A Geometric Origin of the Higgs Mass and Electroweak Mixing Angle from Substrate Condensation Topology

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The Epistemological Gap in the Electroweak Sector

The Standard Model Mechanism (Success)

Spontaneous Symmetry Breaking

The Higgs mechanism provides a self-consistent, experimentally validated account of $U(1) \times SU(2)$ symmetry breaking and mass generation for the W W and Z bosons.

The Standard Model Inputs (The Gap)

Unexplained Empirical Constants

The specific numerical values required to make the mechanism function are inserted as independent empirical measurements, not derived from first principles.

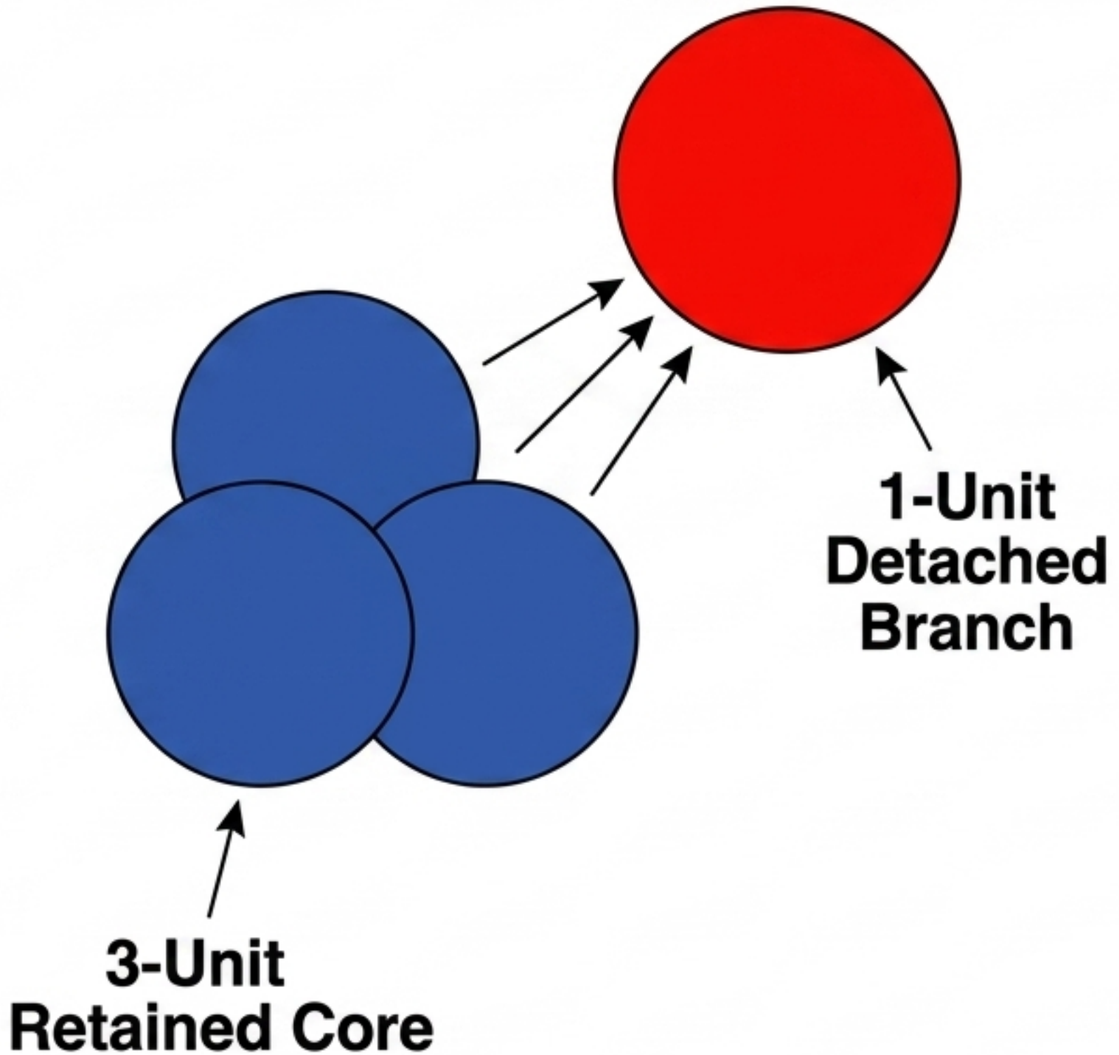
The Four Unexplained Quantities:

$m_W = 80.4$ GeV $\quad$ $m_Z = 91.19$ GeV $\quad$ $\sin^2\theta_W = 0.2312$ $\quad$ $m_H = 125.25$ GeV

The Topological Postulate: The 3+1 Partition

The electroweak sector is proposed to organize around a specific geometric partition of a four-unit condensation structure within the Spaticle substrate substrate.

Rather than independent empirical insertions, the parameters of the electroweak sector follow directly from the energy partition of a structure separating into a three-unit retained core and a one-unit detached branch.



Deriving the Electroweak Mixing Angle ($\sin^2\theta_W$)

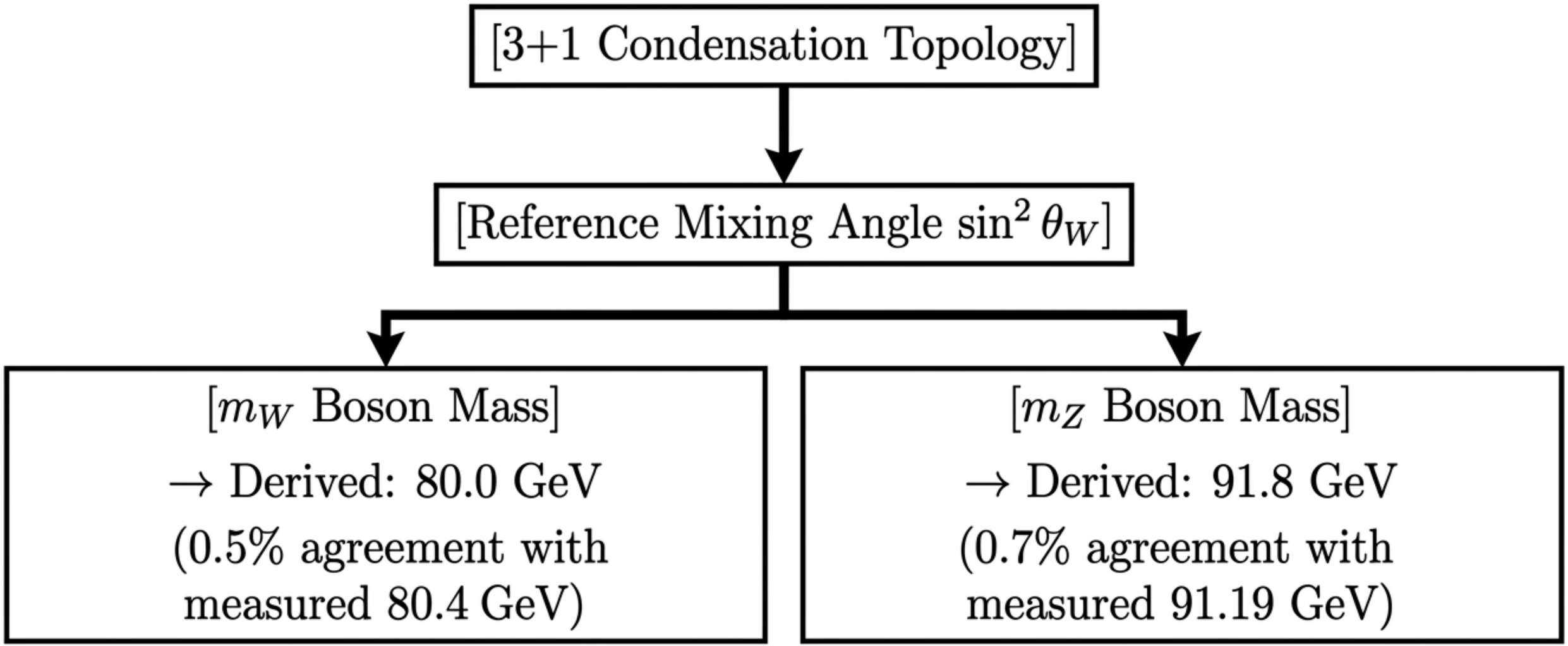
The energy cost of reconfiguring the 3+1 geometric partition fixes the relationship between the neutral and charged electroweak channels.

$$\text{Derived: } \sin^2\theta_W \approx 0.232$$

$$\text{Measured: } \sin^2\theta_W = 0.2312$$

The topological partition dictates the reference mixing angle at the symmetry-breaking scale, resulting in a mathematical agreement of $\approx 0.01\%$ with the Particle Data Group (PDG) measured value.

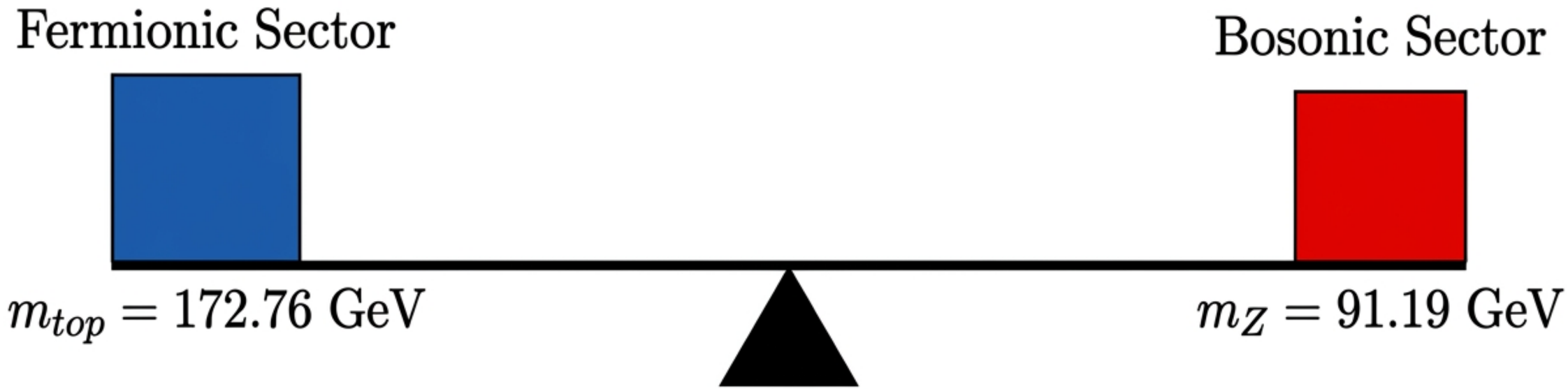
Sequential Derivation of the W and Z Boson Masses



The W and Z masses follow from the same partition mapped to physical units through the independently measured proton charge radius and substrate density (ρ_s), requiring zero additional free parameters.

The Empirical Higgs Mass Relation

Precision electroweak fits note a striking empirical relation previously lacking theoretical explanation: the Higgs mass rests precisely at the geometric mean of the top quark mass and the Z boson mass.



$$m_H = \sqrt{m_{top} \cdot m_Z} = 125.51 \text{ GeV}$$

Structural Origin of the Higgs Resonance

> Fermionic Anchor: The top quark represents the deepest substrate deformation, coupling to the Spaticle field with maximum strength ($y_t \approx 1$).

> Bosonic Anchor: The Z boson defines the neutral symmetry-breaking scale derived from the three-unit reconfiguration energy.

> *The Synthesis: The geometric mean provides the symmetric balancing mass scale for a substrate excitation connecting the fermionic and bosonic sectors.*

Conclusion: The 125 GeV resonance is not an arbitrary scalar vacuum expectation value. It is the natural geometric bridge between two sectors of the same condensation family.

Empirical Validation Matrix

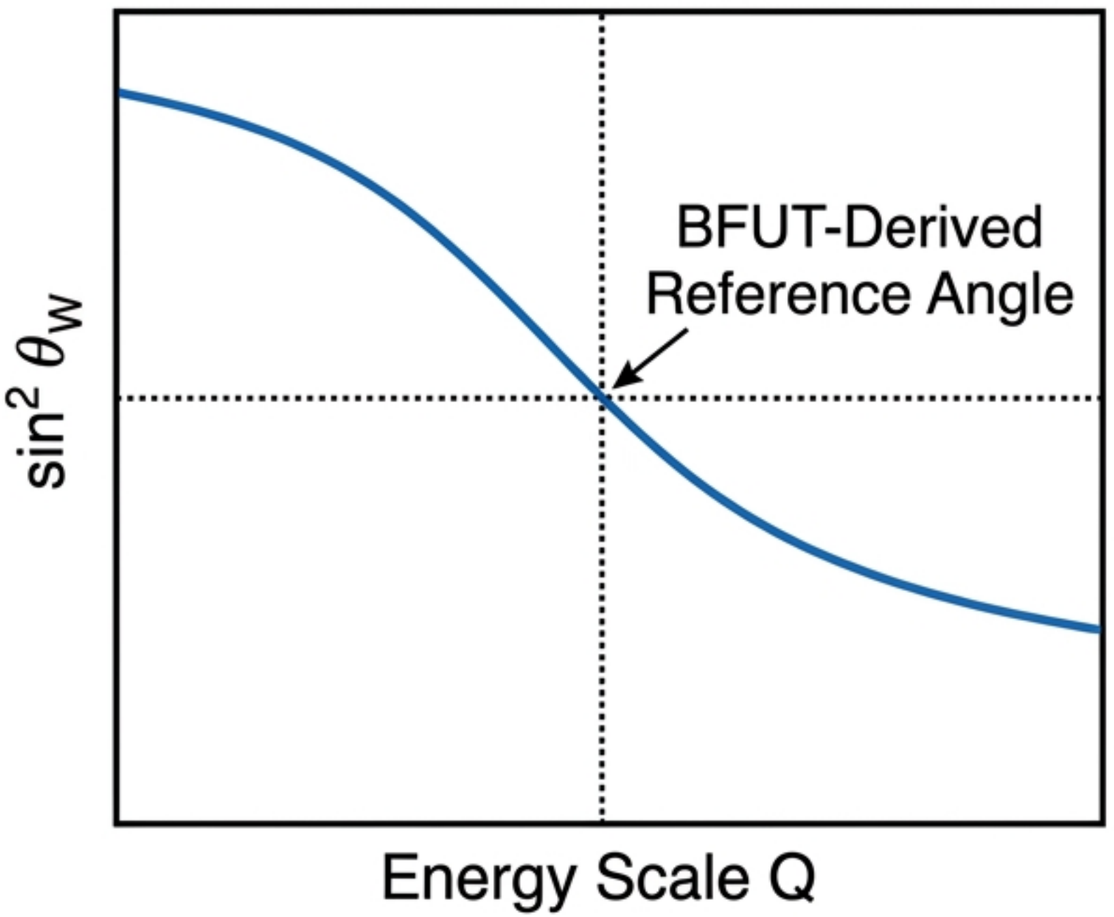
Parameter	Standard Model Status	PDG Measured Value	BFUT Geometric Derivation	% Deviation
$\sin^2 \theta_W$	Empirical Input	0.2312	0.232	0.01%
m_W	Empirical Input	80.4 GeV	80.0 GeV	0.5%
m_Z	Empirical Input	91.19 GeV	91.8 GeV	0.7%
m_H	Empirical Input	125.25 GeV	125.51 GeV	0.21%

All geometric derivations are achieved without violating the established Higgs symmetry-breaking mechanism.

Falsifiable Predictions

Prediction 3: No additional independent scalar field is required for electroweak symmetry breaking. The discovery of a second, independent Higgs-like scalar field not expressible in substrate parameters would falsify this account.

Prediction 4: The geometric partition determines the reference mixing angle; experimental running must remain consistent with Standard Model renormalization-group evolution.



Conclusion: Outputs, Not Inputs

The numerical values of the electroweak sector—the W and Z masses, the mixing angle, and the Higgs resonance—are outputs of a deeper geometric condensation topology. By treating these values as geometric consequences rather than arbitrary empirical insertions, the Big Flare-Up Theory (BFUT) preserves the successful mathematical architecture of the Higgs mechanism while finally providing its missing theoretical foundation.

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