

Note 2.

The Cosmological Structural Intellect.

A dialectical framework for cosmic renewal

Introduction: beyond determinism and design

The concept of the CSI is seen here as the fourth dialectical cosmological logics to help understand how the Universe is evolving and in response to the limitations of two dominant paradigms. First, the determinism of much of modern physics, exemplified by interpretations of Roger Penrose's Conformal Cyclic Cosmology (CCC) which, while mathematically elegant and foundational for the concept of a grand cosmological cycle, describes a cosmos that transforms through passive geometric continuity. The second is the theological or metaphysical 'God-of-the-gaps' reasoning, which invokes an external, transcendent agency to explain the universe's apparent fine-tuning and improbable low-entropy beginning (e.g. Collins, 2009; Plantinga, 2011).

The CSI offers a third path – exploring a model of a universe that may be self-organizing, self-mediating, immanent and material. It represents a historical materialist framework that attempts to rescue dialectical materialism from the sterility of its Soviet past and apply its creative and speculative powers to the grandest of questions - the origin, evolution, and ultimate destiny of the cosmos.

This chapter presents a comprehensive exposition of the CSI, beginning by situating the CSI within its scientific and philosophical foundations, primarily Penrose's CCC together with the dialectical thought of Marx (1973 translation), Gramsci (1971 translation), and Ilyenkov (1979). It then defines the CSI's core nature as a non-conscious, formally intelligent system embedded in the geometry of spacetime. The chapter proceeds to detail the CSI's operational mechanics, describing its function through a triadic process of memory, mediation, and emergence, and its interaction with the 'quantum terrain of possibility' in the late-stage universe.

Foundations - synthesizing Penrose, Marx, Gramsci and Ilyenkov

The CSI is a concept forged at the intersection of speculative physics and revitalized Marxist philosophy. Its primary scientific scaffolding is Roger Penrose's Conformal Cyclic Cosmology (CCC) that posits that the universe is not a linear, one-time event, but a recursive sequence of cosmic epochs, or 'aeons.' Each aeon

begins with a hot, dense Big Bang and ends in a cold, empty state of maximum entropy—a ‘heat death’ dominated by massless particles like photons and gravitons (Penrose, 2005; 2010).

Penrose’s key insight is that the geometry of this final, scale-free state is conformally identical to the geometry of the initial Big Bang singularity. This mathematical equivalence allows for a smooth transition - the infinite future of one aeon is compactified by conformal rescaling to become the finite beginning of the next. In this model, black holes play a crucial role; their eventual evaporation via Hawking radiation returns their entropic content to the cosmos, a necessary step in achieving the ultimate, massless, scale-free state (Gurzadyan & Penrose, 2013; Hawking, 1975).

While CCC provides a compelling mathematical bridge between aeons, it leaves a critical conceptual gap - the mechanism of transition. The model describes a geometric continuity but not an active process of transformation. The transition appears spontaneous, a passive unfolding of mathematical necessity. It is here that the historical dialectical materialist framework enters.

Drawing on a Marxist tradition that views contradiction as the engine of historical change, the CCC is reinterpreted not as a deterministic cycle but as a dialectically recursive process. Each new aeon is not a mere repetition but a ‘transformation that inherits and reorganizes the conditions of its predecessor.

The CSI’s deepest conceptual roots lie in Karl Marx’s notion of the ‘General Intellect’. In the *Grundrisse*, Marx (1973 translation) described the General Intellect as the collective, social knowledge and scientific rationality that, in advanced capitalism, becomes externalized from the individual worker and embedded in the machinery of production. It is the ‘real abstraction’ of human social intelligence made objective in the world.

The CSI is the radical cosmological extension of this idea: it is the universe’s own General Intellect, a substrate of formal, non-conscious intelligence that is immanent to its very structure—its geometry, its quantum fields, and its informational dynamics. The cosmos, in this view, is a self-organizing, self-mediating system that ‘thinks’ its way through cycles of death and rebirth, not through divine will or random chance, but through an embedded logic of transformation.

The intellectual journey from Marx’s social theory to a cosmic structural intellect is mediated by the work of the Soviet philosopher Evald Ilyenkov and the political Marxism of the Italian Communist Antonio

Gramsci. Ilyenkov sought to rescue dialectical materialism from the rigid dogma of Stalinism, which had reduced it to a static affirmation of an eternal, unchanging universe (ref). In his highly speculative essay, “Cosmology of the Spirit (1979), Ilyenkov confronted the thermodynamic ‘heat death’ of the universe—a concept anathema to official Soviet cosmology. He proposed a radical solution: that ‘thinking matter,’ as the highest form of organized matter, has an objective, cosmic role, arguing that when a local system (like the Earth within our Solar System) reaches its entropic end, this thinking spirit would voluntarily sacrifice itself in a conscious, cosmic explosion to provide the energy for the universe’s rebirth. This was a profound move, by rescuing the dialectical principles of change, contradiction, and the ‘negation of the negation’ from dogmatic irrelevance and projecting them onto the grandest of stages—the cosmos itself.

The CSI is the direct, yet critical, descendant of Ilyenkov’s vision. It retains his core insight - that the universe can be a self-renewing, dialectical system - but radically departs from his anthropocentrism and his reliance on a conscious, sacrificial act. The CSI is not a ‘spirit’ but a ‘structural intellect’, operating at the level of the cosmos itself, not as a local agent within it.

This conceptual move is further refined by Antonio Gramsci’s political Marxism, which foregrounded the concept of ‘mediation’. For Gramsci, social transformation in the West was not a simple, violent overthrow (a ‘war of manoeuvre’) but a long, patient ‘war of position,’ where a subordinate class builds a ‘counter-hegemony’ by mediating between the economic ‘structure’ and the cultural ‘superstructure.’ The logic of mediation is elevated from political class struggle to a cosmic principle in the CSI framework, functioning as a selection mechanism on the immanent ‘quantum terrain of possibility’ in an increasingly massless late universe. The CSI is the ultimate mediator, operating between aeons, between the degenerate state of a dying cosmos and the nascent potential of a new one. It is the cosmic analogue of the Gramscian ‘organic intellectual,’ providing the logic that allows for a new cosmological ‘historical bloc’ to emerge from the contradictions of the old.

Thus, the CSI is a synthesis – taking the material framework of Penrose’s CCC, the idea of a structural intellect from Marx, dialectical agency of Ilyenkov’s thinking matter, and the mediating logic of Gramsci’s political theory, to forge them into a new model where mathematics is not merely descriptive but is the very medium through which the universe ‘thinks’ its way into the next aeon.

The nature of the CSI: a non-conscious, formally intelligent system

The CSI is defined as much by what it is not as by what it is. It is explicitly not a conscious mind, whether human or divine. It is also not a random, stochastic process. The universe's rebirth is not a matter of chance or the statistical luck of a multiverse. The CSI, that operates as a cosmological 'undertaker' in the late universe and 'midwife' in the transition and rebirth, occupies a third ontological category as a non-conscious, formally intelligent system.

This 'formal intelligence' is embedded within the physical universe itself—in its geometry, its quantum fields, and its informational dynamics. It is the 'embedded logic' that governs the cosmos's evolution. This intelligence is best understood as a set of immanent, self-organizing principles that operate according to a logic of selection, inheritance, and transformation. It is an immanent agency, meaning its power to act arises from within the system, not from an external source.

The primary physical substrate of the CSI is conformal geometry of Penrose's CCC. In the late-stage universe, as it becomes scale-free and massless, the specific geometric relationships that define conformal invariance become the operating system for the CSI. This geometry is not a passive stage but an active logic. It encodes the rules for how information from one aeon can be mapped onto the next, preserving causal relationships and enabling continuity through scale invariance. Massless particles—photons and gravitons—act as the carriers of this continuity, their behaviour governed by the rules of this embedded geometry.

The CSI as a multi-dimensional intellect

The Cosmological Structural Intellect (CSI) is defined as much by what it is not as by what it is. It is not a conscious agent—neither divine nor human—and it is not a stochastic mechanism governed by chance or multiversal randomness. Instead, the CSI occupies a distinct ontological category - that of a non-conscious, formally intelligent system—an immanent rationality embedded in the very fabric of physical law.

This 'formal intelligence' is not metaphorical. It is the structural logic of cosmic self-organisation, operating through geometry, symmetry, quantum information, and thermodynamic constraint. It functions as both undertaker and midwife. In the late aeon, it dissolves the particularities of matter and entropy; at the conformal boundary, it selects and transmits only those configurations compatible with a coherent rebirth. Its agency is not external but immanent, arising from within the universe's own material dynamics.

Crucially, the CSI is multi-dimensional in both scope and function, operating across four interwoven dimensions:

1. Geometric dimension – conformal invariance as operating system

The primary substrate of the CSI is the conformal geometry of Penrose's CCC. In the late universe—devoid of mass, scale, and entropy gradients—the spacetime metric becomes conformally invariant. This is not a passive background but an active logical framework: it defines how causal structures from one aeon can be faithfully mapped onto the next. Photons and gravitons, as massless carriers of information, become the medium through which this geometric logic enacts continuity. Conformal rescaling is thus not a mathematical trick but a selection rule—a formal principle that preserves rational structure while discarding contingent noise.

2. Thermodynamic dimension – entropy as generative condition

The CSI reframes entropy not as terminal decay but as a necessary precondition for renewal. By ensuring that all massive particles decay before the aeonic boundary, the CSI transforms the high-entropy end-state of one aeon into the low-entropy beginning of the next. This is the core dialectical move: destruction becomes preparation; degeneration becomes purification. The CSI does not violate the Second Law—it orchestrates its resolution through cosmological time.

3. Informational dimension – holographic encoding and memory

At black hole horizons and across the conformal boundary, the CSI operates through holographic principles: information is not lost but encoded on surfaces (e.g., $S = A/4$). Gravitational radiation from evaporating black holes survives as “Hawking points” in the CMB of the next aeon—material memory inscribed by the CSI. This informational continuity ensures that the cosmos is not a series of disconnected cycles but a historical totality, where each aeon inherits the rational residue of its predecessor.

4. Mediation dimension – formative and summative selection

The CSI thus acts in two modes, formative and summative. Its summative function occurs at the aeonic boundary when it performs global selection, filtering quantum possibilities to ensure conformal smoothness and low entropy. The formative function occurs throughout the aeon, operating locally—especially in extreme environments like black holes—guiding the reconfiguration of matter into geometry, elevating quantum effects into structural memory, and maintaining coherence amid rupture.

Thus, the CSI is not a single event but a continuous process of rational curation, distributed across spacetime. In this view, the universe is a dialectically recursive system, in which contradiction (entropy vs. order), mediation (black holes, conformal mapping), and transformation (aeonic rebirth) are governed by an immanent logic of self-correction and renewal.

The summative mechanics of the CSI - memory, mediation and emergence

The transition between aeons is not a singular event but a structured, three-stage process —memory, mediation, and emergence—that provides a dynamic model for how the CSI enacts cosmic transformation.

1. Memory/residual phase - the substrate of possibility

The first phase begins as the old aeon approaches its entropic end. During this phase, the Universe is not yet dead but is in a state of ‘dialectical activation.’

Entropy, the accumulation of disorder - is not an empty void but a ‘substrate of disorganized potential.’

The key actors in this phase are photons and the latent structure of spacetime.

Photons as archival agents - as massive structures decay and black holes evaporate, photons become the dominant physical entities. Their stretched wavelengths and diffuse energy encode the history of the universe’s structure—the imprints of galaxies, stars, and the quantum fluctuations of the early cosmos. They act as archival agents, preserving the memory of the old aeon.

Structured Intellect as dormant coding - the CSI itself exists in this phase as dormant mathematical coding—‘not thinking, but encoded logic’ preserved in the topology of spacetime or the configuration of quantum fields. This latent logic is the cosmic DNA, the blueprint to guide the next cycle. This phase contains the ‘terrain of degeneration’ that still holds the latent information necessary for its own renewal. It is the raw material from which the old universe will be transformed and a new one built.

2. Mediation/transitional phase: the deep instant of selection

This is the critical, ‘deep instant’ of the cosmological cycle; the moment of ‘contradiction saturation,’ where the degenerative forces of the old aeon can no longer be internally resolved, and a qualitative leap is required in which the CSI undertakes mediation.

Photons as mediators of change - in this phase, photons enable minimal quantum interactions, potentially triggering informational shifts.

Structured intellect as a 'cosmic filter' - the CSI begins to 'select,' not through conscious reflection, but through a process of activation in response to emergent conditions in the quantum terrain. It operates as a 'cosmological filter' or 'algorithm, choosing paths of reconfiguration that are most stable and coherent. This is the moment where the 'principle of least action'—a logic of economy and efficiency—guides the selection of the new cosmic path.

The quantum terrain of possibility - central to this phase is the unique environment of the late-stage universe. With gravity weakened and massive particles decayed, the mechanisms of quantum decoherence are minimized, allowing quantum superpositions to persist on a macroscopic, cosmic scale, creating a vast 'field of immanent potential.' The CSI's selection process occurs within this terrain, a process of 'orchestration' rather than random 'collapse.' This phase is the 'activation of logic,' where the latent structure of the past is reconfigured into the potential of the future.

3. Emergence/reborn phase - the realization of a new form

The final phase is the birth of the new aeon, a low-entropy Big Bang that is the direct result of the CSI's mediated selection.

Photons as structural scaffolding - the selected quantum information is reorganized. Photons shift their role from 'conveyors of memory' to 'structural scaffolding,' providing the foundational architecture for the new universe's matter and energy.

Structured Intellect as a directive agent - the CSI continues to operate in 'cosmic decision-making,' shaping the reborn state through its encoded logic. This logic ensures that the new universe begins in a 'pre-programmed' state for the rapid emergence of structure—a direct explanation for the 'impossibly early' galaxies observed by the JWST.

The formative role of CSI: black holes as loci of ongoing rational selection

In its summative mode, the CSI operates at the conformal boundary between aeons, ensuring that only scale-free, low-entropy data seed the next Big Bang. But if the CSI is immanent throughout cosmic history, then its work must also occur within the aeon—especially in regions where physical hierarchies collapse, and new articulations of force become possible. Black holes are such regions.

In the Standard Model, black holes are cosmic dead-ends where matter and information are lost forever, creating the infamous ‘black hole information paradox.’ In the CSI framework, their role is profoundly reinterpreted in which they can be regarded as ‘cosmic machines’ that perform the essential act of information compression and transformation. The CSI ensures that gravitational collapse, while locally catastrophic, preserves global coherence through the holographic encoding of information on the event horizon (as suggested by the Bekenstein–Hawking entropy formula: $S = A/4$). It mediates the refunctionalisation of matter into geometry - quantum information is not lost but transcribed into spacetime structure and regulates Hawking evaporation so that black holes dissipate in a manner compatible with conformal smoothness, preparing their gravitational residue for transmission across the aeonic boundary as ‘Hawking points.’ Thus, black holes are structured filter, where the CSI performs real-time cosmological curation. Extreme curvature near the horizon becomes a laboratory of rational selection, testing which quantum-gravitational configurations can survive the transition from matter-dominated to radiation-dominated regimes.

This formative role transforms our understanding of the cosmological double shuffle. Quantum effects, though subordinate in most of the cosmos, are temporarily elevated at horizons—not as noise, but as carriers of structural memory. In this light, every black hole is a micro-conjuncture—a local site where the CSI resolves tension between entropy and order, locality and non-locality, finitude and infinity. And because black holes are ubiquitous—from stellar remnants to supermassive cores—they ensure that cosmic renewal is not deferred to the end of time but enacted continuously.

In its summative role in the late universe, the black hole thus serves as the conceptual boundary between the ‘physical’ reality of the old aeon and the ‘a-physical’ logic that will seed the new. Its evaporation via Hawking radiation is not a sign of information loss, but the final step in this transformation, releasing the formally encoded data back into the late-stage universe as a substrate for the CSI to act upon. The discovery of massive, ‘naked’ black holes in the very early universe by the JWST is not a contradiction but

a confirmation. These could be the first physical manifestations of the CSI's logic in the new aeon—the 'seeds' around which galaxies rapidly formed, a direct act of 'cosmic selection' to impose early order.

Dark Matter and Dark Energy as a-physical forces of purpose

Dark matter and dark energy, which together constitute 95 per cent of the universe's energy content, are the dominant yet enigmatic forces of cosmic evolution. The CSI framework assigns them a clear, teleonomic purpose. Dark Matter functions as the A-Physical Blueprint and Dark Energy as Cosmic Driver. Dark matter's primary effect is to provide the gravitational 'scaffolding' for galaxy formation, being the manifestation of the 'a-physical' blueprint from the previous aeon; the 'ghost in the machine,' the presently invisible force that guides the universe's unfolding from its very beginning, ensuring that matter clumps into galaxies and stars, creating the conditions for complexity and life (ref). The function of Dark energy, on the other hand, is to drive the expansion of the cosmos toward its terminal, scale-free state. Its repulsive force is not a random constant, but a purposeful act of the current aeon, clearing the stage for the next cycle of creation.

Local heating and a new modular universe

Validation for the CSI framework comes not just from science-informed speculation but also from recent empirical data, particularly the work of astrophysicist Richard Lieu. Lieu's analysis of JWST data (Lieu, 2023) has provided strong evidence for local heating and a modular expansion in the early universe; findings that directly challenge the standard, homogeneous Big Bang model. The Λ CDM model posits a smooth, uniform inflationary epoch that homogenises the universe, followed by a gradual, gravitational clumping of matter. Lieu's observations, however, reveal a universe that is highly 'textured' from its inception. The evidence for local heating—pockets of intense, non-uniform energy release in the early universe - suggests that the Big Bang was not a single, monolithic explosion but a more of a modular phase transition.

This modular view is consistent with the CSI framework in which the 'Deep Instant' of the transition is not a uniform event but a process of 'sequential activation' where different segments of the new aeon are unpacked according to the inherited cosmic blueprint. Local heating is the physical signature of this process—the friction and energy release generated as the CSI translates the geometry of the old aeon and forges the new one in specific locales or sites of high informational density.

Furthermore, this modular logic explains the ‘impossibly early’ formation of massive galaxies. The CSI’s inherited blueprint, a product of cosmic ‘earning’ over countless previous aeons, provides a pre-programmed set of instructions for rapid, non-random structure formation. The universe is not starting from a blank chaotic slate; it is beginning with a sophisticated, low entropy ‘starter kit’ that enables the fast and efficient assembly of complex systems. The JWST’s observations of a mature, structured early universe (Donnan et al., 2023; Lieu, 2023), are thus not a crisis for cosmology, but a direct confirmation of a dialectically recursive cosmos guided by a structural intellect

Summary

The CSI’s most profound function is its dialectical transformation of apparent opposites. It bridges the contradiction between coldness (maximum entropy) and heat (rebirth) by transforming terminal decay into compressed potential. As the universe approaches heat death, the CSI operates as a cosmological filter, selecting paths of reconfiguration based on emergent opportunities within the degenerate terrain. Through local activation, it generates pockets of heating and emergent forms from otherwise latent structure. This process fundamentally transforms Penrose’s Conformal Cyclic Cosmology from a deterministic geometric model into a dialectical system of negation and sublation, where the universe’s formal intelligence enacts renewal through immanent logic rather than external intervention.

The CSI thus constitutes a cosmological third way—neither theological nor purely mechanical—where the universe possesses immanent agency without consciousness, enabling it to transform itself through the recursive logic of cosmic evolution. This framework provides a rigorous alternative to both divine explanations of fine-tuning and random quantum collapse models, offering instead a vision of a self-organizing cosmos that perpetually renews itself through embedded mathematical intelligence.

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