# Saturation, Refusal, and Initial Conditions in Finite Information-Bearing Systems

*A Structural Note * Shrikant Bhosale * twistpool.com * 2026*

## Abstract

This note presents seven axioms governing the behaviour of any finite system that carries information toward its maximum realisable complexity. Three theorems are derived: (1) classical extrapolation beyond saturation is structurally forbidden; (2) the transition at saturation -- the Refusal event -- necessarily produces non-zero residual correlations; (3) this structure is scale-invariant, appearing identically at cosmological, cognitive, and social scales. No specific physical mechanism is assumed. Observational implications are stated without being used as post-hoc justification.

**Saturation, Refusal, and Initial Conditions**

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## 0. Abstract

This note presents seven axioms governing the behavior of any finite system that carries information toward its maximum realizable complexity. From these axioms we derive three theorems: that classical extrapolation beyond saturation is structurally forbidden; that the transition at saturation -- the Refusal event -- necessarily produces non-zero residual correlations; and that this structure is scale-invariant, appearing identically at the level of cosmological initial conditions, agent perception, and social systems. No specific physical mechanism is assumed. The axioms are stated as constraints on what is possible for finite information-bearing systems. Observational implications are noted without being used as justification.

## 1. Motivation

Classical physics extrapolates without bound. Given a trajectory and a law, it computes forward and backward without limit. This extrapolation succeeds across an extraordinary range of

scales and has produced the most precise predictions in the history of science.

It fails at two kinds of boundary: where quantities become formally infinite (singularities), and where the system approaches its maximum realizable complexity. These boundaries are not the same thing, but they share a common feature: classical extrapolation, applied past them, produces physically unrealizable states.

This note is concerned with the second kind of boundary. We do not assume a specific physical system. We ask: what must be true, structurally, for any finite system that carries information toward its maximum realizable complexity? What constraints does that situation impose on classical extrapolation? What replaces the extrapolation when it fails?

The answers, we will show, are not contingent on the details of any particular system. They follow from the axioms alone.

## 2. Axioms

The following axioms are stated as structural constraints. They do not assume a particular physical substrate, scale, or mechanism. They apply to any finite system that carries information.

### A1.  Finite Capacity

Every finite system S has a maximum realizable complexity $C_{max}(S) < ?$. This is the upper bound on the number of distinguishable states S can instantiate given its finite resources.

### A2.  Monotone Approach

A system evolving toward $C_{max}$ under classical dynamics approaches that bound monotonically as long as classical extrapolation remains valid. There is no mechanism within classical dynamics to prevent approach to $C_{max}$.

### A3.  Failure of Classical Extrapolation

Classical extrapolation of system dynamics becomes physically unrealizable in the neighborhood of $C_{max}$. States formally predicted by classical extrapolation past $C_{max}$ do not correspond to any realizable configuration of the system.

### A4.  The Refusal Event

At or before $C_{max}$, the system undergoes a structural transition -- the Refusal event -- in which classical extrapolation is replaced by a qualitatively different dynamical regime. The Refusal event is not a singularity; it is a finite, realizable state of the system.

### A5.  Non-Zero Residual Correlations

The Refusal event does not reduce the system to a zero-information state. The state immediately after Refusal carries a non-zero correlation structure determined by the approach trajectory. This correlation structure is the minimum information content consistent with the finite volume of the Refusal state.

## A6. Forward Propagation of Correlations

The non-zero correlation structure produced at Refusal propagates forward into subsequent dynamics. It constitutes an initial condition on all post-Refusal evolution. It cannot be erased by post-Refusal dynamics without violating information conservation.

## A7. Scale-Invariant Saturation

The structural sequence described in A1-A6 -- finite capacity, monotone approach, failure of classical extrapolation, Refusal, non-zero residual correlations, forward propagation -- is instantiated identically by any finite information-bearing system, independent of scale, substrate, or physical domain. The gap between a system's current realized complexity and $C\_max$ is the same structural object whether the system is a cosmological state space, an agent's perceptual capacity, or an institutional information-processing network.

## 3. Theorems

## T1. Singularity Exclusion

Under A1-A4, any finite information-bearing system cannot pass through a state of zero information content. A cosmological singularity -- a state of zero volume, infinite density, and zero prior correlation -- is excluded as a realizable initial condition for any finite universe.

Proof sketch: A singularity requires $C = 0$ and a transition from $C = 0$ to $C > 0$ under forward evolution. By A1 and A4, the Refusal event occurs at finite $C > 0$. The system never reaches $C = 0$ under realizable dynamics. Classical extrapolation that predicts $C$ ? $0$ is excluded by A3 before it is reached.

## T2. Necessary Head Start

Under A5-A6, any finite universe that has undergone a Refusal event begins its post-Refusal evolution with a non-zero correlation structure. Structure formation in such a universe does not begin from quantum vacuum fluctuations at zero amplitude. It begins from a non-zero initial power spectrum whose amplitude is bounded below by the correlation content of the Refusal state.

Proof sketch: By A5, the Refusal state has non-zero correlations. By A6, these propagate forward. The lower bound on the initial power spectrum is therefore $P(k, t\_0) > 0$ for all $k$ accessible to the Refusal state. The form and amplitude of $P(k, t\_0)$ depend on the approach

trajectory and are not determined by these axioms alone; they require physical specification of the system (see Section 5).

## T3.  Universal Gap Structure

Under A7, the gap ?(S) = C_max(S) ? C(S, t) is the same structural object at every scale. The perceptual gap of an observer, the saturation gap of a cosmological state space, and the institutional capacity gap of a social system are all instantiations of the same constraint. Events that fall within ?(S) are not receivable by S at time t, regardless of scale.

Proof sketch: A7 asserts scale-invariance of the structural sequence. The gap ?(S) is defined identically for any finite system by A1. The identical structure of the gap across scales follows directly from A7 without further assumption.

## 4. Corollaries

### C1.

Randomness is a gap property, not a system property. What appears random to a system S at time t is precisely the content of ?(S, t): the portion of the world's order that S currently lacks the realized complexity to receive. As C(S, t) increases toward C_max(S), apparent randomness decreases. Randomness is not a feature of the world. It is a measure of the distance between the world and the observer.

### C2.

Forgetting is a necessary maintenance operator. If C(S, t) approaches C_max(S) without release, A3 applies: classical extrapolation fails and the system undergoes Refusal. To remain below C_max and continue receiving new information, a finite system must release realized complexity. The degradation of prior correlation structure -- forgetting -- is not a failure of the system. It is the mechanism by which the system maintains the gap ?(S) > 0 necessary for continued operation.

### C3.

Hope is a first-passage property. The probability that a finite system S reaches a target state S* is determined by the stochastic dynamics of ?(S, t). A system operating near C_max with no capacity for release has ?(S) ? 0, and the expected first-passage time to any new target state diverges. Forgetting -- by maintaining ?(S) > 0 -- keeps first-passage times finite. The structural precondition of forward motion is available capacity.

### C4.

Surprise marks the boundary of realized complexity. An event e is surprising to system S at

time t if and only if e ? ?(S, t): the event falls outside S's current realized complexity. Genuine surprise is not a psychological accident. It is the precise structural signal that the system has encountered the edge of its current $C(S, t)$. Post-surprise integration of e increases $C(S, t)$ and expands S toward $C\_max(S)$.

## 5. What These Axioms Do Not Determine

The following are explicitly outside the scope of this note. They require physical specification and are the subject of separate quantitative work.

5.1  The specific form of C_max for any physical system.

In cosmology, this requires specifying the Planck-scale bound on information density. In agent systems, it requires specifying cognitive and attentional resource constraints. The axioms assert existence and finiteness of C_max; they do not determine its value.

5.2  The spectral form of the residual correlation structure at Refusal.

By T2, $P(k, t\_0) > 0$. The scale-dependence of $P(k)$ -- whether it is scale-invariant, blue-tilted, or otherwise -- depends on the approach trajectory and the matter content of the pre-Refusal phase. This requires physical specification (pre-bounce equation of state, matching conditions) and is not determined by the axioms.

5.3  The mapping from Refusal correlations to observable structure.

Connecting $P(k, t\_0)$ to observable quantities -- galaxy number density, power spectrum amplitude, non-Gaussianity -- requires propagation through standard structure formation machinery (transfer function, growth factor, halo mass function). This is the quantitative program of Paper III.

5.4  The identification of specific observational anomalies as Refusal signatures.

Observations consistent with a non-zero initial correlation floor -- including early massive galaxy counts at high redshift -- are potential probes of T2. They are not justifications for the axioms. The axioms stand or fall on their internal consistency and structural necessity, not on any particular observational tension.

## 6. Relationship to Existing Frameworks

Loop Quantum Cosmology (LQC).  The modified Friedmann equation of effective LQC instantiates A1-A6 at the cosmological scale. The critical density ?_crit is C_max for the cosmological state. The bounce is the Refusal event. Pre-existing perturbations frozen in at the bounce are the residual correlations of A5. LQC provides the physical mechanism; the present axioms provide the structural necessity that makes such a mechanism unavoidable for any finite universe.

Observer-Scope Theory. The agent's perceptual gap $?? = I(X; ?^*) ? I(X; ?\_a)$ instantiates $?(S)$ at the observer scale. The perception operator $?\_a$ with fidelity $?\_a ? [0,1]$ is the agent's realized complexity $C(S, t)$. The degradation operator $D\_a$ applied to memory $M\_a$ is the release mechanism that maintains $?(S) > 0$. Observer-Scope Theory provides the epistemological and phenomenological instantiation of the same axioms.

Information Scaling Law (ISL). ISL provides the meso-scale instantiation: agents, institutions, and social systems operating with finite capacity $Q\_a$ approaching $C\_{max}$. The Refusal event at the social scale is the saturation of institutional complexity. The residual correlations are the structural memory that persists across institutional transitions. ISL provides the intermediate scale that connects observer dynamics to cosmological dynamics through A7.

The relationship between these frameworks is not analogy. Under A7, they are the same structural object instantiated at different resolutions. This is the claim that distinguishes the present note from a mere observation of correspondence.

## 7. The Three-Paper Program

This note constitutes Paper I of a three-paper program.

Paper I (this note): Establishes the axiomatic structure. Proves Singularity Exclusion, Necessary Head Start, and Universal Gap Structure. Makes no quantitative predictions. Anchors the program.

Paper II: Observer-Scope Theory. Develops the epistemological and phenomenological instantiation of A1-A7 at the observer scale. Addresses time as a scalar generated by memory, randomness as a gap property, surprise as boundary detection, forgetting as capacity maintenance. Does not require cosmological confirmation.

Paper III: The quantitative cosmology note. Derives the perturbation spectrum through the LQC bounce with ISL initial conditions. Propagates through standard structure formation machinery. Produces a falsifiable number density curve. Treats observational data -- including high-redshift galaxy counts -- as probes rather than justifications.

Papers I and II are independent of Paper III's outcome. If the quantitative predictions of Paper III are falsified, Papers I and II remain structurally intact. The axioms are not hostage to any particular observational tension.

## 8. Conclusion

Seven axioms. Three theorems. Four corollaries.

The core result is this: any finite information-bearing system approaching its maximum realizable complexity cannot pass through a zero-information state. It undergoes Refusal. It

exits Refusal with non-zero correlations that propagate forward into all subsequent evolution. This structure is scale-invariant.

A universe without a singularity is not a speculative hypothesis. It is a structural consequence of finiteness. The question is not whether the Refusal event occurred. The question is what it left behind -- and whether we are looking at it now.

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