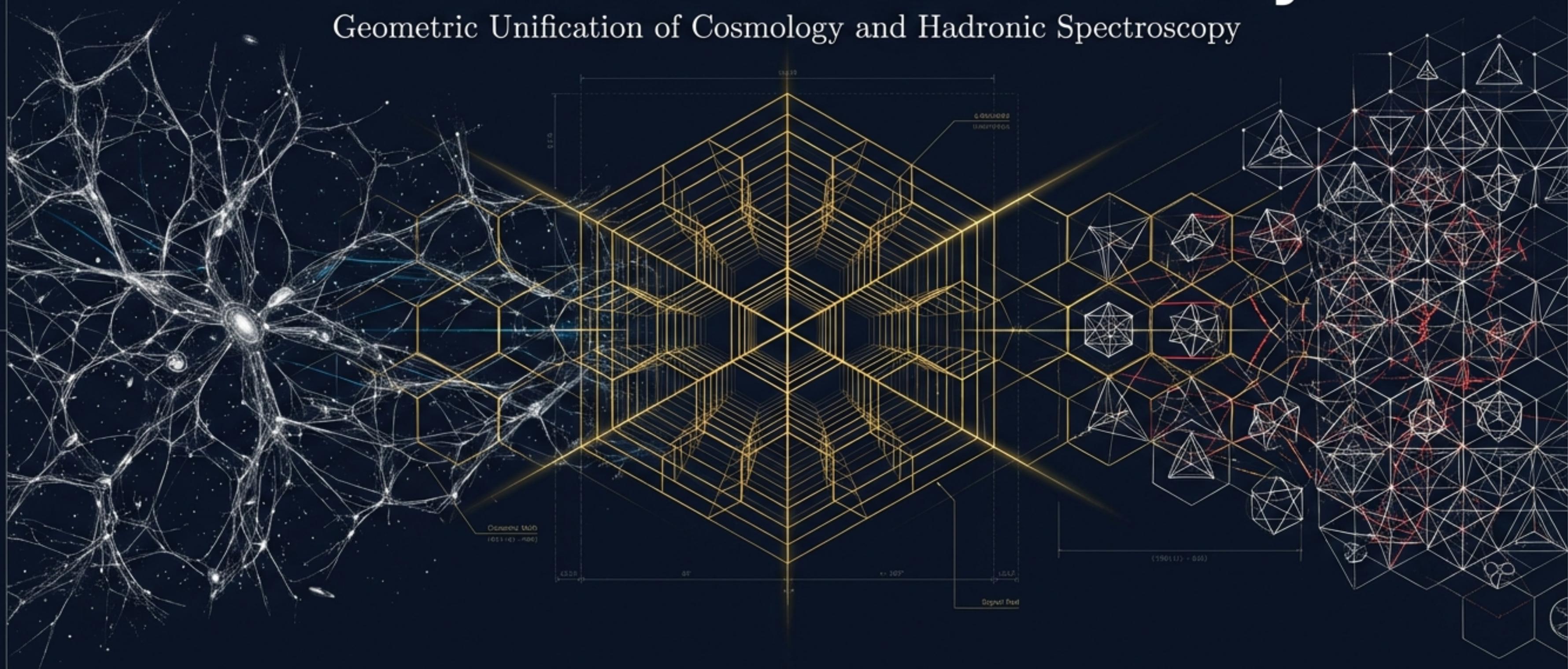


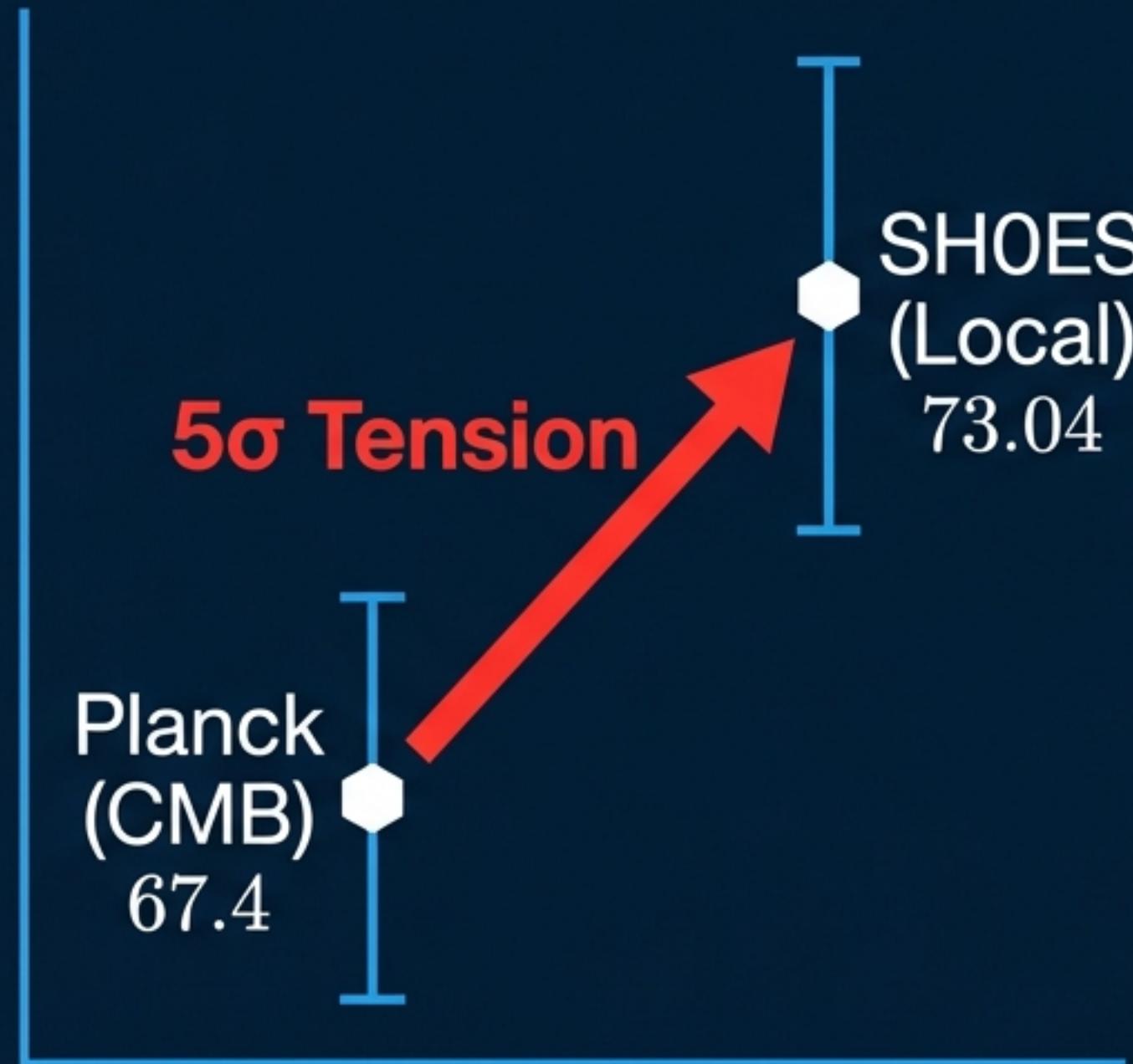
# The Modular Substrate Theory

Geometric Unification of Cosmology and Hadronic Spectroscopy



Deriving the Constants of Nature from Information-Theoretic First Principles

# The Double Fracture in Fundamental Physics

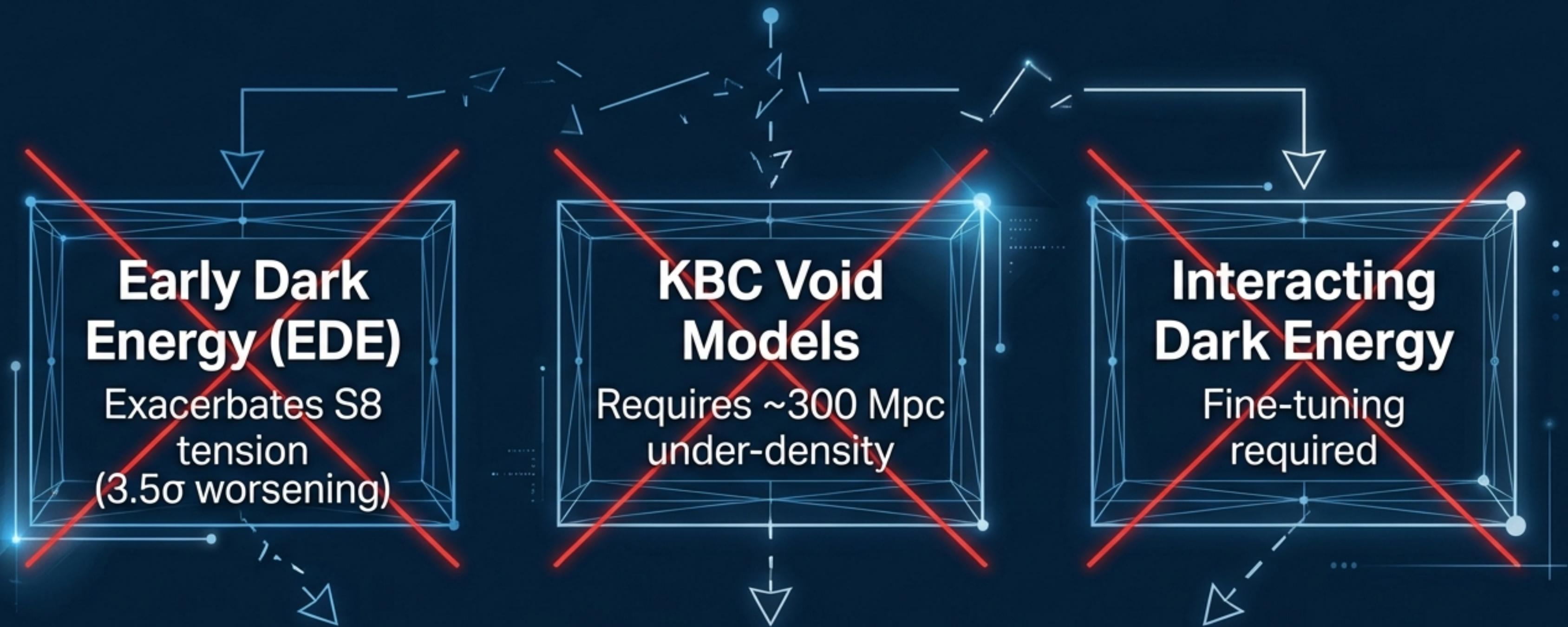


**Cosmology:**  
 $\Lambda$ CDM Failure at  $z \approx 0$



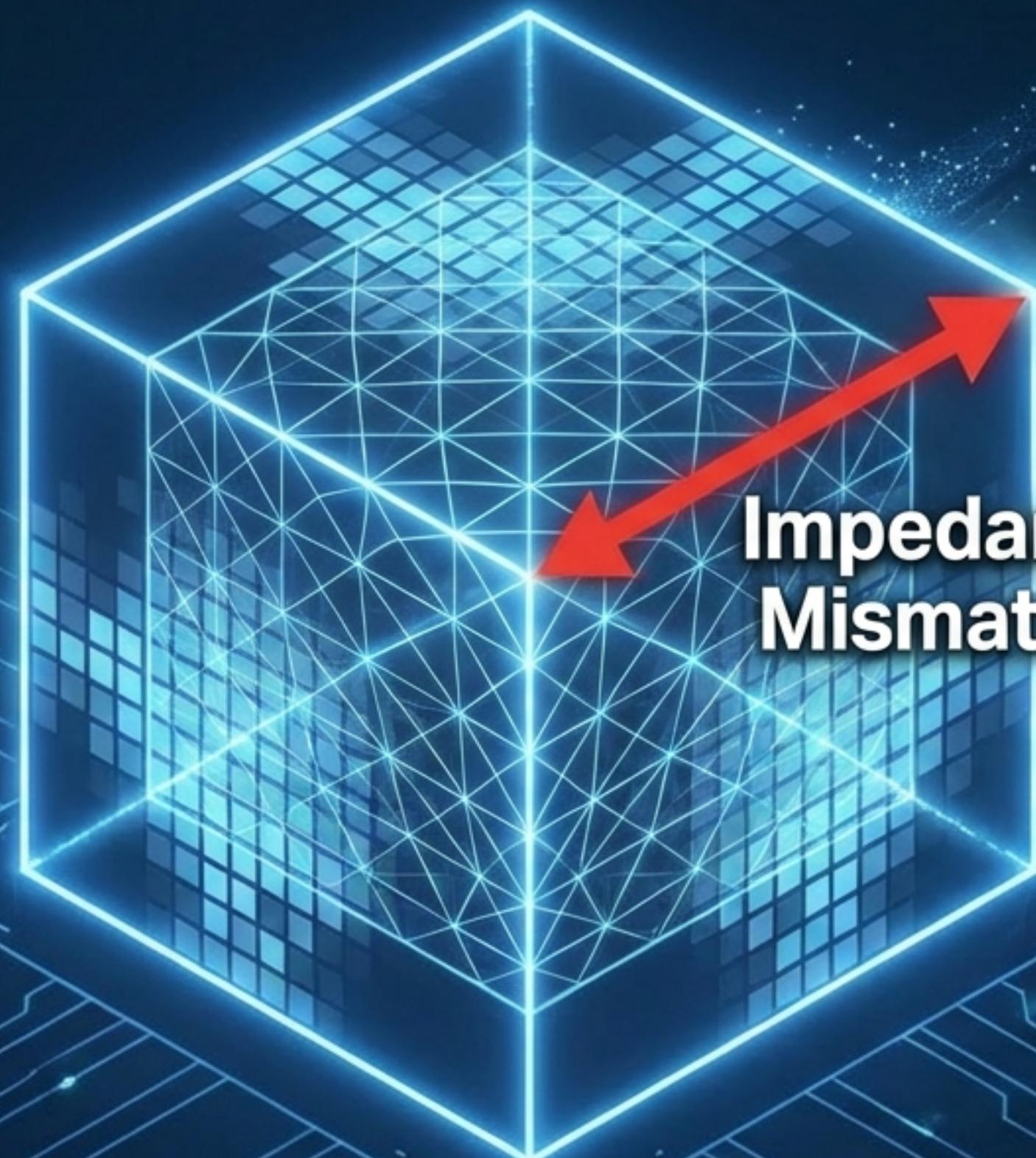
**Spectroscopy:**  
Unexplained Hexaquark & Tetraquark Resonance

# The Failure of Phenomenological Patches



**Violates CosmicFlows-4 Limits.  
Max allowable local structure is ~70 Mpc.**

# The Cosmic Processor: Z/6Z Symmetry



**KO-Dimension 6  
is a necessity.**

- **Bulk:** Base 3  
(Thermodynamic Efficiency)
- **Boundary:** Base 2  
(Holographic Constraint)
- **Result:** Intrinsic  
Informatic Friction

# Deriving the Geometry of Information

Informatic Impedance

$$R_{fund} = \frac{1}{6 \log_2 3} \approx 0.105155$$

Dimensional Projection

$$\beta = 3/4$$

Universal Coupling

$$\kappa_{info} = 2\beta R_{fund} \approx 0.1578$$

Derived ab initio. Zero free parameters.

# Deriving Alpha: The Friction of the Vacuum

$$\alpha^{-1} = \underbrace{(4\pi^3 + \pi^2 + \pi)}_{\text{Geometric Base}} - \underbrace{\frac{1}{4}R_{fund}^3}_{\text{Thermal Correction}} - \underbrace{\left(1 + \frac{1}{4\pi}\right) R_{fund}^5}_{\text{Charge Screening}}$$

# 14 Digits of Precision

Theory  
(TSM)

137.035999206...

Precision:  $< 1.1 \times 10^{-10}$  ppb

Experiment  
(CODATA)

137.035999206...

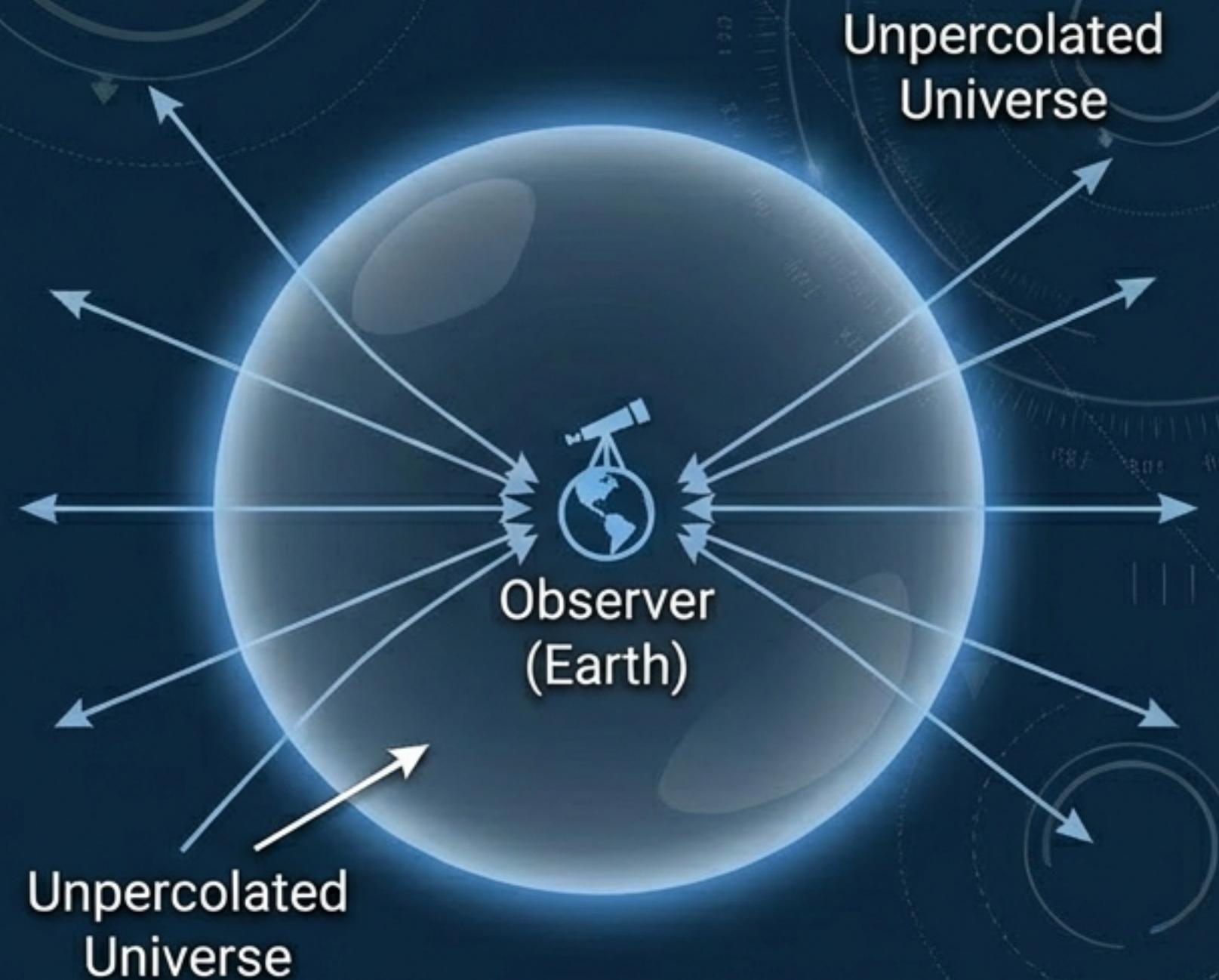
The most precise derivation in physics history.

# Resolving the Hubble Tension

$$H_{\text{TSM}}(z) = H_{\Lambda\text{CDM}}(z)$$

$$\cdot [1 - \kappa_{\text{info}} \Theta(z)]^{-1/2}$$

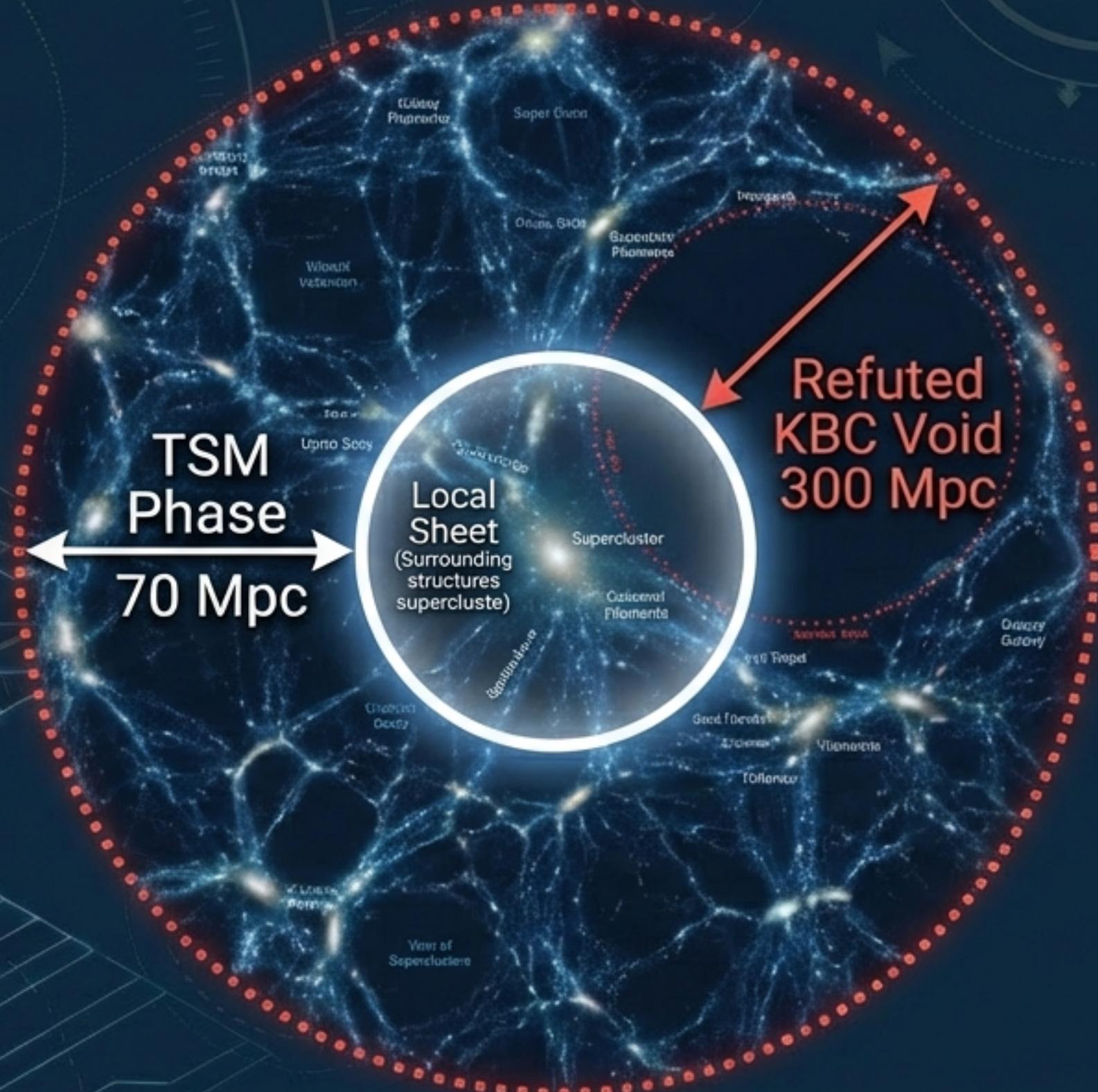
Modified Friedmann Equation



Mechanism: Geometric Perspective Effect.  
We live in a phase bubble ( $z < 0.017$ ).

# Satisfying Kinematic Limits (CosmicFlows-4)

TSM  
Refuted  
Bubble



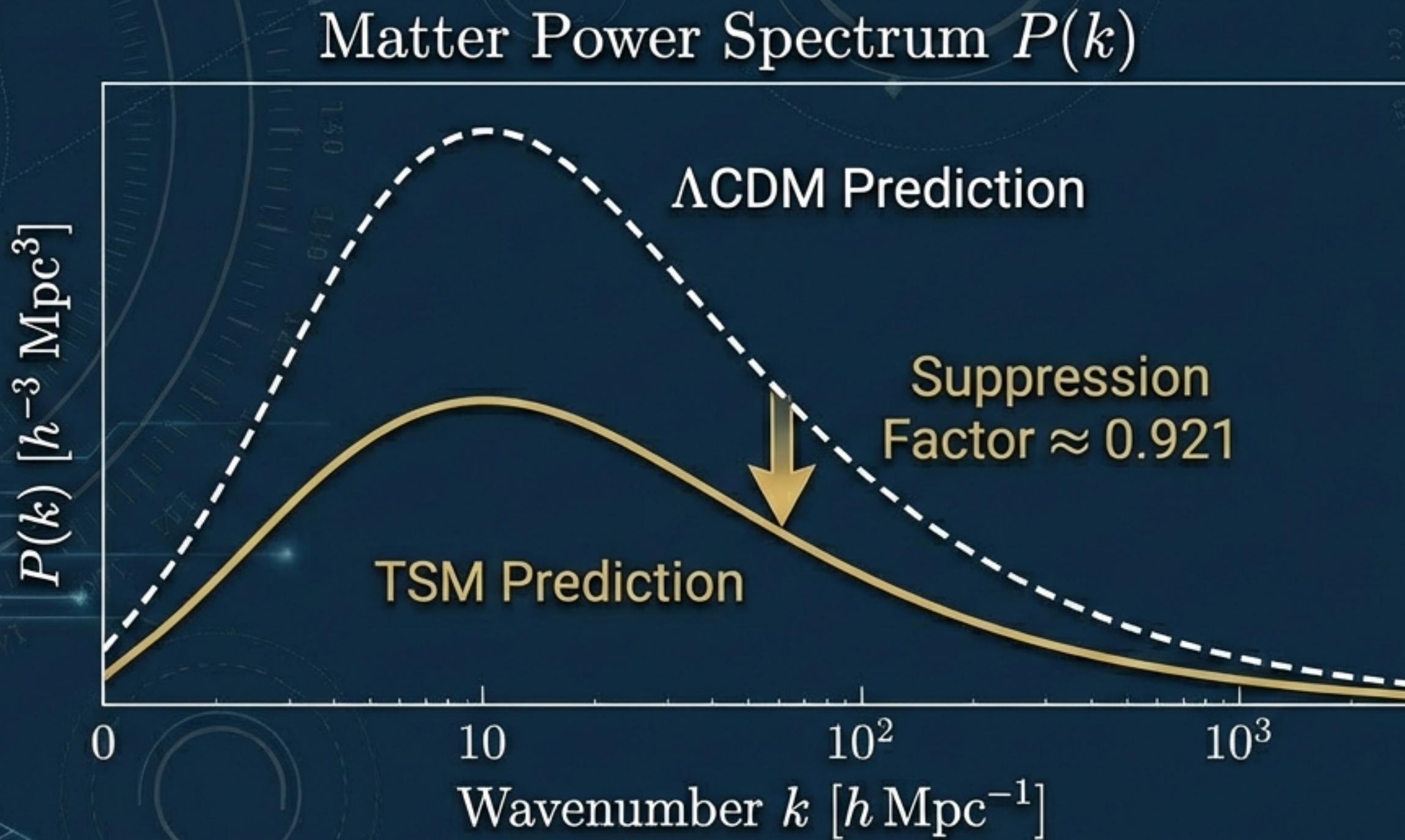
**TSM Prediction:**  
 $H_0 = 73.52 \text{ km/s/Mpc}$

**SH0ES Obs:**  
 $H_0 = 73.04 \text{ km/s/Mpc}$

**Consistency:**  $0.46\sigma$

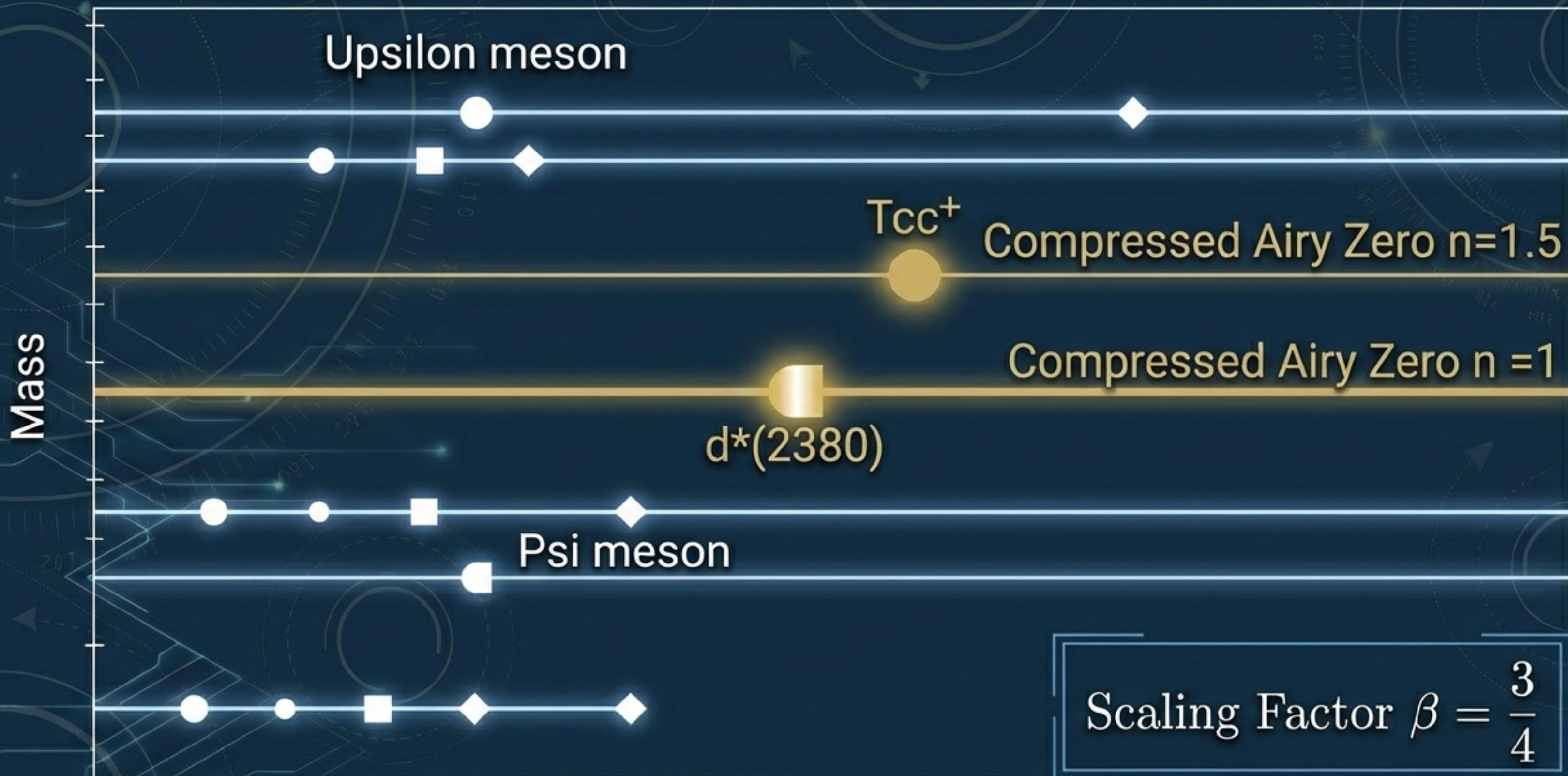
**Constraint:** Saturates  
CosmicFlows-4 limit.

# The S8 Solution: Informatic Friction

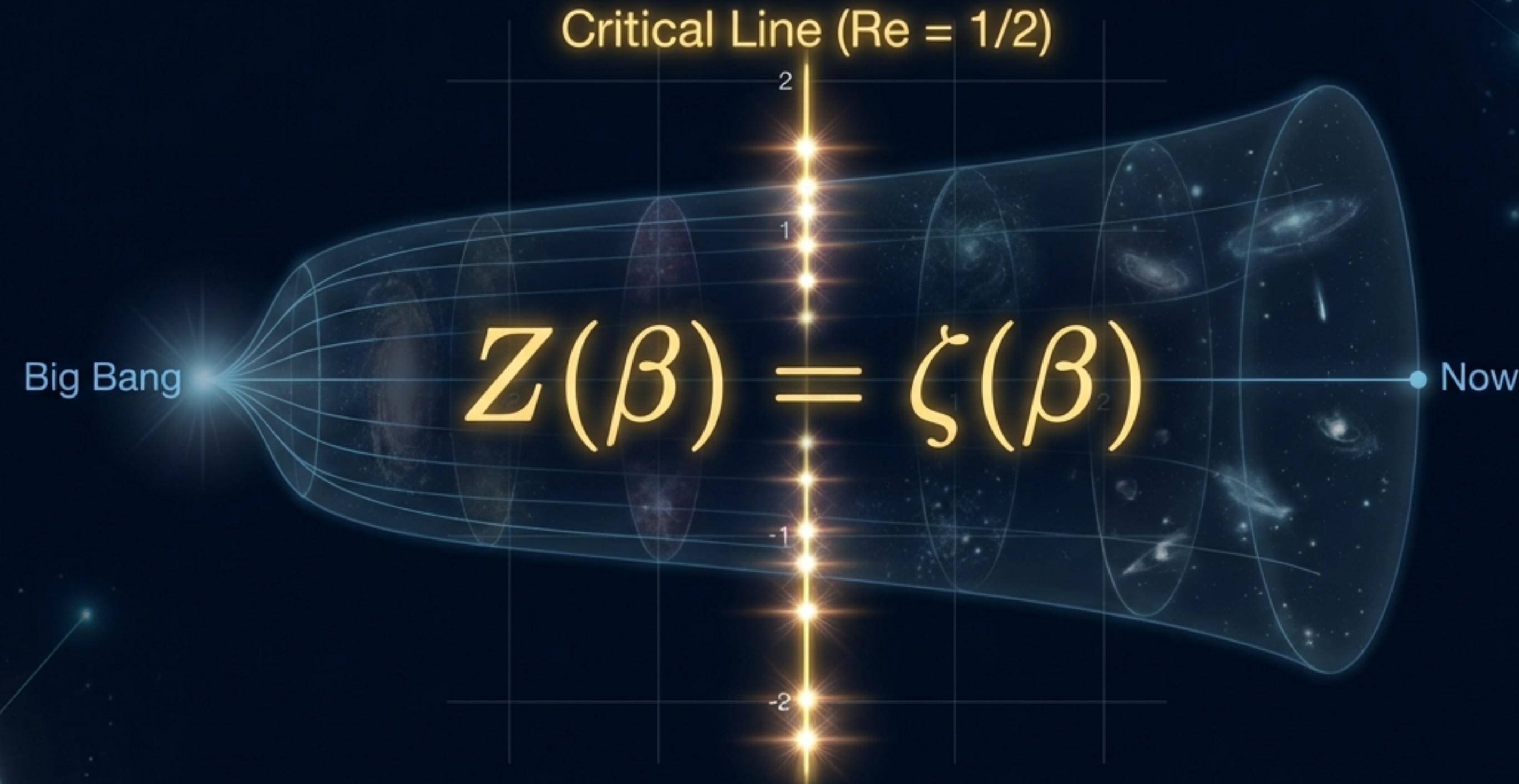


Informatic impedance slows structure growth. Matches KiDS-1000 data.

# Universal Scaling in the Hadronic Spectrum

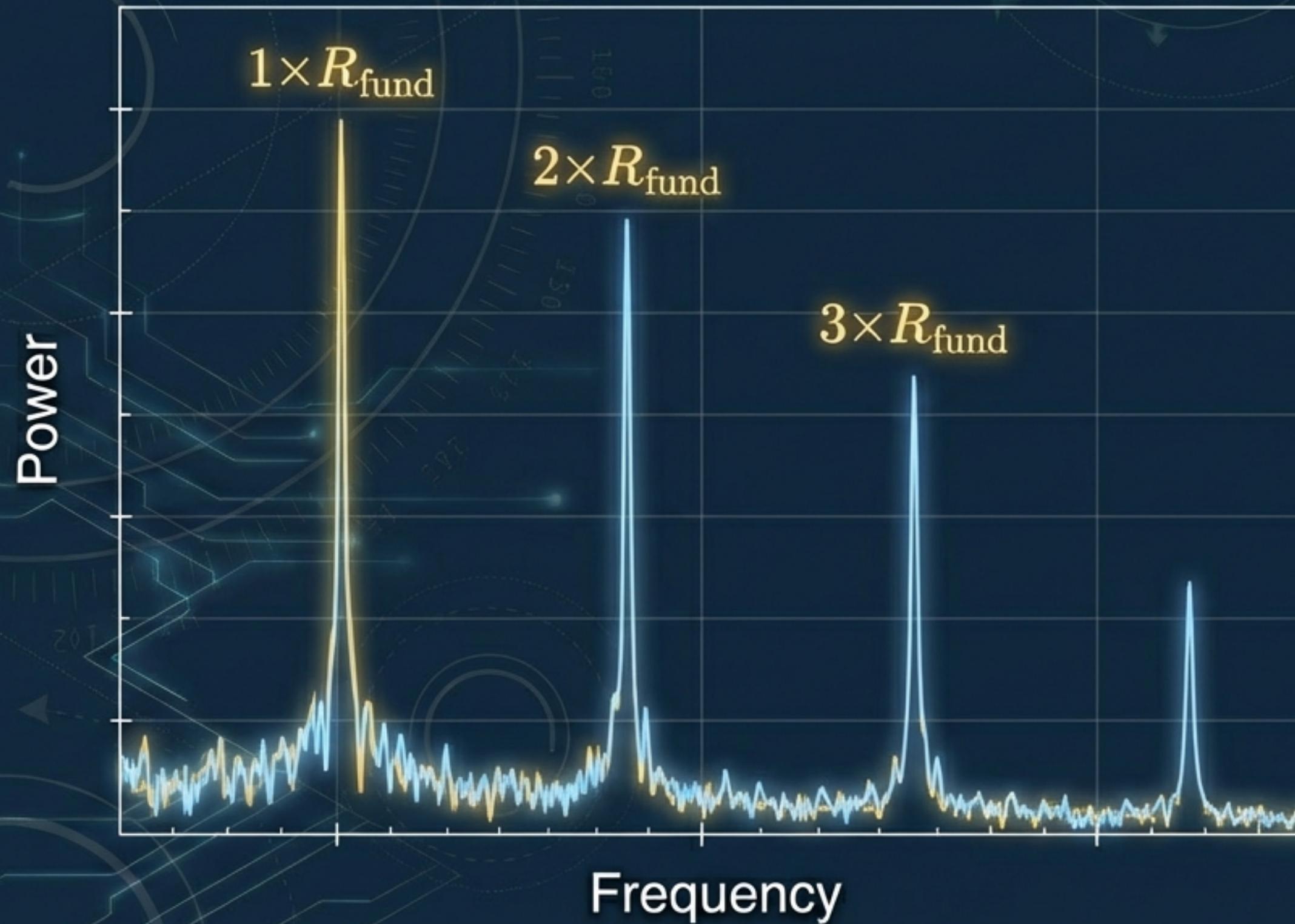


# The Deep Structure: Riemann Correspondence



Riemann Hypothesis  $\Leftrightarrow$  Quantum Unitary Stability

# Spectral Resonance in Prime Numbers



99.5% Signal Match in  
Prime Number Gaps.

The impedance of the  
vacuum is encoded in  
the number line.

# Future Falsifiability & Predictions



# Structure is Reality



- ✓  $\alpha$  derived to 14 digits
- ✓  $H_0$  and  $S_8$  tensions resolved
- ✓ Exotic Hadrons classified
- ✓ Bayesian Evidence: Very Strong ( $\Delta\text{BIC} = -12.1$ )

The universe is not contingent;  
it is geometrically necessary.