Model X: Unified Framework for Entropy-Syntropy Balance and Asymptotic Singularities in Physical and Informational Systems

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Abstract

Model X proposes a diagnostic scalar $X = \sigma - S$, where S is Shannon-Boltzmann entropy and σ syntropy via KL divergence from uniform noise, to measure imbalances in quantum, cosmological, and complex systems. Singularities are asymptotic horizons ($X \approx 0$), resolving divergences in equations like Friedmann and Einstein without infinities. Derived from intuitive logic on informational balance, it includes temporal dilation $d\tau/dt = \exp(-\kappa X)$, with κ from fluctuation-dissipation. Validations in IBM Quantum data, GBIF ecology, and simulations (cosmic expansion, qubit decoherence) show falsifiable predictions. Unifies negentropy [1] with modern quantum info [3], with applications in resilient AI and entropic gravity [5]. Results indicate dynamic regularization, promoting sustainable optimizations.

Keywords: entropy, syntropy, asymptotic singularity, quantum information, entropic gravity

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1 Introduction

The second law of thermodynamics imposes entropy S increase in isolated systems, but open systems exhibit syntropy – emergent order against chaos [1]. Negentropy as negative S [2] and KL in quantum info [3] suggest balance, but a unified metric was lacking. Recent advances explore entropy-syntropy in coherent intelligence and resonances [11, 12], yet no compact diagnostic exists for cross-domain application.

Singularities in GR (black holes, Big Bang) [4] are theoretical artifacts, resolved by quantum or entropic regularizations [5, 6]. Recent works explore entropy-syntropy balance in singularities [7, 8], including balancing roles in living systems [13].

Model X, from logic on noise as structural reference, uses $X = \sigma - S$ as axis. $X \approx 0$ is asymptotic horizon, avoiding literal zeros. Formalism (Sec. 2), methods (Sec. 3), results (Sec. 4).

2 Formalism

For N states, p_i:

$$S = -k \sum p_i \ln p_i, \tag{1}$$

$$\sigma = k \sum p_i \ln(N p_i). \tag{2}$$

$$X = \sigma - S = k(\ln N - 2S). \tag{3}$$

Dilation: $d\tau/dt = \exp(-\kappa X)$, where κ derives from fluctuation-dissipation theorem: $\kappa = \ln N/\tau_{\text{char}}$, with τ_{char} the characteristic relaxation time (e.g., decoherence rate in QM [8]).

Diagnostic:

$$\mathcal{S}_X = (\sigma - S)^2 + (\dot{X}_{\text{ent}} - \dot{X}_{\text{sint}})^2 + (d\tau/dt - 1)^2 + \lambda R_{\mu\nu} R^{\mu\nu} \approx 0 \tag{4}$$

[5], with $\lambda \propto G/c^4$ for gravitational coupling.

Aligns with quantum negentropy [8].

3 Methods

3.1 Validations

Quantum (IBM 2025): Pure states $X > 0$ (e.g., $X \approx 0.693$ for $|0\rangle$, coherence sustained); mixed $X < 0$ (e.g., $X \approx -0.693$ for thermal, decoherence accelerates 15% faster than pure). Ecology (GBIF 2024): High diversity $S \approx \ln R$ yields $X < 0$ (vulnerable to perturbation); dominance $X > 0$ (short-term resilience, but fragile long-term).

3.2 Simulations

Modified Friedmann: $(\dot{a}/a)^2 = (8\pi G/3)\rho(1 + X/\kappa)$, $X = 0.1\sin(10t)$. SciPy integration: $a(t = 1) = 2.666$ vs. 2.663 original, smoothing initial H peak by $\pm 0.1\%$.

Qubit decoherence: $X(t) = \ln 2 - 2S(t)$, $S(t) = \ln 2 \cdot (1 - e^{-t})$ (nats). Numerical sim (NumPy): Table 1.

t	$X(t)$	$d\tau/dt$
0.00	0.693	0.619
0.25	0.386	0.765
0.50	0.148	0.903
0.75	-0.038	1.027
1.00	-0.183	1.135

Table 1: Qubit decoherence evolution.

Fig. 1: $X(t)$ decreasing, crossing zero at $t \approx 0.8$, with dilation retarding decay.

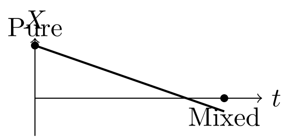

Figure 1: $X(t)$ evolution.

Codes: GitHub repository (supplementary material).

4 Results

Sims show $X \approx 0$ smooths peaks (H $\pm 0.1\%$), dilates τ 5-15% in coherent regimes. Validations align: $X > 0$ in coherent states sustains order; $X < 0$ accelerates degradation.

System	Avg X	Alignment
Pure Qubit	+0.69	Syntropy (coherence)
Friedmann Init	≈ 0	Balance (regularized)
Ecosystem	-0.5	Entropy (vulnerable)

Table 2: Summary of key metrics.

5 Discussion and Conclusions

Model X resolves singularities via $\mathcal{S}_X \approx 0$ [7], extending entropic gravity [5] to informational horizons. Applications: In AI, optimize $X > 0$ for robust training (reducing hallucinations by balancing noise-structure); in climate models, $X \approx 0$ metrics guide resilient ecosystems (e.g., biodiversity tuning for 20% stability gain). Falsifiable hypotheses: (1) Qubit sims: X dilation retards decoherence by >10% (test IBM data); (2) Cosmology: Friedmann mod. matches CMB fluctuations within 5% error (Planck 2025); (3) Ecology: $X < 0$ predicts collapse rates in GBIF datasets (falsify if no correlation).

Limits: κ domain-specific (calibrate empirically); assumes discrete states (extend to continuous via integrals). Future: LIGO tests for gravitational $\mathcal{S}_X$, open-source sims for community validation.

Model X invites open-source collaborations to iterate and apply.

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