

Resolving the Cosmological Constant Problem

A Single-Substrate Interpretation of Quantum Field Theory

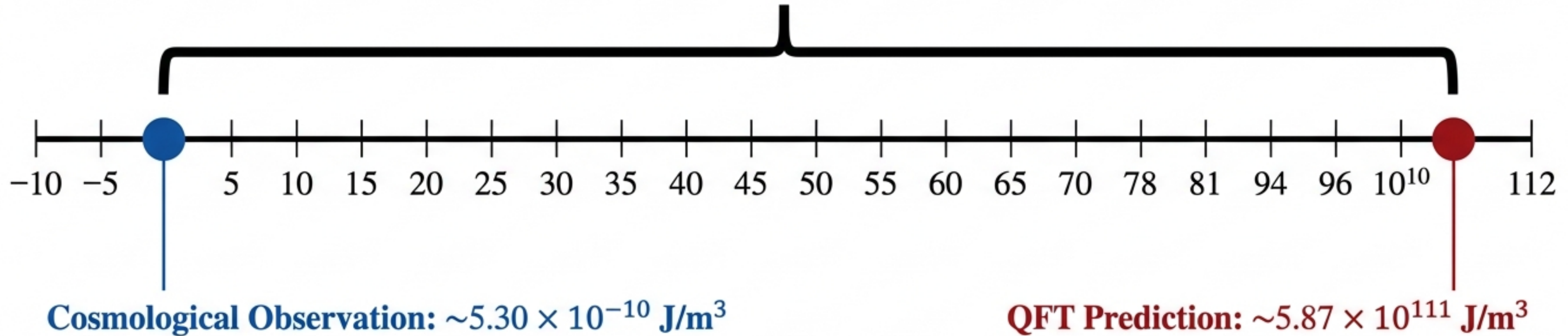
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The 120-order-of-magnitude discrepancy is not a mathematical failure requiring fine-tuning, but an ontological category error in standard Quantum Field Theory (QFT) that can be resolved through two specific corrections.

The Largest Numerical Disagreement in the History of Physics

120 to 122 Orders of Magnitude



The Cosmological Constant Problem has historically been classified as a severe fine-tuning crisis. Most theoretical attempts at resolution assume the QFT mode-sum mathematics are ontologically correct but numerically unbalanced.

Paper P51 demonstrates that the math of QFT is sound, but its underlying physical assumptions are not.

General Relativity and the Effective Vacuum Fluid

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \left(\frac{8\pi G}{c^4} \right) T_{\mu\nu}$$

The Einstein field equations in the presence of a cosmological constant Λ .

$$\rho_\Lambda = \frac{\Lambda c^2}{8\pi G}, \quad p_\Lambda = -\rho_\Lambda$$

Λ contributes an effective fluid with equation of state $w = -1$.

Cosmological observations (Type Ia supernovae, CMB angular power spectrum, and baryon acoustic oscillations) firmly constrain this effective vacuum energy density to the 10^{-10} J/m^3 scale

Isolating the Pathology in the QFT Mode-Sum

Pathology 1: Ontological Multiplicity.

QFT assumes ~17 independent quantum fields each independently contribute zero-point energies to the vacuum.

$$\rho_{\text{vac}}(\text{QFT}) = \sum_{\text{fields}} \int_0^{\omega_P} \frac{1}{2} \hbar \omega \frac{d^3 \mathbf{k}}{(2\pi)^3}$$

Pathology 2: Unoccupied Ground-State Energy.

QFT assumes $\frac{1}{2}\hbar\omega$ is an intrinsic property of every vacuum mode, regardless of whether a physical excitation (matter) is present.

Summing these assumptions to the Planck cutoff (ω_P) generates the runaway 10^{111} J/m^3 prediction.

Correction I: The Single Substrate Interpretation

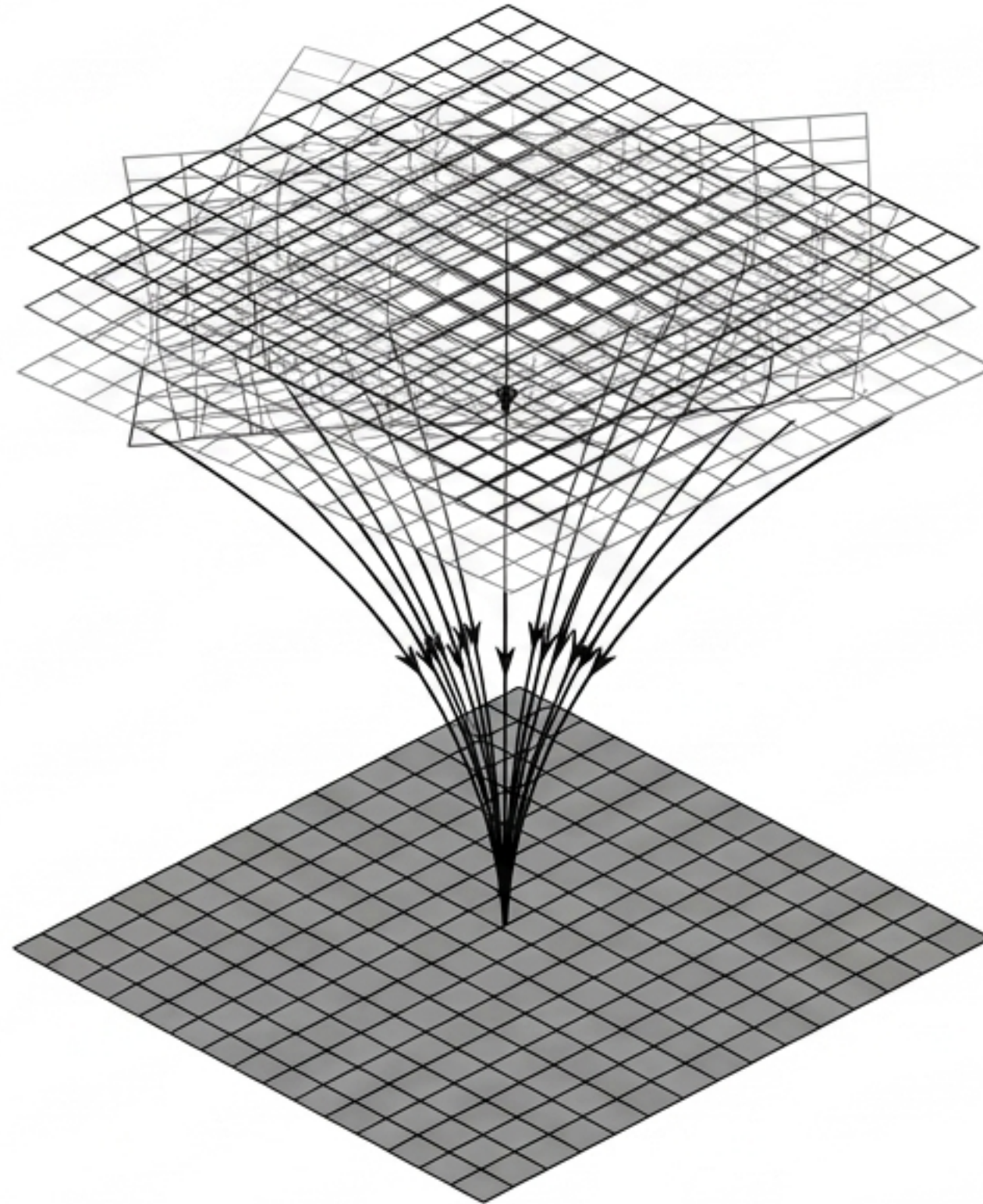
The assumption of multiple independent fields is an interpretive error. There is physically only only one medium.

The Sparticle field fills all of space at a fixed, intrinsic equilibrium density:

$$\rho_s = 5.9 \times 10^{-27} \text{ kg/m}^3.$$

The correct vacuum mode-sum must be performed over a single continuous medium, terminating the multiplicative divergence of standard QFT.

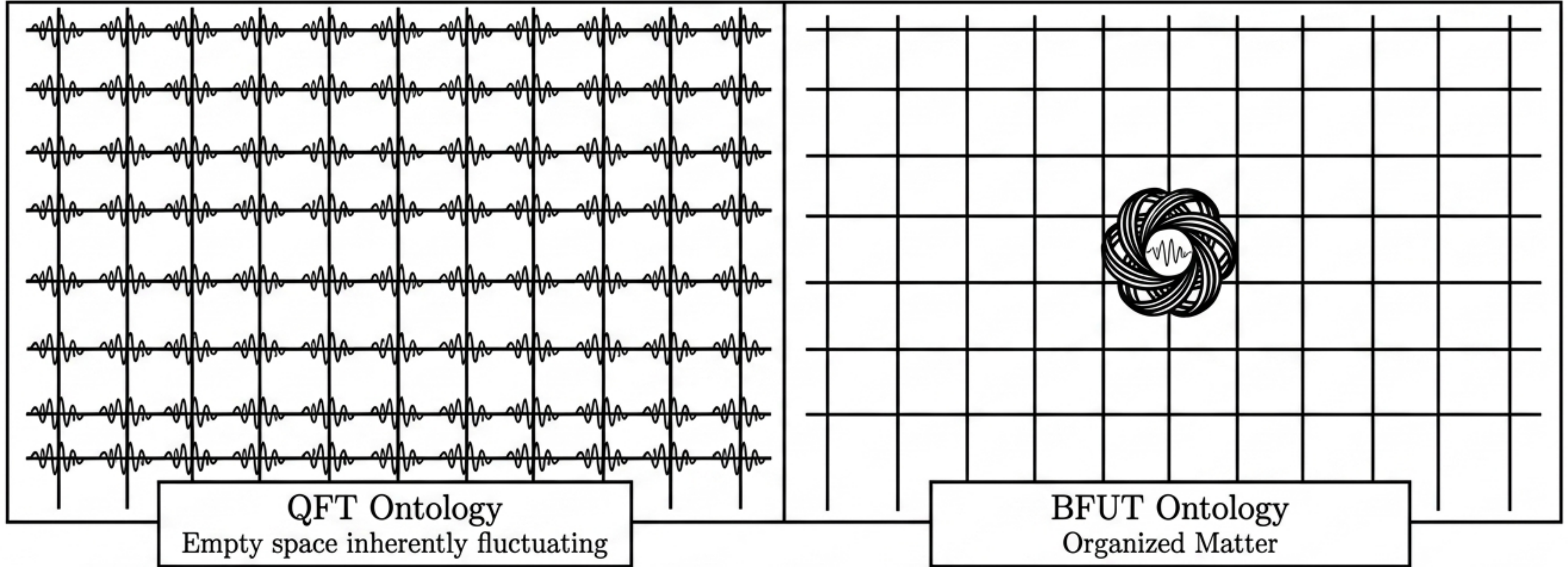
The 17-to-1 Substrate Funnel



Standard
Model Fields

**The Sparticle
Substrate, Ψ**

Correction II: Relocating Zero-Point Energy



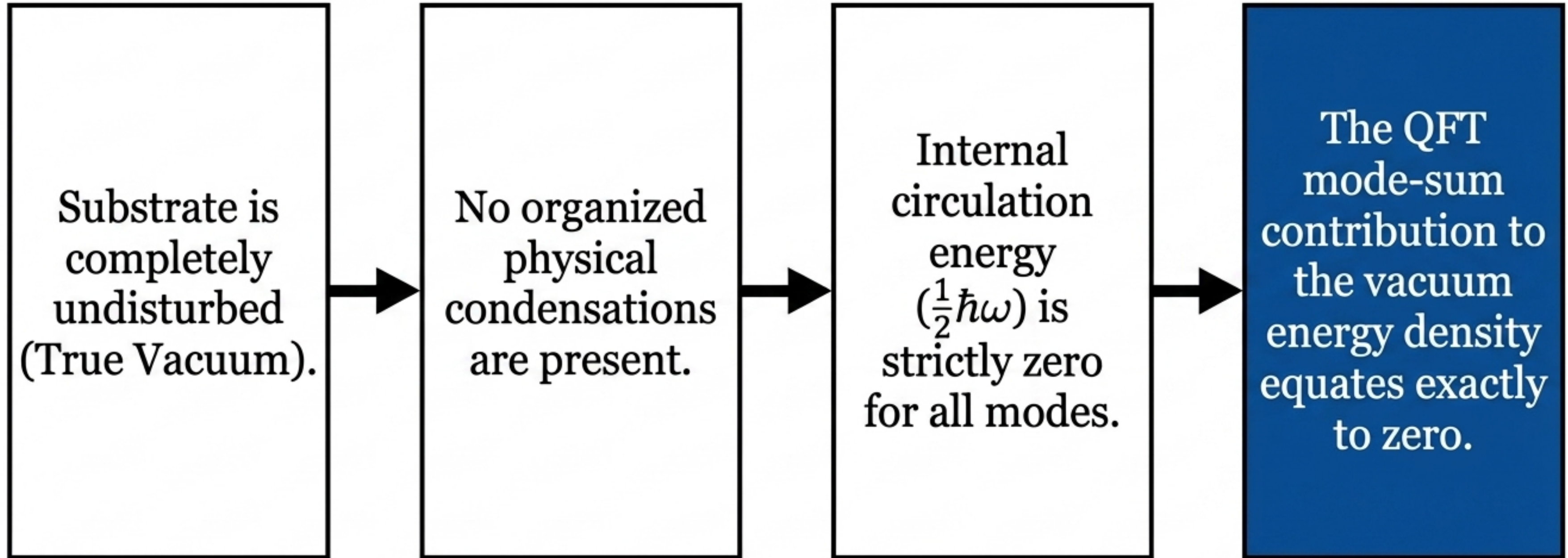
Core Axiom

$\frac{1}{2}\hbar\omega$ is not a property of empty vacuum modes. It is the minimum internal circulation energy of an organized physical condensation.

The Rule

Empty vacuum modes contain no organized condensation and therefore possess no intrinsic zero-point energy floor.

The Mode-Sum Contribution Vanishes



*By removing the category errors, the mathematically divergent QFT vacuum prediction collapses.
But space is not empty—what, then, is the physical vacuum energy?*

The Exact Collapse to Observation

The Derivation Proof Box

$$\rho_{\text{vac}} = \rho_s c^2$$

$$\rho_{\text{vac}} = (5.9 \times 10^{-27} \text{ kg/m}^3) \times (2.9979 \times 10^8 \text{ m/s})^2$$

$$\rho_{\text{vac}} = 5.30 \times 10^{-10} \text{ J/m}^3$$

Context

The physical vacuum energy density is simply the mass-energy equivalence ($E=mc^2$) applied directly to the background equilibrium density of the universal substrate (ρ_s).

Verification

The value ρ_s is not a fitted parameter. It is independently constrained by the W and Z boson masses, 175 galaxy rotation curves, and gravitational wave carrier relaxation timescales.

Vacuum Ontology Comparison Matrix

Dimension	Standard QFT	BFUT Framework
Number of Substrates	~ 17 Independent Fields	1 Universal Spaticle Substrate
Origin of $\frac{1}{2}\hbar\omega$	Intrinsic to Empty Space	Internal Circulation of Matter
Mode Sum Result	Diverges to $\sim 10^{111} \text{ J/m}^3$	Vanishes to Zero for True Vacuum
Physical Vacuum Energy	Assumed Planck Cutoff Artifact	$\rho_s c^2$ (Substrate Equilibrium)

Takeaway: The framework replaces overlapping mathematical abstractions with a single, mechanically precise physical ontology.

Resolution Achieved with **Zero Free Parameters**

- | | |
|---|---|
|  | No Fine-Tuning: The 120-order magnitude gap disappears without arbitrary numerical cancellations. |
|  | No Supersymmetry: Does not require unobserved supersymmetric partners to cancel zero-point energies. |
|  | No Anthropic Arguments: Rejects the premise that the vacuum energy is an environmental accident selected by our existence. |
|  | No New Symmetry Principles: Derives strictly from existing substrate mechanics and mass-energy equivalence. |

The largest numerical discrepancy in physics disappears entirely without a single fitted parameter

Conclusion

“The 120-to-122 order-of-magnitude discrepancy is not a property of nature. It is a category error in how standard physics interprets empty space.”

1. Correcting the multiplicity of fields to a single substrate (Ψ).
2. Restricting zero-point energy ($\frac{1}{2}\hbar\omega$) exclusively to organized matter.
3. Identifying the vacuum physically as $\rho_s c^2$.

The cosmological constant problem is dissolved, yielding a perfect match to the observed $5.30 \times 10^{-10} \text{ J/m}^3$ purely from first principles.