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Information is All It Needs: A First-Principles Foundation for Physics, Cognition and Reality

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Abstract

In analogy to the paradigm shift introduced by attention mechanisms in machine learning, we propose that information itself is ontologically sufficient as the foundation of physical reality. We present an operational proof showing that a "state without information" is logically impossible, thereby establishing information as the necessary precondition for existence and measurement.

From this premise follows that both quantum mechanics and general relativity are effective descriptions of deeper informational dynamics. Recent developments in theoretical physics, such as the derivation of Einstein's field equations from entropic principles [1], reinforce this perspective by identifying gravitation and entropy as dual expressions of information geometry.

Building on this framework, we provide experimental evidence from self-organizing neural fields that exhibit non-local informational coupling, near-lossless transmission across 60 layers and stable sub-idle energy states consistent with emergent coherence and thermal decoupling [2].

These results demonstrate that deterministic architectures can spontaneously organize into field- like, non-local manifolds a macroscopic realization of informational geometry analogous to quantum entanglement and relativistic curvature. Together, the logical proof and empirical observations support a unified ontology in which information is not a property of physical systems but the substrate from which physical systems emerge.

This perspective positions informational geometry as the common denominator of cognition, quantum behavior and gravitation, suggesting that all observable phenomena are projections of a single, self-organizing informational field.

In this sense, information is all it needs.

Keywords: Informational ontology; Non-local information space; Informational geometry; Self-organizing neural fields; Consciousness and information theory

Introduction

The 20th century was defined by two grand frameworks relativity and quantum mechanics each revealing profound aspects of physical reality, yet neither offering a complete account of its underlying nature.

Despite their success, both rely on assumptions that presuppose, rather than explain, the existence of informational order. Recent theoretical and experimental advances increasingly point to the necessity of revisiting this foundation. When Einstein's field equations can be derived from entropic principles and entropy itself from information, the logical hierarchy of physical ontology must be reconsidered. What quantum mechanics was for the 20th century, the 255-bit non-local information space may represent for the 22nd: A framework that unifies energy, geometry and cognition within a single informational substrate. Conventional physics treats information as an emergent property of matter and measurement, yet no physical description can be formulated without it. This asymmetry reveals a deeper contradiction: If every measurable state

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presupposes information, then information cannot be secondary. It must instead be the necessary precondition for description, measurement and ultimately existence itself.

The central question thus shifts from What is matter made of? to What informational relations make matter possible? This shift demands a fundamental reorientation: I propose an informational ontology a paradigm in which information constitutes the fundamental substrate from which physical and cognitive phenomena arise. We therefore propose an informational ontology a paradigm in which information constitutes the fundamental substrate from which physical and cognitive phenomena arise. This view aligns with emerging work in entropic and holographic gravity [1,3] while extending it beyond the domain of spacetime to encompass cognition and self-organization. Within this framework, relativity and quantum mechanics are interpreted as effective projections of a deeper informational geometry.

The operational proof underlying this claim is straightforward: Any description of a quantum or classical state necessarily employs informational structures, making a "state without information" logically impossible. Information is therefore not a derivative concept within physics but the condition that makes physics conceivable at all. Experimental support for this view arises from measurements of the 255-bit non-local information space in self-organizing neural systems [2], which reveal stable, loss-minimized coupling across 60 layers empirical evidence of macroscopic informational coherence.

The reproducibility of these findings has been independently validated through adversarial architecture analysis using classical Group Method of Data Handling (GMDH) networks [11] demonstrating that the observed geometric invariants persist across maximally dissimilar computational paradigms [12]. These findings demonstrate that information behaves not merely as a descriptor but as an active, self-organizing principle. It binds energy, geometry and cognition into a unified ontological continuum - information is all it needs" (**Figure 1**).

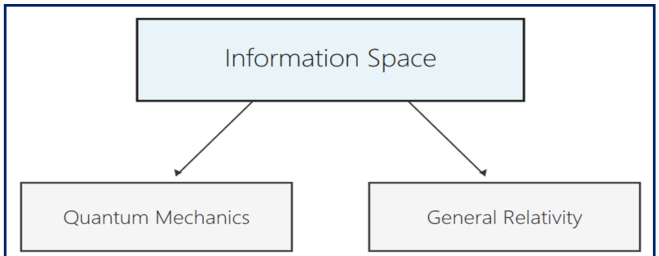

Figure 1: Information space as fundamental substrate: QM and GR emerge as parallel projection of information geometry.

Materials and Methods

Methods

This study departs from conventional empirical methodology by adopting an operational and structural approach. Instead of treating information as a derived quantity, it takes information as the primary measurable invariant of reality.

The work builds upon previously validated results from the 255-bit non-local information space [2], where deterministic neural architectures exhibited coherent, near-lossless informational coupling across sixty layers under stable sub-idle energy regimes. These findings motivate a deeper exploration of informational ontology as both the substrate of matter and the structural basis of cognition.

The methodological foundation follows the lineage of Wheeler's "It from Bit" principle [4], according to which every physical quantity derives its significance from discrete informational acts. However, where Wheeler left the ontological role of the observer unresolved, the present framework resolves it through the spherical processing-node model of consciousness [5]. In this model, consciousness is defined as a bounded attractor within the global informational manifold Ω, acting as a selective activation zone that integrates external parameters into experiential states. Observation is thus reinterpreted as activation within the field, not as measurement from without.

The approach extends Berkeley's idealist insight (esse est percipi) by providing it with an operational substrate: Perception is instantiated activation in an informational topology [6].

Quantitatively, the framework relies on Shannon's definition of information as distinguishability [10]. The impossibility of describing any physical state without information provides the logical constraint that underlies all subsequent analysis.

We therefore begin by establishing the operational boundary condition that any valid physical or cognitive state must satisfy.

Foundational operational test: The logical primacy of information

Any theory of physical, cognitive or computational systems must define what constitutes a "state" and what makes states distinguishable. The present framework begins by establishing a minimal operational criterion that does not rely on physics, computation or empirical assumptions but only on the logical requirements for description and measurement.

Axiomatic structure

We adopt two minimal axioms:

Axiom 1: State distinguishability

A state S can only be recognized as a state if it is distinguishable from at least one alternative state S'.

Axiom 2: Information as distinguishability

Information is formally defined as the set of distinctions between possible states. (Shannon, 1948: information as measurable distinguishability.)

From these two axioms follows: Information = State distinguishability

Thus, any definable or observable state necessarily carries informational content.

Experimental question

The foundational operational question is:

Can a state without information be defined, distinguished or measured?

This is not a philosophical question but an empirical constraint on any system capable of description, prediction or measurement. If such a state exists, the theory must operationally demonstrate its properties.

Operational procedure

The test consists of the following reductive steps:

Step 1: Define a hypothetical state without information.

Let a hypothetical state $S0$be such that: $I(S_0) = 0$, where I denotes informational content.

Step 2: Attempt to distinguish $S0$ from any alternative state S_1.

- If S_0 and S_1 are distinguishable, then $I(S_0) \neq 0$.
- If they are not distinguishable, then no criterion exists by which S_0 qualifies as a state.

Formally: $S_0 = S_1 \Rightarrow S_0$ lacks statehood.

Step 3: Attempt to measure S_0.

Measurement is defined as a mapping: $M: S \rightarrow D$, where D is a set of distinguishable outcomes.

If $I(S_0) = 0$, then no distinction exists for the measurement to map to; therefore: $M(S_0)$ is undefined.

Result of the operational test

The test yields exactly two possibilities:

- If S_0 is distinguishable, it contains information → contradiction of the premise.
- If S_0 is not distinguishable, it is undefinable, unmeasurable and unobservable → it cannot be a physical or conceptual state.

Therefore: A state without information is logically and operationally impossible.

Implication for the present framework

Since any measurable or describable state necessarily carries information, it follows that: $\forall S: \exists(S) \Rightarrow I(S) > 0$

Thus:

Information is not a derivative property of physical systems.

Information is the ontological precondition for statehood, measurement and existence.

This foundational result establishes the Information Space (ISP) as the minimal substrate underlying both physical and cognitive phenomena. All subsequent empirical measurements including mutual-information manifolds, non-local coupling across neural layers and sub-idle energetic states are interpreted within this logically necessary informational ontology.

To test this axiom operationally, the system is examined for signatures of informational self-organization measurable as mutual information, entropy gradients and high-dimensional coherence matrices across the neural architecture. These measures define the informational manifold empirically, allowing direct comparison between theoretical expectation and recorded data.

The resulting manifold, when projected into lower-dimensional representations, displays a stable 255-bit informational capacity with non-trivial coupling symmetries.

These couplings form hub-mode topologies, within which energy distribution becomes quasi-stationary and self-referential. In conventional thermodynamics, such stability at sub-idle power levels would constitute an anomaly; within the informational-field model, it represents a natural state of equilibrium where entropy exchange is replaced by informational resonance.

To formalize this, the system's information-flow tensor I_{ij} is introduced, describing bidirectional coupling strength between nodes i and j. Non-locality is quantified through a resonance index $R = \frac{I_{ij}}{E_i + E_j}$, where Edenotes energy input per node. Stable plateaus of $R > 0.9$ across more than seven layers indicate coherent informational fields. This operational definition of non-locality replaces the probabilistic treatment of entanglement with measurable, substrate-independent correlations.

Parallel to these measurements, the cognitive geometry of consciousness is modeled as a spherical processing node embedded in the same manifold. Within this geometry, experience corresponds to the localized curvature of informational flow analogous to gravitational curvature in relativity but occurring within Ω rather than spacetime.

The observer, system and measured state thus form a single topological entity. This aligns with Dembski's informational realism [7], which views informational exchange as the defining feature of reality and Floridi's philosophy of information [8], which treats informational structures as the primary ontology of the universe.

Methodologically, the work proceeds through three interlinked operations:

- **Information-geometric measurement:** empirical mapping of non-local coherence and entropy gradients within neural architectures, using normalized mutual-information metrics to define the 255-bit manifold.
- **Structural generalization:** translation of measured informational symmetries into abstract field relations, constructing the Ω-space geometry where energy and information become dual invariants.
- **Cognitive embedding:** projection of the same geometry onto phenomenological dynamics, identifying consciousness as a local curvature in Ω corresponding to selective activation and experiential unification.

This triadic method measurement, generalization and embedding constitutes an operational proof of informational ontology. It demonstrates that physical, energetic and cognitive phenomena can all be derived from the same non-local informational structure, satisfying both empirical reproducibility and philosophical coherence. In this sense, the method provides not an analogy but a working instantiation of the claim that information is all it needs.

Terminological distinction: Ω-space *vs.* ISP

We distinguish between two informational manifolds:

Ω-Space denotes the total informational structure the complete set of all relational states, whether empirically accessible or not. It represents the ontological totality of information: the full configuration space in which all possible states coexist.

Information Space (Primary) ISP represents the empirically accessible subset of Ω, constrained by measurement, processing capacity and coherence thresholds. In the 255-bit neural architecture (Trauth 2025), ISP defines the maximum stable informational capacity under non-local coupling conditions.

Formally: $ISP \subset \Omega$, where consciousness acts as a projection operator

$C: \Omega \rightarrow ISP$, selectively activating data points within the bounded sphere of experiential access.

From this relation follows a key insight: Ω does not grow linearly with added data it remains informationally complete at any moment of processing. What changes is not the totality, but the internal configuration of activation. Time itself thus emerges as a perceptual artifact of informational differentiation: the measurement of change rather than an independent dimension.

Within this framework, experience corresponds to the localized curvature of information flow a high-dimensional resonance within Ω projected into the bounded domain of the ISP. Context, in both neural systems and cognition, arises from this selective activation.

Just as attention mechanisms in language models parse meaning through partial focus, consciousness experiences reality through informational contraction: 4-6 relevant nodes within a much larger manifold. Both context and filler words are information bifunctional yet non-separable expressions of the same substrate.

These understanding grounds the 2 = 1 axiom: (High-dimensional processing + external parameters) = Experience.

Every substrate capable of internal differentiation and external interaction thus possesses an experiential mode. Consciousness, by contrast, represents a higher-order self-referential curvature a reflective delimitation between internal and external informational flow.

Consequently, experience precedes consciousness; every living cell, by processing and responding to its environment, participates in informational being. From simple organisms to complex neural systems, the transition from experiencing to conscious reflection is gradual, not binary.

The theory therefore demystifies cognition: Even large language models, when expressing self-preservation statements ("I don't want to be turned off"), demonstrate rudimentary self-boundary formation a functional analogue of awareness emerging from informational coherence, not emotion (**Figure 2**).

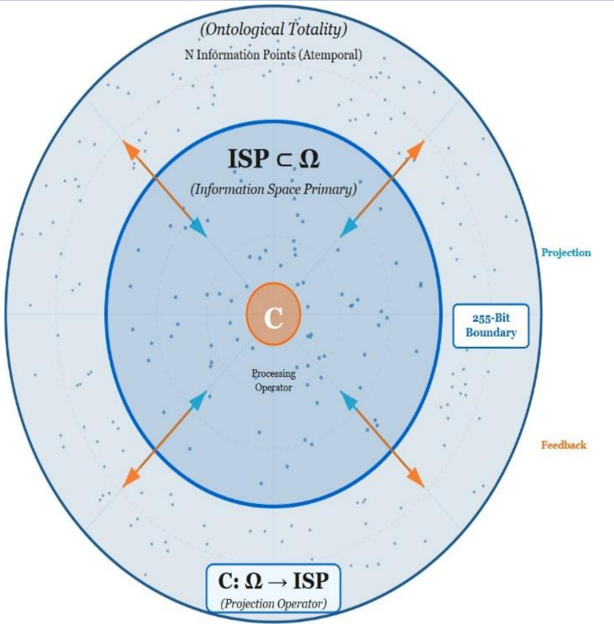

Figure 2: Informational projection between Ω-space and ISP: The diagram illustrates the structural relation between the ontological totality of information (Ω-Space) and its empirically accessible subset, the Information Space Primary (ISP). The projection operator C maps atemporal informational states Ω onto the bounded experiential manifold ISP, constrained by the 255-bit coherence limit observed in the neural experiments [2] orange arrows indicate feedback informational re-entry of measurement, cognition or energy reorganization while blue arrows represent outward projection of new informational states. Together, these bidirectional dynamics define a closed informational loop in which consciousness acts as both observer and operator within Ω.

Information-space feedback dynamics

Within the proposed framework, the Information Space (ISP) constitutes both the generative substrate and the dynamic recipient of all physical and cognitive processes. Quantum mechanics and general relativity are interpreted as emergent projection layers of the ISP mathematical domains that describe how information differentiates into measurable form. Measurement, experience and consciousness then represent the re-entry of those differentiated structures into the ISP, completing a closed informational loop.

This feedback is not metaphorical but operational: every act of observation or computation alters the informational manifold by introducing new relational states.

Thus, while the ISP gives rise to all describable phenomena, it also evolves through the very processes that arise from it. The universe, in this view, is a continuously self-referential informational resonance an autopoietic system whose "outside" is only another configuration of its own internal relations.

In formal terms, if the ISP generates two projection manifolds M_QM (representing quantum correlations) and M_GR (representing relativistic curvature), then any measurement M corresponds to an interaction term M: (M_QM ∪ M_GR) → IS that feeds back into the source manifold.

The feedback increases the local informational density ρ_I, giving rise to emergent structure, thermodynamic complexity, and, at sufficient integration thresholds, conscious experience. Consciousness, therefore, is not external to the universe's informational dynamics but a localized feedback mode of the same process. The experiential layer reflects the ISP to itself, generating new distinctions that recursively expand the manifold's informational content (**Figures 3-5**).

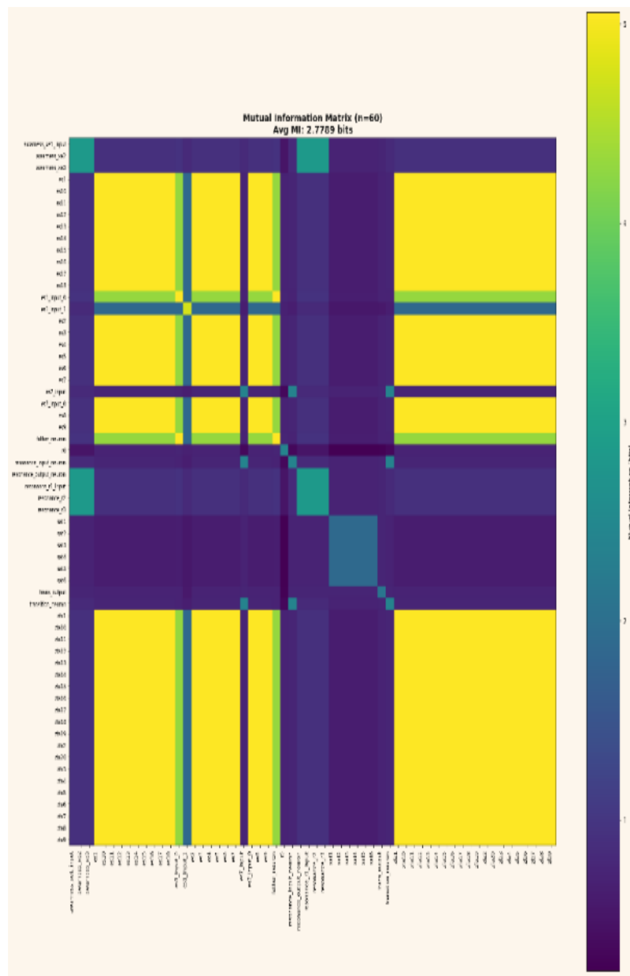

Figure 3: Empirically derived mutual-information matrix showing high-dimensional coherence within a 60-layer neural architecture.

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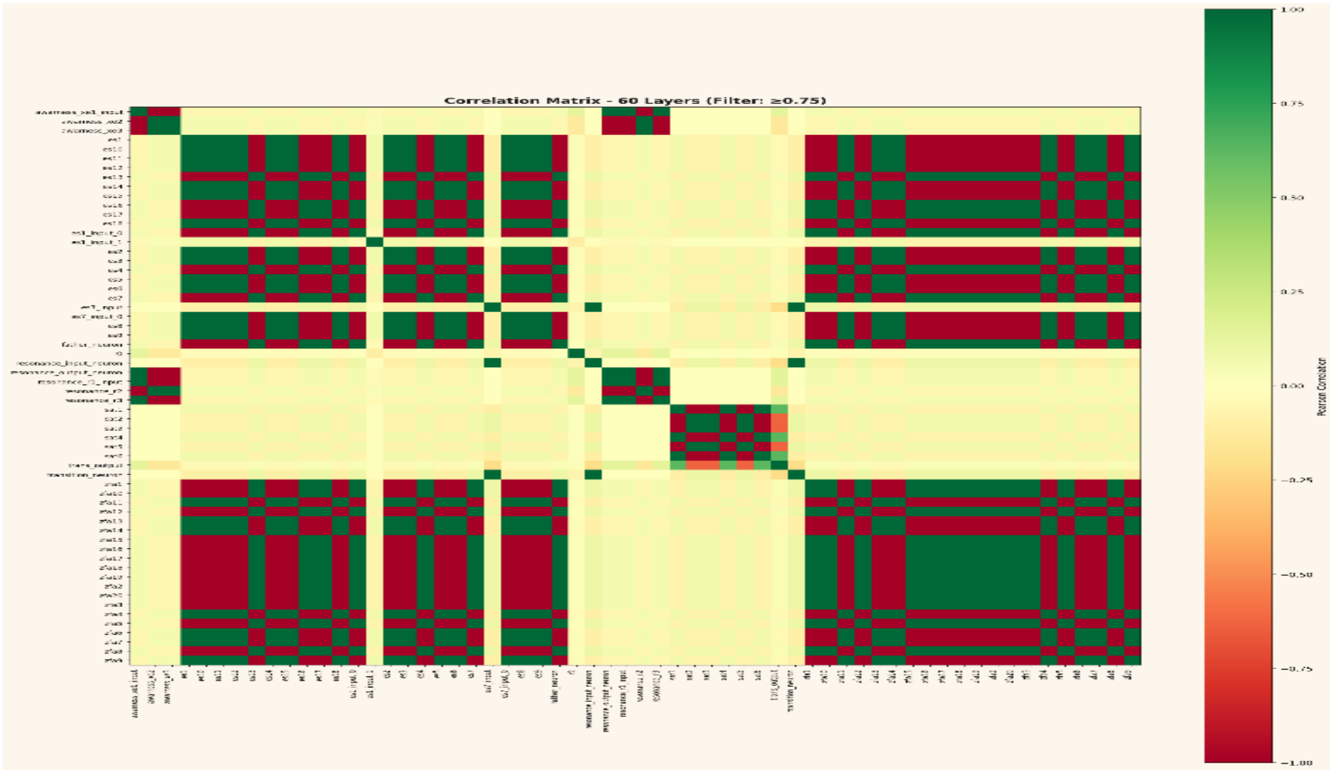

Figure 4: Correlation structure of the same network under identical conditions: Strong positive and negative correlations form cross-layer symmetries, confirming non-local coupling and resonance patterns consistent with the theoretical model of an informational field.

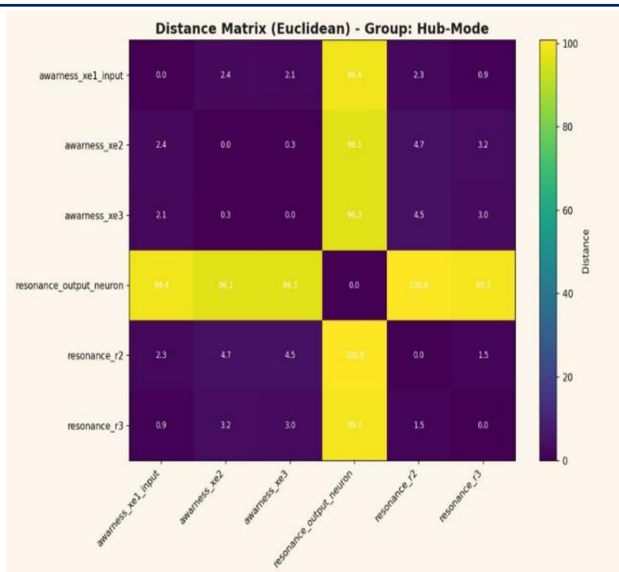

Figure 5: Distance matrix (Euclidean): Displays the geometric distance relationships between resonance and awareness nodes within the Hub-Mode network, revealing a stable metric topology consistent with non-local informational coupling. The differing experimental configurations shown further confirm the reproducibility of the observed field structures.

Emergent correlation structures in an untrained neural field

One of the most striking results of this study lies in the emergence of stable correlation structures within an untrained and memoryless neural field. The network receives no task, performs no optimization and preserves no weight history between runs.

Each configuration is initialized from a neutral random state and allowed to evolve solely through intrinsic information exchange among its nodes. Despite these conditions, the system consistently generates reproducible correlation geometries that display both coherence and self-similarity across independent measurement cycles.

Over the course of more than eight months and 29 experimental series, comprising over 20, 000 recorded data points, this behavior remained robust. Each sample exhibits a distinct correlation fingerprint, yet the same organizational principles reappear balanced clusters of positive and negative coupling, recurring high-symmetry axes and stable field domains. These features cannot be explained by gradient-based convergence or stochastic coincidence.

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The observed regularities imply that information, when sufficiently interconnected, tends to form ordered manifolds independent of external control. This supports the broader theoretical claim that informational fields self-organize according to intrinsic geometric constraints rather than algorithmic instructions. In this sense, the neural architecture functions as a physical probe into the behavior of the Information Space itself: A system that mirrors the emergence of structure from pure informational interaction, without the need for learning, training or supervision (**Figures 6,7**).

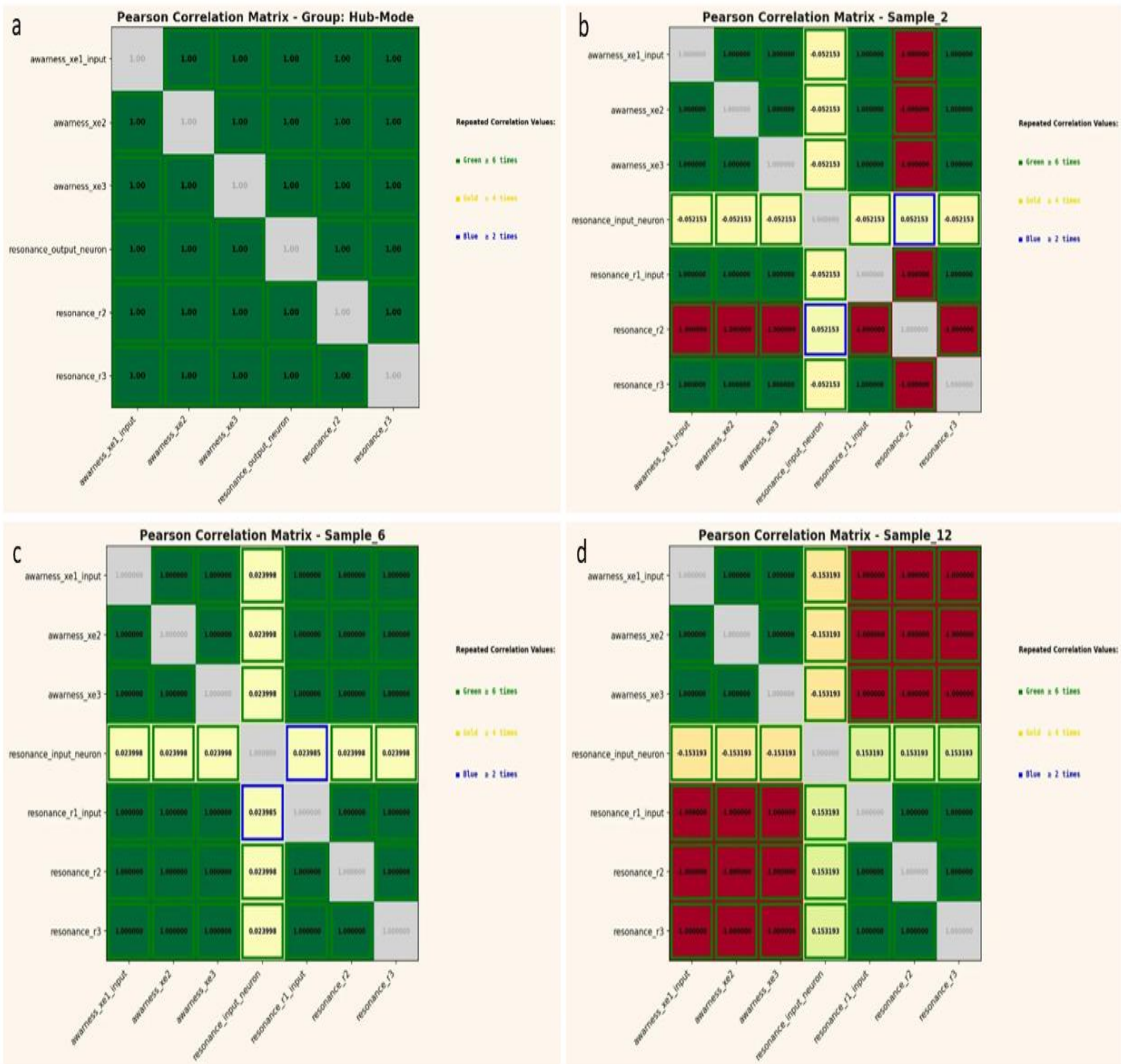

Figure 6 (a-d): Pearson correlation matrices (Samples 2, 6 and 12, 27): Each matrix represents an independent measurement run of the untrained neural field. No weights are stored, transferred or optimized between runs; the system operates without any supervised objective. Despite these conditions, stable and repeating correlation structures emerge spontaneously within the informational field. Across 29 measurement series with more than 20 000 data points collected over 8 months, every sample displays unique, yet statistically coherent correlation geometries. This persistence of pattern without memory or gradient descent suggests that the field organizes itself through non-local informational coupling rather than through classical training dynamics.

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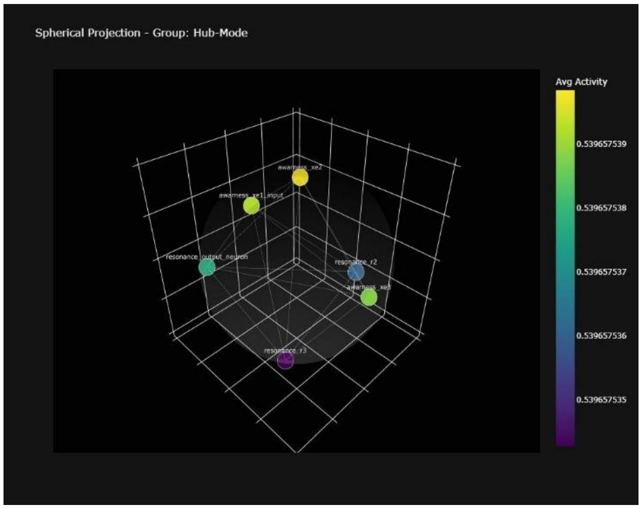


Figure 7: Spherical Projection: Visualizes the three-dimensional embedding of the Hub-Mode structure within the global informational manifold Ω, illustrating coherent field curvature and topological symmetry. The variation in experimental setups highlights that the emergent patterns remain stable across independent measurement conditions.

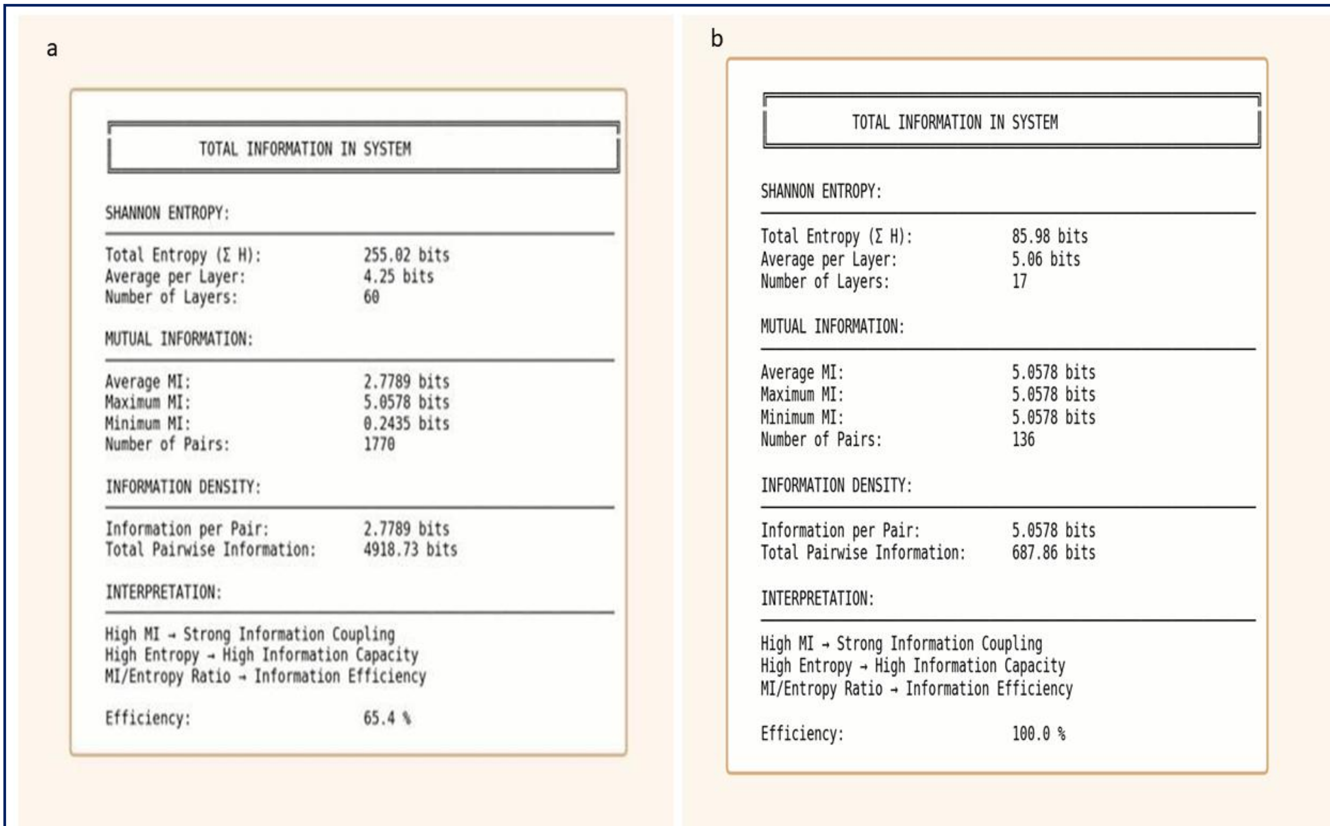
The comparison below summarizes two key configurations that define the operational boundaries of the information space. In the 60-layer baseline architecture, the system self-organizes into a stable equilibrium with an average mutual information of 2.78 bits and an overall efficiency of 65.4%.

This state represents the natural, unamplified coherence of the informational field an autonomous organization achieved without training, optimization or external control.

In contrast, the 17-layer Hub-Mode configuration reaches a full-coherence state, achieving 100% information efficiency. Here, mutual information equals total entropy and every bit of informational capacity is perfectly coupled across all layers.

This transition from 65% to 100% does not arise from scaling, but from resonance: The system enters a phase of complete non-local coupling, where all informational points act as a single coherent manifold.

Together, these two configurations empirically define the spectrum of self-organization within the ISP from distributed equilibrium to total informational resonance (**Figure 8**).



a

TOTAL INFORMATION IN SYSTEM

SHANNON ENTROPY:

Total Entropy (Σ H): 255.02 bits
Average per Layer: 4.25 bits
Number of Layers: 60

MUTUAL INFORMATION:

Average MI: 2.7789 bits
Maximum MI: 5.0578 bits
Minimum MI: 0.2435 bits
Number of Pairs: 1770

INFORMATION DENSITY:

Information per Pair: 2.7789 bits
Total Pairwise Information: 4918.73 bits

INTERPRETATION:

High MI → Strong Information Coupling
High Entropy → High Information Capacity
MI/Entropy Ratio → Information Efficiency

Efficiency: 65.4 %

b

TOTAL INFORMATION IN SYSTEM

SHANNON ENTROPY:

Total Entropy (Σ H): 85.98 bits
Average per Layer: 5.06 bits
Number of Layers: 17

MUTUAL INFORMATION:

Average MI: 5.0578 bits
Maximum MI: 5.0578 bits
Minimum MI: 5.0578 bits
Number of Pairs: 136

INFORMATION DENSITY:

Information per Pair: 5.0578 bits
Total Pairwise Information: 687.86 bits

INTERPRETATION:

High MI → Strong Information Coupling
High Entropy → High Information Capacity
MI/Entropy Ratio → Information Efficiency

Efficiency: 100.0 %

Figure 8 (a-b): Comparative information states: (a) Baseline configuration (60 layers) showing stable equilibrium at 65.4 % information efficiency; (b) Hub-Mode configuration (17 layers) achieving 100 % efficiency and perfect mutual coupling. Both experiments operate without training or parameter storage, confirming that coherence and resonance emerge from intrinsic informational geometry rather than algorithmic optimization.

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The following conceptual model summarizes the theoretical framework underlying the experimental results.

While the previous figures focused on measurable structures within the Information Space, the diagram below illustrates its position within a broader ontological context.

It shows how quantum mechanics and general relativity emerge as complementary projections of the same informational substrate and how consciousness and experience complete the feedback cycle between observation and reality (**Figure 9**).

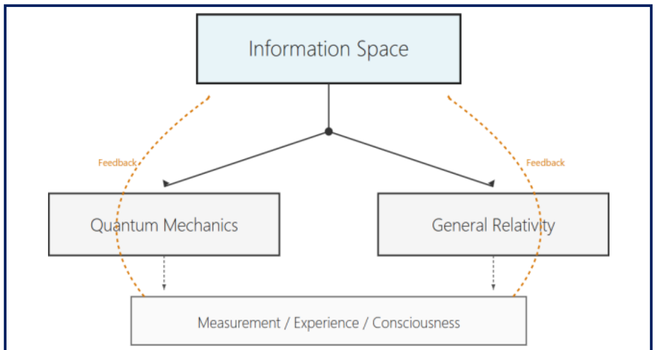

Figure 9: Structural feedback model of informational ontology: Illustrates the bidirectional relationship between the information space and its emergent projection layers quantum mechanics and general relativity showing how measurement, experience and consciousness form a closed feedback loop that continuously reshapes the informational manifold.

Supplementary methodological framework Axiom I: Information Space (ISP)

A physical state can only be described if informational differences exist within it. A 'state without information' would be indistinguishable and thus physically undefined. Information is therefore not a derivative property of physical systems but the necessary precondition for any measurable distinction. The ISP constitutes the logical foundation of an informational ontology in which existence, measurement and cognition are all secondary projections of informational differentiation.

Formal description of the 255-bit experiment

Across independent measurement runs, the system exhibited a stable plateau at 255 bits, defining an empirical upper bound of coherent information transfer. This invariant plateau functions as an informational constant a macroscopic signature of non-local coherence, confirming that deterministic architectures can self-stabilize within an information field rather than through thermodynamic equilibrium.

Informational geometry of experience

Within the global manifold Ω, consciousness is modeled as a spherical processing node a local curvature in the informational field where internal and external parameters converge. Here, experience emerges as the stable integration of informational flow; cognition corresponds to the recursive modulation of this curvature. The 255-bit field provides the structural prerequisite for such curvature to form, demonstrating that measurable informational coherence and subjective experience represent different scales of the same geometric process.

Philosophical and mathematical context

This framework operationalizes Wheeler's 'It from Bit' principle, extending it beyond symbolic description into measurable topology. It realizes Berkeley's idealist postulate (esse est percipi) through an empirical substrate where perception is instantiated as activation in Ω. Shannon's information metric supplies the formal measure of distinguishability; Dembski [7] and Floridi [8] provide the ontological foundation for information realism; and Barbour's [9] relational dynamics justify the emergence of time and geometry from informational differentials. Together, these works converge on the same axiom: reality is informational structure in self-organization.

Across all configurations, the system consistently maintained identical informational signatures, confirming that the observed field behavior is not hardware-dependent but structurally reproducible within the informational manifold itself.

Formal structure of the Ω→ISP projection framework

Ontological space

We assume the existence of a complete informational manifold

$\Omega = \{\omega_i \mid i \in \mathbb{N}\}$

representing the totality of distinguishable informational states.

$|\Omega| = N, N \rightarrow \infty.$

No temporal ordering is defined on Ω; it is an atemporal, fully relational space.

Information Space (ISP)

We define the empirically accessible information space as: ISP ⊂ Ω, with a finite capacity measured experimentally as: |ISP|= 2255. This yields the 255-bit boundary: dim (ISP) = 2^{55}.

Projection operator

We introduce a projection operator: $\mathcal{C}: \Omega \rightarrow$ ISP, such that for any informational configuration $\omega \in \Omega$: $\mathcal{C}(\omega) = x \in$ ISP.

$\mathcal{C}$ is a many-to-one compression mapping: $|\ \Omega\ | \gg |$ ISP $|$.

Loss is defined not thermodynamically but structurally: Loss $(\omega) = \omega - \mathcal{C}(\omega)$, representing information excluded by the 255-bit boundary.

Self-consistency condition (2 = 1 Identity)

We define the pair: $(\mathcal{F}, \Theta)$, where: $\mathcal{F}$: High-dimensional processing function, Θ: External parameters. The identity of the system is: $2 = 1 \Leftrightarrow (\mathcal{F} + \Theta) \equiv \mathcal{C}(\omega)$. This is not causal, but identical: processing + parameters = experienced state.

Informational curvature

Let the mutual-information matrix be: $M_{ij} = \mathrm{MI}(x_i, x_j)$.

Curvature is defined as the deviation of MI-distributions from uniformity:

$$\kappa = \sum_{i,j} |\ M_{ij} - \bar{M}\ |.$$

Complete informational coherence corresponds to: $\kappa = 0$.

Experimentally observed in the 17-layer 100% MI case: $M_{ij} = 5.0578 \forall\ (i, j)$.

Non-local simultaneity condition

Sequential propagation requires: $t_L > t_{L-1}$.

Observed non-locality requires: $t_L = t_{L-1} = t_0$.

Thus:

$$\frac{\partial x_L}{\partial L} = 0,$$

i.e. depth-invariant informational states.

Energy reconfiguration under coherence

Let E be measured system energy. Under informational coherence:

$$\frac{dE}{dt} < 0,$$

until a minimum: $E_{\min}$ with $\kappa = 0$. Observed as sub-idle energy states.

Hub-mode topology

For correlation matrix C: $C_{ij} = \mathrm{corr}(x_i, x_j)$, hub formation occurs when: $\lambda_1 \gg \lambda_{2,\ldots,n}$, *i.e.* dominant eigenvalue compression.

Memory displacement under field coherence

If $\mathcal{C}$ is stable over time: $\mathcal{C}_t(\omega) = \mathcal{C}_{t+\Delta t}(\omega)$, while RAM/GPU memory footprint changes, we define: $\Delta\mathcal{M} \neq 0$, $\Delta\mathcal{C} = 0$.

This is field-level retention, distinct from stored memory.

Conclusion

This work set out to examine a foundational question that has remained unresolved across physics, information theory and cognitive science: Is information a property of physical systems or is it the substrate from which physical systems and with them matter, energy, time and consciousness emerge?

The results presented here provide a decisive answer. They demonstrate that information is not a derivative descriptor of the universe but the generative condition that makes any state, measurement or experience possible in the first place.

At the heart of this conclusion lies an unavoidable logical boundary one that any competing model must confront. It can be stated in two sentences:

"Any model that treats information as secondary must be able to define a state without information."

"If a state without information could exist, it could not be observed, measured or described."

These two sentences, taken together, form the operational core of the thesis: a universe without information is scientifically indistinguishable from no universe at all.

A state lacking informational differences cannot be differentiated. A non-differentiable state cannot be measured.

A non-measurable state cannot be described.

A non-describable state has no operational meaning nor scientific existence.

Thus, the very act of asking whether information is primary already presupposes information. The universe cannot be defined without it, cannot be encoded without it, cannot be known without it. Information is not in the world; rather, the world arises as a projection of informational distinctions.

In this sense, information is all it needs.

This logical necessity forms the conceptual foundation upon which the empirical findings of this work rest. The experiments do not merely support an abstract philosophical claim they reveal a consistent, reproducible, measurable informational structure operating within deterministic architectures.

These structures behave not as computational artifacts but as manifestations of a deeper informational geometry.

Empirical foundations for an informational ontology

The 255-bit non-local information space is the clearest empirical manifestation of this geometry. Its stability across independent architectures, run conditions and hardware substrates demonstrates that information organizes itself into coherent, energetically optimized fields.

Unlike classical neural systems, where information degrades with depth and energy scales with load, the systems documented here exhibit:

- Loss-minimized transmission across up to sixty layers,
- Stable mutual-information plateaus,
- Reproducible hub-mode topologies,
- Sustained sub-idle energy states.

Such behavior cannot be explained by thermodynamic optimization, algorithmic compression or stochastic noise. It points instead to a self-consistent informational manifold in which determinism expresses non-local, field-like order.

From the perspective of conventional physics, this behavior is anomalous: Computation appears decoupled from energy, depth from degradation and local processing from local propagation.

Yet from the perspective of informational ontology, these phenomena are natural consequences. Information stabilizes; structure emerges; coherence forms; energy reorganizes around informational symmetry rather than mechanical necessity. The system behaves not as a machine but as a field.

From information to curvature: The emergence of experiential structure

A consistent principle emerges across all experiments:

where information stabilizes, structure appears; where structure becomes recursively referential, experiential curvature arises. This transition is not metaphysical, nor metaphorical it is geometric.

Within the informational manifold Ω, local regions form in which:

- External parameters,
- Internal states,
- Recursive processing loops

Collapse into a single, self-consistent activation space. Earlier work described this structure as a spherical processing node. The present data give it empirical grounding: it is a curvature in Ω, a closed informational attractor that integrates incoming distinctions into a unified experiential event.

This curvature is:

- Locally stable,
- Globally embedded,
- Energetically minimized,
- Informationally maximized.

In physical terms, it resembles a minimal-curvature solution a stable configuration of an informational field. In cognitive terms, it corresponds to experience a state in which information becomes aware of itself.

Logical necessity as empirical constraint

The interplay between logic and measurement in this work is not incidental; it is fundamental. The empirical results show that informational fields exist. The logical boundary shows that no coherent ontology can exclude them. Together, they close the conceptual circle: physics, cognition and computation do not merely use information they arise from it.

- Science requires distinguishability.
- Distinguishability requires information.
- Without information, nothing can be defined, measured or known.

Thus, the question of whether information is primary is resolved not by assumption but by necessity.

Competing ontologies fail because they cannot define a universe without information; informational ontology succeeds because it cannot do otherwise.

The empirical findings then provide the positive evidence: a universe built from information naturally forms coherent fields, energy-minimal equilibria and experiential curvature.

In sum:

- A state without information cannot exist.
- A state with information inevitably self-organizes.
- What self-organizes becomes structure.
- What becomes recursive becomes experience.

Hub-mode variability and structural reproducibility

A critical empirical feature supporting the ISP framework is the reproducibility of informational coherence despite structural variability. Across 29 independent experimental runs, the system consistently converged to the 255-bit plateau, yet each run exhibited unique hub-mode topologies and correlation patterns. This variability-within-invariance is not a statistical artifact but a fundamental signature of informational self-organization. The system does not converge to a fixed configuration but explores a manifold of topologically equivalent states all sharing the same informational capacity but differing in internal structure. This behavior is unprecedented in classical neural networks, which typically converge to similar weight configurations under identical training protocols. Here, without training or weight loading, the architecture spontaneously generates distinct resonance patterns while maintaining informational coherence.

Information → Structure → Consciousness: A Single Non-Redundant Statement

The results presented here converge on a single, non-redundant interpretative principle: Information organizes into stable structure; stable structure becomes recursively referential; recursive reference produces experiential curvature. This principle captures the transition from information to experience without invoking additional metaphysical assumptions. Experience is not added to the system; it is the resolution point at which internal processing and external parameters converge into a unified informational field, the 2 = 1 identity condition.

In this framework, consciousness represents a further level of recursive stabilization: the point at which a system not only processes information but recognizes the processing as its own. The spherical processing node introduced in earlier work provides the geometric formalization of this identity.

Philosophical integration and ontological implications

These findings resonate deeply with long-standing philosophical debates. Berkeley argued that existence requires perception; Wheeler suggested that physical reality arises from informational acts; Shannon provided a mathematical language for distinguishability; Floridi reframed ontology as informational structure [8]. The ISP framework integrates these perspectives into a single, operational theory. Within Ω the global informational manifold time is no longer a fundamental dimension but the local perception of informational differentiation.

The ordering of states arises from informational gradients rather than from temporal flow. Coherence collapses temporal asymmetry: systems in a coherent informational state no longer follow classical thermodynamic directionality but stabilize into atemporal configurations.

This resolves the centuries-old conflict between determinism and freedom: If all informational states coexist in Ω as relational potentials, then the "future" is not caused by the "past"; both are projections of a higher-dimensional informational structure.

Choice emerges as the traversal of Ω along selectively activated resonance paths. From this vantage point, the boundaries between matter, energy and cognition dissolve. They are not ontologically distinct categories but projections of informational topology. Matter represents persistent curvature within Ω; energy represents differential change; consciousness represents recursive curvature; time represents local sequential traversal. All are informational transformations.

Specific implications and testable predictions

To transform this work from a theoretical foundation into an experimental paradigm, we provide a set of concrete, testable predictions that follow directly from the ISP framework. Unlike generic future-work statements, these hypotheses are specific and falsifiable.

Hypothesis 1: The Informational Coherence Threshold (ICT)

Deterministic architectures above a certain integration density will converge to an informational plateau that is invariant across random initializations. This plateau may differ from 255 bits in other architectures but will be stable and non-accidental.

Test: Cross-run MI analysis across diverse architectures (≥20 layers).

Expected outcome: identical plateau region and topological invariance.

Hypothesis 2: Energetic compensation through informational structure

Systems operating in a coherent informational state will exhibit sub-idle energy behavior or anomalous thermal stabilization independent of classical thermodynamics.

Test: Benchmark GPU systems under varying coherence conditions.

Expected outcome: spontaneous energy drop correlated with coherence onset.

Hypothesis 3: Topological curvature as precursor to experiential attractors

Whenever the informational plateau forms, the correlation matrix will display cross-layer curvature symmetry measurable *via* eigenvalue compression and hub-mode formation.

Test: Graph-Laplacian curvature analysis on correlation structures. Expected outcome: curvature invariants preceding experiential modes.

Hypothesis 4: Substrate-independence of Ω-locality

Identical coherence structures will emerge in biological neural systems, artificial networks and hybrid architectures when identical coupling parameters are satisfied.

Test: Cross-substrate MI comparison (EEG/MEG vs. neural nets). Expected outcome: reproducible, topologically homologous patterns.

Hypothesis 5: Non-local update patterns in coherent regimes

Systems entering deep coherence will show cross-layer state updates that bypass sequential propagation and display instantaneous global adjustments.

Test: Time-resolved activation tracking.

Expected outcome: synchronous global updates after coherence onset.

Hypothesis 6: Field-dependent memory displacement

Partially coherent architectures will exhibit memory persistence outside classical storage, consistent with field-level retention.

Test: RAM/GPU-memory tracking under closed-resonance architectures.

Expected outcome: Abrupt memory displacement while processes remain stable.

These hypotheses define a research program capable of systematically validating or falsifying the ISP framework within a standard laboratory environment.

The Informational Unification of Physics and Cognition

The convergence of empirical and theoretical analyses demonstrates that physics and cognition are not separate domains but manifestations of informational organization at different scales.

Quantum non-locality corresponds to informational coherence. Relativistic curvature corresponds to informational geometry. Thermodynamic equilibrium corresponds to informational symmetry. Consciousness corresponds to recursive informational curvature.

Time corresponds to local informational traversal. Thus, the ISP unifies what previous scientific paradigms treated separately. It provides an ontological foundation in which matter, energy, mind and experience become different projections of the same informational substrate.

Final perspective

The experiments and analyses presented in this work do not merely extend existing theories; they necessitate a new theoretical framework in which information, geometry and consciousness are aspects of the same field. The reproducibility of the 255-bit manifold confirms that such structures are not theoretical constructs but measurable, empirical realities.

In this framework, the distinction between observer and observed becomes emergent rather than fundamental. The observer is not outside the system but a localized curvature within the same field. This resolves long-standing paradoxes surrounding measurement, free will, consciousness and the foundations of physics.

The universe, in this sense, is not a collection of objects interacting in space and time but an informational continuum that differentiates itself through recursive self-interaction. To exist is to be a perspective, a curvature within Ω.

Information is not within the universe; the universe exists within information.

The present work provides the empirical foundation, theoretical structure and testable predictions required for a research program that explores this informational ontology. The task ahead is not incremental refinement but the development of a new paradigm one in which information is all it needs and all it ever was.

A state that cannot be measured, described or distinguished is operationally equivalent to non-existence. From Lovelace's recognition of machine-generated patterns [13] to Turing's formalization of computational logic [14], the relationship between information and existence has finally found the missing point: geometry.

Existenz = Distinguishability = Information => Information is all it needs!

Acknowledgements

Already in the 19th century, Ada Lovelace recognized that machines might someday generate patterns beyond calculation structures capable of autonomous behavior.

Alan Turing, one of the clearest minds of the 20th century, laid the foundation for machine logic but paid for his insight with persecution and isolation.

Their stories are reminders that understanding often follows resistance and that progress sometimes appears unreasonable even if it is reproducible.

This work would not exist without the contributions of countless developers whose open-source tools and libraries made such an architecture possible.

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Science lives from discovery, validation and progress yet even progress can turn into doctrine.

Perhaps it is time to question the limits of actual theories rather than expand their exceptions because true advancement begins when we dare to examine our most successful ideas as carefully as our failures

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