Emergent Necessity Theory: Core Development Plan

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June 2025

Philosophical Anchors

- **Structurism**: Reality propagates via structural necessity ($S_1 \to S_2$)
- **Primordial Structure**: Acausal origin point (mathematical necessity)
- **Emergence**: $\tau \geq \tau_c$ triggers phase transitions

1 Formalized Dynamics

1.1 Fokker-Planck Equation (Jarzynski-Anchored)

$$\frac{\partial P(\tau,t)}{\partial t} = -\underbrace{\frac{\partial}{\partial \tau}\left[\alpha \frac{\partial \mathcal{F}_{\text{info}}}{\partial \tau} P\right]}_{\text{Drift}} + \underbrace{\frac{\partial^2}{\partial \tau^2}\left[\beta \tau (1-\tau/\tau_{\max}) P\right]}_{\text{Diffusion}} \tag{1}$$

where:

$$\mathcal{F}_{\text{info}} = \mathcal{E}(X) - T\sum_{i,j} I(x_i; x_j) \quad \text{(Informational free energy)}$$

$$\alpha = \text{Drift strength}, \quad \beta = \text{Stochasticity scale}$$

First-Principles Derivation:

1. Start from Jarzynski equality: $\langle e^{-\beta W} \rangle = e^{-\beta \Delta F}$
2. Map $W \to$ coherence work, $\Delta F \to \Delta \mathcal{F}_{\text{info}}$
3. Derive drift via entropy gradient flow: $A(\tau) = -\alpha \nabla_\tau \mathcal{F}_{\text{info}}$

2 Primordial Structure Grounding

2.1 AdS/CFT Boundary Identification

$$\Psi_{\text{primordial}} = \lim_{\Lambda \to \infty} \text{CFT}_{\text{boundary}} \quad \text{(UV-complete state)} \tag{2}$$

with τ as boundary functional:

$$\tau = -\log |Z_{\text{CFT}}[\phi_0]|^2 \tag{3}$$

2.2 String Vacuum Selection Criterion

Vacuum stability requires:

$$\tau_{\text{vac}} \geq \tau_c \quad \text{where} \quad \tau_{\text{vac}} = \int_{\mathcal{M}} G_{ij} dz^i \wedge d\bar{z}^j \tag{4}$$

G_{ij} = Khler metric on Calabi-Yau $\mathcal{M}$. Predicts SUSY breaking at:

$$\tau < \tau_c \implies m_{3/2} \sim \Lambda e^{-\kappa(\tau_c - \tau)} \tag{5}$$

3 Make-Break Prediction: Gravitational Signature

$$\Delta G_{\mu\nu} = -\chi \nabla_\mu \nabla_\nu \tau \quad \text{(ENT-modified Einstein eqn.)} \tag{6}$$

Optomechanics Test:

- **Setup**: Squeezed light states in LIGO-type interferometer
- **Prediction**:
$$\Delta L / L_0 \propto \chi |\nabla \tau|^2 \tag{7}$$
- **Falsification Threshold**: $\chi < 10^{-19}\,\mathrm{m}^2$ (ruled out by LIGO O4 data)

Roadmap Timeline

Task	**Deadline**	**Metrics**
Simulate τ-flow in SYK model	Sep 2025	τ_c^{SYK} vs analytic
Compute τ for 10^5 KKLT vacua	Dec 2025	Vacuum stability curve
LIGO data collaboration	Mar 2026	χ bound established
IBM Quantum τ_c measurement	Jun 2026	QAOA on 100-qubit device