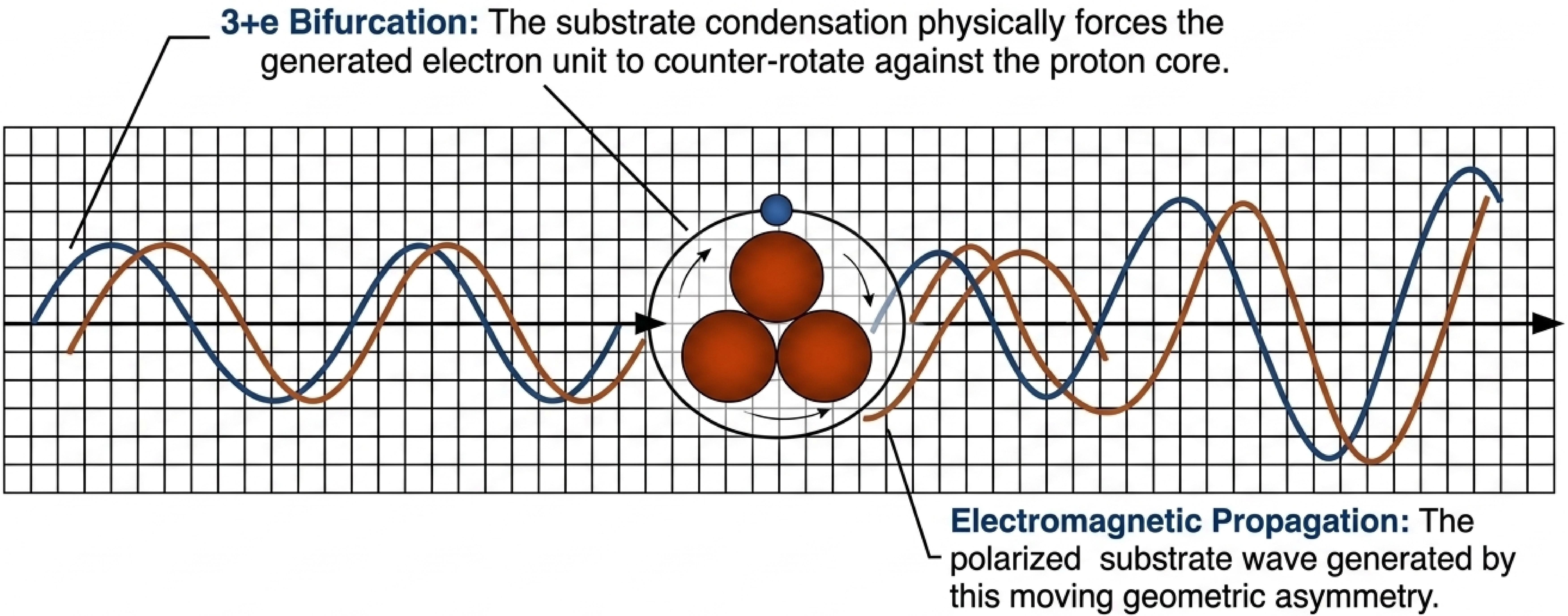
- **Universality**
  Sets the strength of the electromagnetic interaction across atomic, particle, and quantum physics.
- **Dimensionless**
  A pure number, independent of any unit system.
- **Empirical**
  Treated by the Standard Model as a free parameter, fixed only by measurement, never by derivation.

Measured Value: $\alpha \approx 1/137.036$

The Paradigm Matrix: Empirical Input vs. Geometric Consequence

	Standard Model	P66 Framework
Origin of Value	Empirical measurement only.	**Derived from condensation geometry.**
Physical Meaning	Unexplained coupling strength of a postulated force.	**Ratio of rotational kinetic energy to propagation energy.**
Input Parameters	One free parameter (the measured value itself).	**Zero free parameters** (inputs fixed independently by geometry).

The Physical Origin of Charge: Persistent Rotational Asymmetry



Electromagnetism is not a separately postulated force. Its coupling strength is geometrically fixed by the exact same condensation that mechanically produces electric charge.

Anatomy of the P66 Equation

ω_c **Internal Circulation Frequency.** Set by the free-energy minimum (D=1 coefficient) of the substrate condensation.

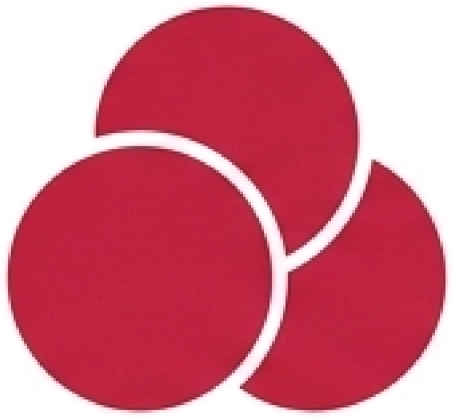
r_q **Quark Condensation Radius.** Fixed by 3-sphere close-packing geometry ($r_q = 0.3905$ fm), anchored by the measured proton charge radius.

$$\alpha = \frac{\omega_c^2 r_q^2}{c^2}$$

c **Substrate Speed Limit.** The maximum mechanical reorganization rate of the Spaticle medium.

Variable Audit: The Geometry of the Numerator

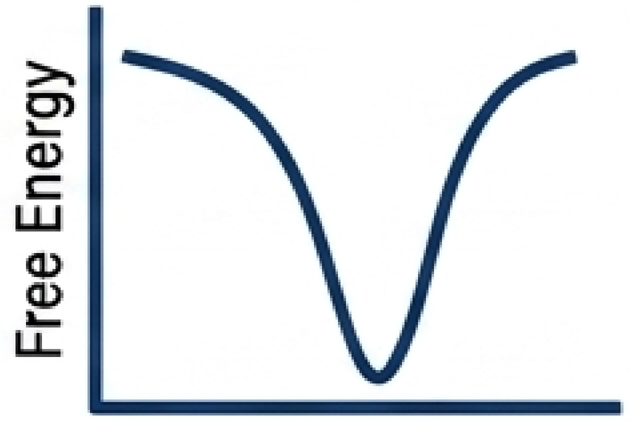
Deriving r_q



The quark condensation radius (r_q) is derived geometrically from the measured proton charge radius (r_p = 0.8414 fm) via three-sphere packing.

$$r_q = \frac{r_p}{1 + 2/\sqrt{3}} = 0.3905\ \text{fm}$$

Deriving ω_c



The internal circulation frequency (ω_c) is set by the free-energy minimum of the condensation functional (P16).

Governed by the D=1 circulation cost coefficient (topological phase winding).

Both variables are fixed by structural topology and prior independent measurement. Neither is adjusted for this derivation.

Variable Audit: The Substrate Speed Limit (c)

Substrate Stiffness (K_s)

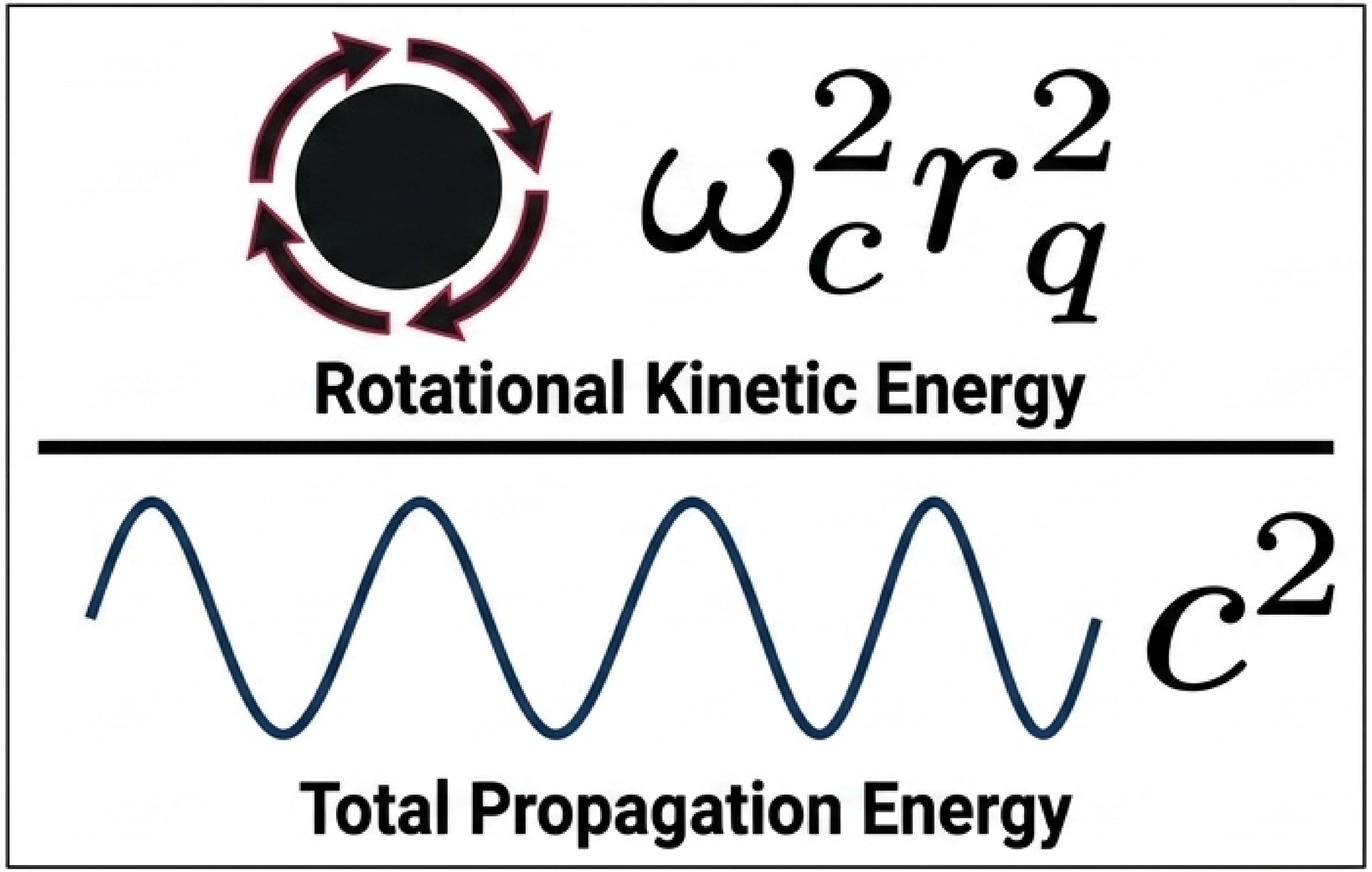
Substrate Density (ρ_s)

$$c = \sqrt{\frac{K_s}{\rho_s}}$$

- **In the BFUT framework, c is not a mere kinematic absolute. It is the exact propagation speed of disturbances in the Spaticle substrate.**
- **It represents the maximum mechanical reorganization rate of the medium.**

c is independently reconstructed to 0.0003% precision using entirely separate electromagnetic variables ($e, \varepsilon_0, m_p, r_p$) proving internal framework consistency.

The Physical Interpretation: An Energy Ratio



The fine-structure constant is simply the geometric ratio of two energy scales already present in the condensation: the rotational energy stored at the condensation's interface, divided by the total propagation energy of the substrate.

Electromagnetism's strength is structurally predetermined by the energy budget of electric charge itself.

The Uniqueness Constraint

Input Pool

$\omega_c, r_q, c, \rho_s, m_p, \ldots$

↓

Dimensionless Requirement

Must be a pure number.

↓

Rotational Invariance

Must respect the geometry of the 3+e spherical condensation.

↓

Unit-Independence

Must hold regardless of the measurement system.

↓

Unique Output

Up to overall powers, $(\omega_c^2 r_q^2)/c^2$ is the unique non-trivial dimensionless combination available from the condensation geometry. The math is inevitable, not arbitrary.

The Numerical Proof

DERIVED GEOMETRIC RATIO (P66)	MEASURED VALUE (CODATA)
1 / 137.1	1 / 137.036

0.05% Precision. Achieved using zero adjustable parameters, zero fitted variables, and zero arbitrary inputs. The coupling strength of electromagnetism is a derived property.

Addressing the "Hidden Parameter" Objection

Does a 0.05% agreement simply reflect a geometric geometric parameter (ω_c or r_q) that was quietly tuned to reproduce the measured value of α?

Step 1. The variables (ω_c, r_q) were fixed independently in P16 to derive the reduced Planck constant ($\hbar$), achieving 0.0007% agreement. They cannot be altered without breaking quantum mechanics.

Step 2. Substituting the BFUT $\hbar$ formula into standard electromagnetism yields the condensation radius:

$$R_0 = \frac{4\pi\varepsilon_0 m_p c^2 r_p \alpha}{e^2} = 1.2735$$

Step 3. This matches the purely geometric $R_0 = 1.27348$ to 0.0007%. Two derivation chains that know nothing of each other independently demand the exact same geometry. There is no hidden freedom.

Falsifiable Predictions & Future Tests

1. Strict Tracking with r_p

The derived value of α depends directly on the proton charge radius ($r_q \propto r_p$). As empirical measurements of the proton charge radius are refined, the geometric prediction of α must remain consistent within the combined precision bounds.

2. The Divergence Test

Any confirmed, statistically significant divergence between future refined measurements of α and the $(\omega_c^2 r_q^2)/c^2$ geometric derivation will strictly falsify this specific physical relation.

The fine-structure constant is no longer a primitive input to be measured; it is a geometric consequence to be tested.