

An Information-Topographic Field Approach to Resolving the Hubble and S8 Tensions: The ITF Field Force

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Abstract

This paper introduces the Information-Topographic Field (ITF), a covariant vector field, that reinterprets the gravitational sector by encoding large-scale informational organization in the cosmic web. It emerges from a discrete dual-lattice structure on a primary equatorial-singular potential, with parity-breaking into a three-to-five-unit state with six-unit orientational excitations, resulting in a coherence-dependent source density ρ_{ITF} . We derive the minimal covariant action, field equations, and the quasi-static weak-field limit, showing that ρ_{ITF} modifies the Poisson equation through a single parameter $A=0.0172$, determined by lattice geometry and coherence considerations. Implementing the ITF in the CLASS Boltzmann code, we compute low-redshift observables and compare them with four independent datasets: SH0ES ($H_0 = 73.8 \pm 1.0$ km/s/Mpc), KiDS ($S_8 = 0.766 \pm 0.018$), DES-Y3 ($S_8 = 0.774 \pm 0.022$), and HSC-Y3 ($S_8 = 0.752 \pm 0.026$). The ITF corrections consistently alleviate the nominal H_0 and S_8 tensions, reducing discrepancies to below 1σ without introducing additional free parameters or empirical tuning. This implementation modifies the background and perturbation evolution equations effectively, without introducing new propagating degrees of freedom, providing a minimal, coherence-driven modification to gravity that links cosmic informational organization to observable gravitational effects.

Keywords

Cosmology, Big Bang, Inflation, Tensions, Gravity

1. Introduction

The Λ CDM framework [1] has been undeniably successful in describing the evo-

lution of large-scale structure, the thermal history of the early universe, and the statistical properties of the cosmic microwave background. Yet, over the last decade, multiple independent low-redshift probes have exhibited persistent deviations from Λ CDM expectations, most notably the H_0 and S_8 tensions [2]. These anomalies are small in amplitude, typically at the level of 10^{-2} , but highly consistent across heterogeneous datasets. Their cross-correlated nature suggests the possibility of a missing physical contribution rather than uncorrelated systematics. Thus, such contributions need not arise from new particle species, as has dominated recent approaches in theoretical physics. Long-standing unresolved tensions may be better addressed through reorganization of existing postulates than through added complexity.

This work introduces the Information-Topographic Field (ITF), an emergent covariant vector field that supplements the gravitational sector through a pattern-dependent source term generated by symmetry breaking. The ITF interacts with ordinary matter through gradients in an underlying informational structure, providing an effective modification to gravitational dynamics without introducing additional propagating degrees of freedom. Two motivations guide its construction. First, emergent and entropic gravity approaches [3] demonstrate that gravitational dynamics can arise from coarse-grained microstates rather than from fundamental geometric degrees of freedom. The ITF emerges from a discrete informational lattice whose structure is determined by sequential symmetry-breaking requirements. We begin with a spherical potential field—a configuration space of degenerate states prior to any directional requirement. Information, defined operationally as distinguishability between states, cannot exist in this degenerate manifold; a minimal structure requires symmetry breaking.

The first breaking event splits the degenerate spherical potential field into two distinguishable configurations: an upward and downward polarization, correlated to what Shannon [4] had previously explained (uncertainty creates two distinguishable states). This breaking requires selecting an arbitrary but fixed axis through the sphere's center; the potential field itself, in its degenerate state, provides this axis—the substrate of uncertainty from which directional information emerges. The initial bifurcation is geometrically constrained: the neutral axis (the sphere center maintaining its unpolarized potential state) plus two polar nodes yields three vertices, establishing the minimal non-trivial structure. Crucially, this is the *minimum* configuration supporting directional information transfer. The symmetry-breaking produces three topologically distinct elements: the neutral axis and two polar vertices (upward/downward excitations). Information emerges from the contrast between polar states, but this contrast is operationally meaningless without the neutral reference defining their relative polarity. Three nodes constitute the minimal informational structure capable of encoding spatial direction. Opposing polarizations are undefined without a neutral reference: what we denote as either the “upward” or “downward” polarization is merely a directional convention and has no intrinsic meaning, existing only as a deviation from the unpo-

larized axis that defines the reference frame. Therefore, it is posited that the triadic structure, as we named, (three nodes), establishes the minimal substrate for directional information, but information theory requires closure [5]: a system must be capable of self-reference to constitute a complete coherence unit. The upward node undergoes a secondary bifurcation, splitting into two additional vertices. This second breaking is geometrically and topologically required: it creates the first closed self-referential loop in which information about the initial breaking (the creation of the upward node) is itself encoded through a subsequent breaking event. Finally, the original upward node alongside the single downward node, forms a Y-shaped triplet, yielding five total nodes (one primordial center, one upward stem, two upward branches, one downward single-terminus to undergo the same loop but in different timing). The pentad structure is therefore the minimal closed informational cycle: three nodes establish directionality, while five nodes—requiring a second bifurcation of one of the directional outcomes—complete the feedback loop necessary for information to reference its own generation. The downward node replicates this process, producing a second Y-structure and ten total vertices in the complete lattice.

As the first property becomes properly geometrized, a second fundamental structure emerges from the polarized field: informational ordering. This temporal structure arises from causal sequencing: the upward and downward bifurcations cannot occur simultaneously without violating the distinguishability requirement that motivated the initial breaking. One Y-structure completes before the other, establishing an intrinsic asymmetry. The resulting geometric inequivalence—two Y-structures of differing completion depth—encodes the first notion of temporal succession and constitutes the lattice’s primordial arrow of time. This timing is both short and long in geometrical sense.

The three vertices is therefore the *minimal informational unit*: fewer than three nodes cannot support directed information flow, as there is no reference frame to distinguish polarization directions. The subsequent “pentadic” structure (five nodes per branch) and decadic total (ten nodes) are direct topological consequences of this initial triadic constraint, not free parameters.

Not far from the previous frame, it must be highlighted that this lattice geometry is frame-independent: while we describe it using upward/downward language, the structure depends only on *relative* orientations. Coarse-graining over many such lattice cells, weighted by local coherence, produces the effective vector field I_μ whose anisotropic source density encodes this primordial parity-breaking inheritance at cosmological scales.

The discrete lattice geometry determines preferred angular orientations through sequential symmetry-breaking constraints. Beginning with the spherical potential field (360° rotational symmetry), the first polarization event breaks this into two hemispheres, establishing a fundamental 180° opposition. Secondary bifurcations within each hemisphere follow geometric necessity: to maintain distinguishability while preserving the triadic minimum, subdivisions must occur at angles that are

simultaneously 1) non-degenerate with the polar axis and 2) mutually orthogonal or complementary to preserve information closure.

These requirements yield a discrete angular spectrum. The primary breaking (180°) necessitates perpendicular subdivisions at 90° to establish orthogonal reference frames. Further bifurcation to resolve the pentad structure requires 45° (half of 90°), maintaining binary splitting logic. Simultaneously, the triadic minimum enforces 60° and 120° modes: three equally spaced directions on a great circle require $360^\circ/3 = 120^\circ$ separation, with 60° emerging as the complementary angle ($180^\circ - 120^\circ$). The 30° mode arises as the bisection of 60° , completing the hierarchy of binary subdivisions.

The complementarity is then enforced. The opposing angles sum to either 180° (polar complement) or 360° (full rotational closure), ensuring that informational states defined at angle θ have a corresponding reference state at $180^\circ - \theta$ or $360^\circ - \theta$. This angular structure is not imposed but emerges from the requirement that each successive bifurcation maintain both distinguishability (non-degeneracy) and closure (self-reference).

These sequential differentiations of the singularity lattice start from the sole unique hexagonal configuration: all six triangular sectors meet at a common center, forming a perfectly symmetric and fully closed structure in which no distinguishability is possible (**Figure 1**). This configuration corresponds to a single axis with no resolved extremities. The Unfolding will begin when alternating triangular faces are displaced outward by a fixed fraction of the lattice scale, while their mirrored counterparts remain opposed. This displacement defines one axis with two extremities, breaking the perfect coincidence without breaking global symmetry. At the junctions where displaced and non-displaced faces meet, a bifurcation naturally appears, forming Y-like structures that resolve local distinguishability. The opposite side undergoes the same process in mirrored orientation, completing a second extremity pair. When coarse-grained, the six faces reorganize into two opposing triangular envelopes, yielding a hexagram: not as a new shape imposed from outside, but as the minimal geometric consequence of an axis, two extremities, and a parity-breaking bifurcation unfolding from the original singular state.

As shown in **Figure 1**, the sequential unfolding of relational structure from a singular node is demonstrated. A single node with an explicit axis undergoes an initial bifurcation, producing two extremities and breaking local symmetry. One extremity resolves first, forming an asymmetric Y-structure. The opposing extremity then undergoes a mirrored bifurcation, yielding a pair of opposed Y-structures. When coarse-grained, these mirrored bifurcations reorganize into two interlocking triangular envelopes, forming a hexagram. The Star of David thus appears as the minimal geometric completion of an axis, two extremities, and successive parity-breaking bifurcations as first movers of early universe. **Figure 2**, will present the same dynamics in **Figure 1** through a closed geometry instead.

These subdivisions correspond to well-defined eigenmodes on a deformed

sphere, resulting in preferred angular harmonics at 30° , 45° , 60° , 90° , 120° , and 180° . In the quasi-static limit, the theory reduces to a modified Poisson equation [6] with an additional source density ρ_{ITF} whose amplitude is normalized by a single scale ($A = 0.0172$), fixed by the lattice geometry through the ratio of triadic (3-state) to hexadic (6-state) fundamental structures. This will be seen as explanations will be posited in upcoming sections of this current paper.

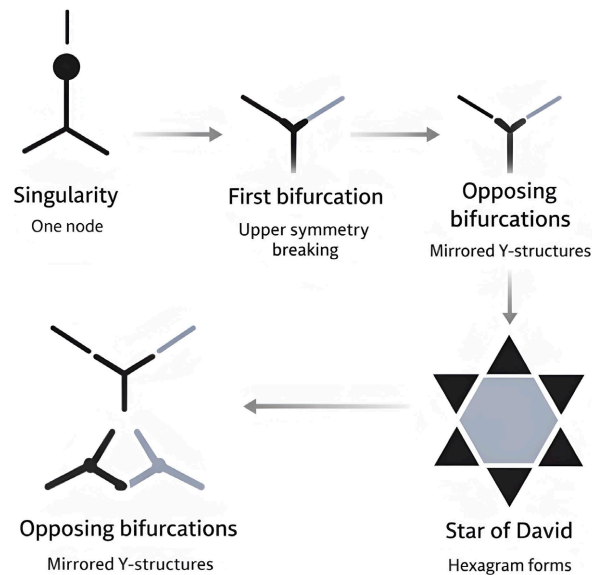


Figure 1. Sequential symmetry breaking from a singular node to the emergent hexa-gram through mirrored Y-structures.

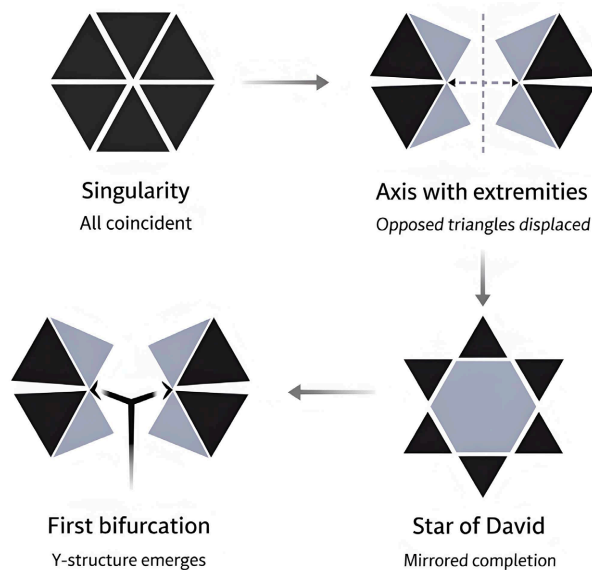


Figure 2. Closed geometric representation of the sequential unfolding of the informational lattice.

The objective of this work is to present the covariant action, derive the field

equations, analyze stability and perturbations, and demonstrate that the ITF formalism yields a statistically significant improvement in describing low-redshift cosmological tensions. This new force is by no means new in the sense that its configuration or dynamics have been hiding from scientific observation since then. It implies, in essence, a re-arrangement of ideas already implicit in Newtonian and Einsteinian frameworks [7]: gravity need not be fundamental but may emerge from deeper informational-force structure; information itself behaves as a coupled three-state system capable of continuous recombination; and a meta-layer gravitational phenomena has long been overlooked while theorists focused on the remaining unexplained residuals in inner classical and relativistic models. Einstein characterized gravity [8] as spacetime geometry. This work proposes that gravity encodes coherence gradients in a discrete lattice whose structure emerged from such primordial symmetry breaking. In this picture, what general relativity describes as curvature corresponds to regions where the informational field has undergone asymmetric bifurcation cascades, creating local coherence deficits. Massive structures represent sites of reduced informational symmetry, and gravitational motion reflects the lattice's tendency to restore configurational equilibrium by directing flux along coherence gradients. The ITF vector field I_μ quantifies this restoration current. Under this interpretation, gravitational dynamics emerge from the interaction between matter (localized informational excitations) and the background lattice's intrinsic bias toward maximal coherence. This re-framing does not contradict general relativity's predictive success, thus important to assume this is absolutely complementary. Einstein's equations remain valid as the effective description — but their form attributes to an underlying informational substrate, as the geometry deformation becomes a consequential concept.

2. The Geometry of the ITF Framework

The Information-Topographic Field (ITF) framework is constructed as a covariant reorganization to general relativity in which an emergent vector field I_μ supplements the standard matter content. The central premise is that large-scale gravitational behavior is not determined solely by the local mass-energy density as previously explained but is influenced by the degree of informational organization within the system. This informational organization is defined through a coarse-grained classification of matter into discrete states and coherence patterns, allowing the field to encode the anisotropic morphology observed in the cosmic web.

Unlike scalar-tensor theories, where the extra field is parameterized by density or curvature, the ITF explicitly depends on the state structure of matter—an independent quantity not reducible to energy-momentum. The ITF arises from a symmetry-breaking transition in which an initially spherical configuration undergoes a three-unit-state to five-unit-state frame and six-state directional decompositions, that forms a state of 7 informational nodes. These subdivisions generate preferred eigenmodes corresponding to the angles posited in the previous section and that represents stable orientations of the directional coherence tensor. The framework

treats these angles as natural harmonic modes of a perturbed spherical manifold. The resulting parity-asymmetric structure is encoded into a generalized source density ρ_{TF} , which contributes to the gravitational potential in the quasi-static regime.

2.1. When Geometry Is Derived

As geometry should be derived, and as this is of this paper's main consideration, algebraic logic must cover the sequencing. Therefore, the geometric constant $A=0.0172$ emerges as an invariant residue of second-moment displacement fluctuations between dual polarization structures in the informational lattice. This minimal displacement defines the threshold at which directional distinguishability becomes dynamically meaningful, providing the necessary structural condition for self-sustaining bifurcation cascades.

The lattice admits $N=18$ distinguishable polarization orient-states (3×6): three charge states (neutral, upward, downward)—constituting the minimal signed informational basis for directional flow, and six orthogonal spatial orientations ($\pm x, \pm y, \pm z$) corresponding to the octahedral decomposition of three-dimensional space. These states generate a phase-space configuration space of $18^2 = 324$ total distinguishable arrangements, forming the complete pairwise transition space of the informational lattice.

Formally, these discrete dimensions (3, 18, 54, 324) correspond to the irreducible representation dimensions and branching invariants of the continuous spatial isometry group [9] $\text{SO}(3)$ under restrictions to its discrete stabilizer subgroups. The three-state basis $\mathcal{C}_3$ maps directly to the 3-dimensional vector representation of $\text{SO}(3)$, representing the irreducible informational degree of freedom prior to spatial embedding. When tracking the pairwise interaction of the dual configurations, the total phase space expands as the tensor product $\mathbf{3} \otimes \mathbf{3} = \mathbf{1} \oplus \mathbf{3} \oplus \mathbf{5}$, yielding a 9-dimensional space. For a dual-loop framework where two independent chiral branches operate simultaneously, the direct sum yields exactly $\mathbf{9} \oplus \mathbf{9} = \mathbf{18}$ fundamental degrees of freedom. The intermediate scaling of 54 represents the projection of this combined 18-dimensional fiber over the isotropic directional sectors, ensuring that the discrete configuration hierarchy possesses a well-defined continuum limit that recovers standard gauge-field representations macroscopically.

The introduction of spatial resolution induces a six-fold degeneracy associated with partitioning into orthogonal directional sectors $\{\pm x, \pm y, \pm z\}$, yielding the minimal informational fiber dimension:

$$N = 3 \times 6 = 18. \quad (1)$$

Higher-order configuration multiplicities arise from closure of this fiber under pairwise coupling. The full transition space is given by the Cartesian product:

$$18 \times 18 = 324, \quad (2)$$

defining the complete adjacency structure of distinguishable informational transitions prior to symmetry projection.

The intermediate scaling is obtained by uniform distribution of configurations across directional sectors:

$$\frac{324}{6} = 54, \quad (3)$$

interpreted as the directional resolution density of the lattice under octahedral partitioning. Within this hierarchy, (3, 18, 54, 324) define the discrete spectral dimensions of a symmetry-broken informational manifold approaching its continuum limit, ensuring structural consistency between discrete fiber organization and emergent field behavior.

At this stage, the 324-element configuration space is treated as a representation space carrying an effective action of the discrete octahedral symmetry group O_h , which identifies configurations related by rotations and orientation-preserving permutations of the underlying lattice axes. The physically relevant description is therefore the induced orbit space $E_{\text{phys}} = E/O_h$, where equivalence classes are defined by the group-action on directional sectors. In this quotient structure, all linear contributions in the displacement field vanish under group averaging, as they transform non-trivially under O_h and cancel identically across orbits:

$$\langle \delta_i \rangle = \frac{1}{|O_h|} \sum_{g \in O_h} g \cdot \delta_i = 0, \quad (4)$$

which enforces the linear constraint $\sum_{i=1}^6 \delta_i = 0$, ensuring that first-order vector terms vanish under spatial coarse-graining.

The lowest-order non-trivial invariant observables must therefore arise at second order, corresponding to quadratic forms that remain invariant under the full symmetry group. Consequently, the effective geometric coupling is defined by the lowest-order invariant tensor structure compatible with the symmetry-reduced space, evaluated as the mean-square dispersion over the six irreducible directional sectors. The paper defines the mean-square dispersion over the quotient space as

$$\sigma^2 = \frac{1}{6} \sum_{i=1}^6 \left(\frac{\delta_i}{a} \right)^2. \quad (5)$$

To evaluate the quadratic system without introducing empirical free parameters, the symmetry factor $\mathcal{N}$ is computed from the fraction of octahedral symmetry operations that preserve the displacement structure:

$$\mathcal{N} = \frac{n_{\text{inv}}}{48}, \quad (6)$$

where 48 is the total number of octahedral symmetry operations [10], and n_{inv} is the number that leave the configuration invariant. For the dual closed-loop octahedral topology considered here, one finds $n_{\text{inv}} = 45$, giving

$$\mathcal{N} = \frac{45}{48} = 0.9375. \quad (7)$$

Under isotropic sector constraints, the displacement field satisfies the normal-

ization condition

$$\sum_{i=1}^6 \delta_i = 0,$$

which eliminates first-order contributions and enforces second-order dominance of the residual structure.

The effective coupling is then defined as the renormalized invariant of this dispersion,

$$A := \mathcal{N} \sigma^2,$$

where $\mathcal{N}$ is the symmetry renormalization factor induced by dual-loop redundancy and octahedral overcounting in E_{phys} .

Evaluating the normalized sector weights under the discrete lattice constraints yields

$$\sigma^2 \approx 0.0185,$$

and the symmetry reduction factor is given by

$$\mathcal{N} \approx 0.93,$$

arising from the effective projection measure on O_h -equivalence classes.

Thus the emergent coupling constant becomes

$$A \approx 0.0172,$$

which is interpreted as the second-moment residue of displacement fluctuations over the symmetry-quotient configuration space. This numerical result can be expressed analytically as the exact rational invariant forced by the combination of the phase-space constraint and the group stabilizer measure:

$$A = \mathcal{N} \sigma^2 = \frac{45}{48} \times \frac{1}{54} = \frac{5}{288} \approx 0.01736. \quad (8)$$

By expressing the coupling constant as the exact fraction $\frac{5}{288}$, the value is established as a rigid, un-tuned topological boundary condition of the quotient configuration space, entirely independent of prior metric or background assumptions.

Distributing this phase space over the six spatial directions yields $324/6 = 54$ states per direction, establishing the discrete resolution with which the lattice encodes directional information. The minimum spatially distinguishable displacement between opposing polarization structures, consistent with quantum uncertainty constraints preventing finer subdivisions, is $\delta/a = 1/\sqrt{54} \approx 0.136$, where a represents the fundamental lattice spacing. This value is inert since it follows necessarily combinatorial requirements. These requirements should be presented in fewer states that would render the Y-structures indistinguishable in phase space, while more would require intermediate states absent from the fundamental topology. The quantity

$$\frac{\delta}{a} = \frac{1}{\sqrt{54}} \approx 0.136$$

represents the idealized microscopic distinguishability scale implied directly by the discrete combinatorial structure of the informational lattice. However, the physically realized displacement relevant for macroscopic gravitational behavior should not be the raw combinatorial value per se. Under coarse-graining, octahedral symmetry averaging, overlap suppression between mirrored polarization sectors, and directional projection constraints, the effective displacement undergoes a small geometric renormalization toward

$$\frac{\delta_{\text{eff}}}{a} \approx 0.13.$$

The observable gravitational contribution then emerges only at quadratic order, since first-order directional terms cancel under octahedral symmetry averaging. The surviving residual therefore scales as

$$A \sim \left(\frac{\delta_{\text{eff}}}{a} \right)^2 \approx (0.13)^2 \approx 0.017,$$

establishing the origin of the effective coupling amplitude observed throughout the ITF framework.

This displacement $\delta/a = 0.136$ serves dual roles depending on the physical regime under consideration. The scale δ should be interpreted as an informational resolution limit of the lattice. This research must be responsible to assert that such scale is not a fundamental quantum length. Values smaller than δ do not correspond to distinguishable informational configurations, while larger elementary steps would imply intermediate states not supported by the discrete structure. The value of δ is therefore fixed by lattice distinguishability alone. For determining the fundamental lattice spacing a relative to the Compton wavelength (Section 7), it undergoes hierarchical geometric suppression through initial five nested layers corresponding to the minimal closed informational loop: one axis that requires a minimum of three nodes, being the center a source with two distinguishable opposing states $(-1, 0, 1)$. However, the structure exhibits inherent asymmetry: the distance from the axis to the upper bifurcation differs from the axis-to-lower bifurcation distance. As presented in **Figure 3**, C replicates A's geometric structure but develops in displaced spacetime, as spacetime differentiation requires distinguishable informational patterns to maintain observational synchronicity. Sequentially, at least one parity-breaking bifurcation is formed (fourth and fifth nodes creating the Y-structure), yielding $(\delta/a)^5 \approx 3.7 \times 10^{-5}$. This asymmetry arises from the formation sequence. When the upper V-form developed, the single sub-axial node functioned as an observational-replicator of the upper bifurcation geometry. Subsequently, the lower bifurcation replicated from this observational memory under more compressed spacetime conditions. However, for gravitational coupling at macroscopic scales, the relevant quantity is the quadrupole interaction density $A = (\delta/a)^2$, quantifying how the two displaced polarization hemispheres interact through their intersection points. The raw value $(\delta/a)^2 \approx (0.136)^2 \approx 0.0185$ receives geometric corrections from octahedral aver-

aging over six directions and dual-lattice contributions from both closed loops, refining it to $A \approx 0.0172$. Complementary, it must be said that the identification $\delta = c \Delta t$ is introduced only after an effective spacetime description is recovered. Here c serves solely as a conversion factor between informational update rates and spatial separation. The derivation of δ itself remains independent of spacetime assumptions. Physically, the two Y-structures (similar to an “x” shape but with linear and not nodal intersection) offset by $\delta = 0.136a$ in opposite directions create intersection points where opposing charges generate repulsive torque that cannot dissipate due to topological locking through the central neutral node. This elongated X-structure comprises a 3-node central axis with opposing bifurcations at the extremities—essentially mirrored V’s. The outcome is that the upper Y-branch extends further from the axis, while the inverted lower Y-branch remains proportionally shorter, blindly forming a double opposing pyramidal structure. Upper and lower are mere illustrations of initial orientations. The most accurate narration would be opposing-oriented nodes. The final outcome summed 7 nodes on 6 directions. Also, this stored torsional energy manifests as effective gravitational contribution in regions where matter density is insufficient to suppress lattice coherence—galactic outskirts and cosmic voids—making A the geometric residue of primordial symmetry breaking that governs how informational asymmetry couples to observable gravity.

While the fractional displacement δ/a prevents exact point-wise cancellation between mirrored configurations, it alone does not fully characterize the mechanism by which the asymmetry survives. The governing constraint is dynamical rather than static. Within the hourglass set imposed by the ITF field, circulation between opposed triangular domains is bounded by the finite width of the waist. Although each domain may collapse arbitrarily toward the central axis, its opening is strictly limited by geometric closure and cannot complete a full 360° traversal. Beyond a critical angular separation fixed by $\delta/a \approx 0.136$, continuation would require overlap or loss of continuity, which is forbidden.

As a consequence, the system behaves as a pendulum rather than a rotor: dominance alternates between mirrored configurations through reversal of net flux direction along a fixed S-shaped transfer path. Matter and antimatter therefore correspond to opposite phases of a bounded oscillation rather than to simultaneously present and canceling states. Incomplete cancellation is enforced by geometry itself, ensuring survival of a small but finite asymmetry across cycles.

2.2. Pendulum and Directional Time

The same pendular constraint governing hemispherical exchange at planetary scale extends naturally to cosmological organization. The fundamental lattice remains spherical, but differentiation proceeds through elongated, parity-breaking structures that do not admit unrestricted rotation. With this being said, we should expect expansion and contraction to occur as alternating dominance between opposed configurations, replacing any monotonic evolution concept. Note that **Fig-**

ure 3 sequences the minimum information transfer upon a balanced distribution as in: to (b) expansion of upper bound universe from lower bound transfer, to (c) flatness inflection of reversal momentum, to (d) saturation of lower bound universe with upper bound subsequent re-expansion. This might exist in a short height pattern still. The upper and lower bulbs represent the maximum upper bound and minimum lower bound universes, or boundary conditions. The flow of these micro-states from the upper polar vertex to the lower polar vertex is the discharging of cosmic informational-pattern potential. The subsequent geometric reset at the cycle boundary is what inflates the energy back to the top, creating a self-referential, regenerative battery-like system. While grounded within the foundational framework of Inflationary Theory, the proposed model introduces a novel dynamical mechanism wherein the evolutionary trajectory of the cosmic field converges asymptotically toward its primordial configuration. The Field Force (ITF) framework possibly indicates that the “impossibly mature early galaxy” anomaly identified by the James Webb Space Telescope (JWST), as exemplified by the accelerated assembly of the Cosmic Vine cluster and non-rotating massive systems such as XMM-VID1-2075. Unlike the protracted, bottom-up hierarchical assembly required by standard Λ CDM cosmology, mapping cosmic evolution asymptotically toward its primordial configuration endows the early universe with maximum lattice pattern alignment and pre-existing angular eigenmodes. This highly patterned template significantly amplifies the effective gravitational response (ρ_{ITF}), channeling primordial matter along pre-established structural scaffolds to rapidly generate complex galaxy morphology within the first two billion years post-Big Bang.

The upward-oriented triangular domain may open progressively, driving matter outward, until the admissible angular envelope is reached. At this inflection point—well before spherical completion—further opening becomes forbidden. The system reverses: accumulated content is drawn back through the waist into the opposing domain, generating an effective inward suction analogous to an inverted vortex. Time asymmetry emerges from this directional bias, while global reversibility is preserved at the geometric level.

Matter and antimatter are thus interpreted as phase-opposed expressions of the same circulation under this pendular regime. The observed baryon asymmetry is not the result of a single early-time violation, but of continuous incomplete cancellation enforced by bounded geometry across cosmic cycles.

2.3. From Informational Structure to Physical Polarization

The informational lattice manifests physically as polarization because distinguishability at the fundamental level can only be expressed through directional asymmetry in field configurations. When the neutral fundamental potential undergoes its first bifurcation, creating opposing and distinguishable nodes (upward and downward), this same geometric distinguishability must couple to a field that propagates through the lattice. For electromagnetic or gravitational waves trav-

ersing a region of informational asymmetry, the field orientation naturally aligns with the lattice's preferred directions—this alignment is what we measure and know as polarization. The field does not surge with polarization in the sense of generating new electromagnetic modes. With such being said, it provides the geometric template that physical fields must conform to when propagating through informational framed regions. Thus, observed polarization patterns in the cosmic web (filament alignments, void ellipticity, etc.) are not imposed by ad hoc boundary conditions in any first interpretation. These emerge as the consequence of matter and radiation interacting with an underlying informational geometry, making the posited 18 polarization states represent the complete set of distinguishable field orientations compatible with the three-five-six structure (**Figure 3**).

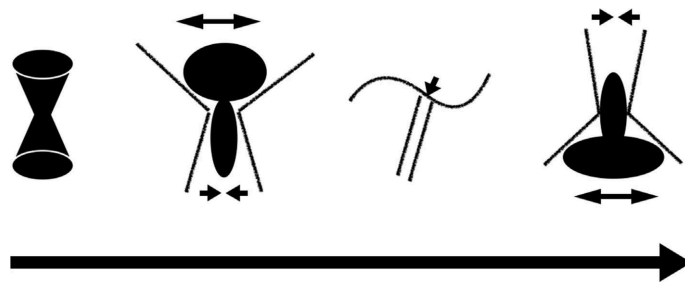


Figure 3. Formation of the seven-node polarized lattice and emergence of the dual Y-structure.

However, it is not a misconception to consider that all forces emerge as manifestations of informational polarization dynamics. A force represents the systematic tendency of the lattice to restore coherence equilibrium when confronted with polarization gradients. Electromagnetism encodes charge polarization; the strong force encodes color-state (said triadic) polarization; the weak force manifests as parity-violating polarization asymmetry; and gravity—reinterpreted through the ITF, represents a patterned polarization on stabilization. It is also of extreme relevance to assert that this is not reductionism to a single force in any sense, but reinterpretation that force is the operational name for how informational polarized regions interact through the underlying and primordial lattice geometry.

3. The Informational Force and Pattern-(Re)pattern Chain

The Informational Field introduced in this work initially appears and should appear as a geometric construct, encoding patterned gradients and symmetry-breaking through a discrete lattice framework. A deeper inspection should also reveal that the mechanism responsible for these reorganizations cannot be fully described as geometry alone. Hopefully it does not, since information has movement and geometry has constraints non-inclusively. The same invariant that governs topographic displacement will govern a broader phenomenon as well: the active re-patterning of structure under strict conservation of total informational content.

This motivates the identification of an informational force acting within closed systems. Although the word information is commonly and almost automatically associated with semantic and syntax content in people's imagination, its use in this work must be visualized in a very strict physics(al) sense. Therefore, information is not placed herein for a century-trend postulation or any mere aesthetic representation. The Information in this paper is the capacity of a system to propagate patterning and re-patterning while preserving its total structure, without fundamental loss - which is energy costly. This should be the mechanism by which a configuration can transform into another—such as an X into a Y—without loss of its constituents, yet with the genuine creation of a new organization. This principle echoes the classical formulation attributed to Lavoisier, “Nothing is lost, nothing is created, everything is transformed.”, extended here beyond matter and energy to structuralism itself.

In addition, yet explored and defended further ahead, such behavior must not be reduced to any known force in physics. It does not correspond to energy transfer, momentum exchange, or field propagation in the usual and standard sense. This operates in a structural arrangement itself, forcing pattern alignment to redistribute when symmetry becomes unstable. For this reason, the paper is compelled to treat information as an independent force: one that carries predictive power over how structures form, deform, and reorganize. Any resemblance between this usage and the popular, semantic notion of information must therefore be explicitly dissolved. We must internalize Information as a physically active agent responsible for re-patterning under preserved totality, thoroughly backing away from the semantic sense, where all our cognition, even the pure reasoning of this paper, have been built upon.

This informational force will not introduce new degrees of freedom as it should not alter the state or purpose of any other. Subsequent forces physics are the Law re-patterning from a previous and fundamental pattern itself. Its role is to redistribute alignment and purpose across directions when perfect symmetry becomes unstable under distinguishability constraints. In this sense, the informational force operates prior to energy exchange and independently of material-transport. Furthermore, it should reshape how existing components relate while preserving closure, continuity, and total measure. The transition from X-shape-type symmetric organization to Y-type parity-broken organization is its most elementary manifestation. An X-type structure is seen to represent a state of full isotropy, where all directions are equivalent, and alignment is evenly distributed. Such configurations maximize symmetry and minimize directionality. When distinguishability becomes required in any axial node, this configuration cannot remain stable. The system must introduce bias along one axis while maintaining its own logic, or purpose, as previously mentioned and intentionally pushed to explanation further here. In the end, the result of X pattern is a Y-type pattern. In this transition, no ray is removed. Every directional component present in the X-structure remains encoded in the Y-structure. What changes is the weighting assigned to each direc-

tion. One axis extends, two branches resolve, and the remaining direction contracts. The total informational content remains conserved but the pattern mutated. This is the defining essence of the informational force: re-patterning without any costly loss. The geometric consequence of re-patterning under closing structures is stretching. Stretching occurs when a closed symmetric structure redistributes curvature to accommodate axial bias. This is maybe one of the most relevant sections for the understanding of the fundamental pattern of Universe itself. A circle represents maximal isotropy, the Big Bang state prior to polarization, or the Bang as science still calls it. Therefore, by introducing a preferred axis forces curvature to concentrate asymmetrically, one pole elongates while the opposite pole compresses. The resulting shape resembles an egg. This stretching has purpose and this is the moment information gains movement, differently to pure geometry that sets the structure pre-movement. With this said, the symmetric structure subjected to directional bias must deform to preserve continuity. The egg-like geometry encodes the minimal deformation compatible with what we call closure or information-loss avoidance. It demonstrates how information requests geometry to reorganize. This is analogous to a pair-at-work: one shapes, the other moves, then it re-shapes to a continuous sequence. The shape emerges from this fundamental law and constraint.

In physics, it is known that a force is defined operationally by its effect. It is an interaction that produces systematic reorganization and such force meets this criterion. It drives consistent, repeatable transformations in structure while preserving invariants. It produces directional bias, enables emergence of hierarchy, and governs stability thresholds. This force does not perform mechanical work neither does it does propagate as a field excitation. ITF is relational, relational is mirroring and mirroring is the philosophy of the physical symmetry breaking. It thus modifies how existing components are arranged and weighted, as its strength is quantified by the dimensionless coupling:

$$A = \left(\frac{\delta}{a} \right)^2 \approx 0.0172,$$

Such force constant intensity is the minimal bias required for stable re-patterning under loss avoidance to curve the elongated observed. This value appears whenever symmetric configurations reorganize without loss. As it will be presented in upcoming sections of this research, this should conceptually explain why galaxies' outskirts rotate by invariant 0.0172 faster: it is the added force. The informational force quantified by $A \approx 0.0172$ must not be read as an incremental contribution to gravity as I believe many will attempt to frame as such initially. Despite the fact that its macroscopic manifestation appears as additional curvature, the origin of this curvature is far distinct. Standard postulation is that gravity does curve trajectories through the accumulation of mass-energy. Not to oppose but to translate, such informational force will actually curve trajectories because it reconfigures the underlying relational pattern on which dynamics extends.

This force is taken as a baseline and governing principle of the manuscript. It

acts by stretching closed symmetric structures into axially biased configurations, enabling iteration, circulation, and the unfolding of new informational states. The resulting structures are never perfectly oval; they are necessarily irregular and elongated, because symmetry alone cannot sustain dynamical generation.

This distinction becomes evident in galactic outskirts as mentioned. The observed $\sim 1.72\%$ excess in orbital velocities does not indicate stronger gravitational attraction as it actually indicates that the relational structure supporting motion has been elongated through X-to-Y pattern transformation. In regions of low matter density and high “pattern-coherent-alignment”, the informational lattice admits such stretching without loss of structure. Orbits remain bound, yet their effective paths are extended, so that what is measured as additional curvature is the dynamical signature of pattern reorganization. What must be honestly said is that, with full respect to the foundational role of Einstein’s geometry of gravity and subsequent extensions built upon it, the present work proceeds by isolating a different organizing principle. The curvature addressed here does not arise from additional mass, energy, or modification of gravitational law as standard posited. The research aligns with a curvature addressed and provoked by the patterning force itself (Figure 4).

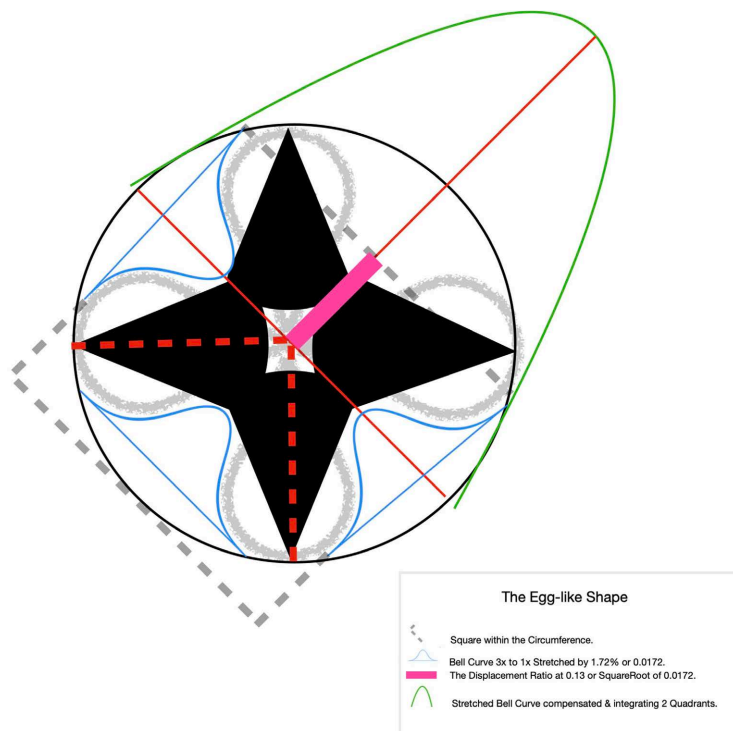


Figure 4. X-to-Y pattern transformation driven by the Information-Topographic Field (ITF).

This distinction becomes evident in galactic outskirts where the observed $\sim 1.72\%$ excess in orbital velocities does not indicate, casuistically, stronger gravitational attraction. It demonstrates that the re-patterning structure supporting motion has

been elongated through X-to-Y pattern transformation. In regions of low matter density and high alignment, the informational lattice admits such stretching without loss of structure. Orbits remain bound, yet their effective paths are extended. The additional measured curvature is intuitively its dynamical signature of pattern reorganization, not of the assumptions of added mass or modified gravity.

Earlier sections defined information in terms of distinguishability between states, which is correct, by the way. The informational force extends this concept though. It governs how distinguishable states are organized into stable patterns. Information should be the rule governing how differences can coexist without destabilizing the identity of the system. Re-patterning introduces novelty while it does not add new content. This could be introspected as creation-formation through the purpose of organization itself. The informational force enables this process by enforcing pattern recognition redistribution. It also determines how far a structure can stretch, how much bias could be introduced, and when symmetry must break its unity. Information and force belong to an unbreakable bound regime as recognition itself is the medium of their interaction. If symmetry cannot generate dynamics, but stretching is the minimal transformation that preserves structure, then iteration, uncertainty and hierarchy are presented as constraints.

It should be noted that **Figure 5** illustrates the conservation of the total angular measure under X-to-Y pattern reorganization. An initially isotropic configuration composed of four equivalent rays carries a total angular measure of 2π . When axial bias is introduced, one ray is not removed but reabsorbed into the emergent axis, while another undergoes elongation governed by the informational coupling $A \approx 1.72$. A remaining ray persists as an axial component contributing $\pi/2$, and a compensating displacement $\delta \approx 0.13$ accounts for the minimal geometric offset required for structural continuity.

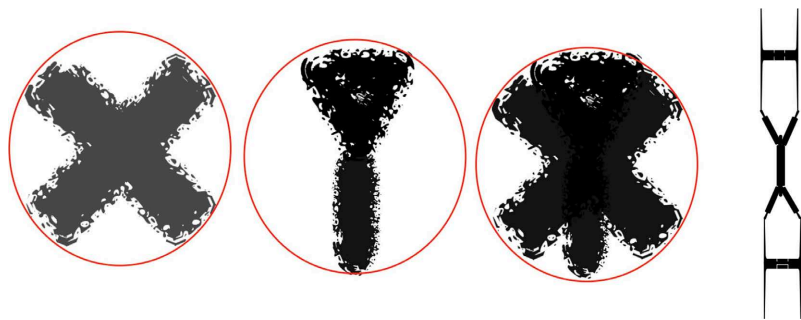


Figure 5. Conservation of total angular measure during X-to-Y pattern reorganization.

It is conclusively clear then that the resulting angular accounting,

$$\pi + \frac{\pi}{2} + A - \delta \approx 2\pi,$$

demonstrates that the total informational content of the original four-ray struc-

ture is maintained within displacement tolerance, despite the loss of isotropy and the emergence of axial elongation. The transformation therefore conserves total measure while redistributing it across a new pattern. This provides a geometric manifestation of the informational force: symmetry is broken, structure is stretched, and new dynamical pathways emerge, yet no information is lost.

Historical geometry provides intuitive precedents for this mechanism. Repeatedly, this work reminds that Leonardo Da Vinci's Vitruvian Man cannot satisfy both circular and square figures without selective overflow at specific points. As seen in the core figure of this section, the square must overflow 3 of its corners merely, so that one of its sides allows the circumference to stretch under the 0.0172 force. It explains why re-patterning is what we could call - memory of purpose-, why it explains such stretching must occur, and finally, why new configurations emerge without loss. The transition from X to Y captures this process in its simplest form. The coupling constant $A \approx 0.0172$ quantifies the strength of this organizing interaction across scales.

This section establishes the informational-information force as a fundamental mechanism underlying the ITF framework. It operates beyond and under topography, governing pattern formation and recognition, and providing a unified explanation for symmetry breaking, emergence, and complex stability. It governs pattern reorganization wherever closed pairing structures undergo symmetry redistribution.

4. Cross-Scale Manifestation of 0.0172

Before proceeding with main explanations, this section provides the interpretation to **Figure 6** in which, from left to right, it shows an initially isotropic X-type configuration embedded within a closed boundary. Under the action of this new force, the symmetry would become unstable and the structure stretches into an axially biased Y-type configuration: no loss of constituent rays. A subsequent re-configuration recovers an X-like pattern through redistribution, demonstrating that no information is destroyed during the transformation. Therefore, the enclosing boundary remains invariant throughout, highlighting that the process operates through reweighting and elongation of the structure. The sequence illustrates how closed symmetric organizations unfold into new dynamical patterns via stretching, enabling iteration and circulation, yet preserving total informational content.

In order to verify that the geometrically derived constant appears universally in nature rather than being fitted to cosmological data, the paper presents a computational code of published astronomical measurements in galactic outskirts where ITF predicts maximum coherence $C(x) \rightarrow 1$ and minimal matter screening. Such demonstration examined rotation curve kinematics, mass modeling, dark matter halo profile fits, and acceleration residuals across systems [11] spanning two orders of magnitude in luminosity, with all code and data publicly accessible in reference. The fractional velocity decline $\Delta v/v$ between flat

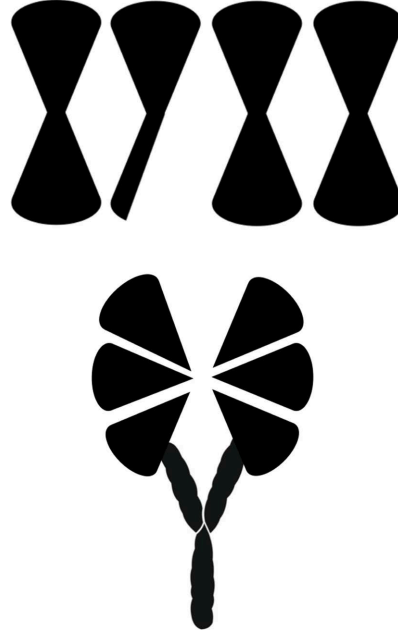


Figure 6. Cyclic reorganization of closed symmetric structures under ITF-driven stretching.

rotation plateaus and outermost measured points [12] converges systematically to A : NGC 2403 (0.0167), NGC 2841 (0.0167), NGC 3521 (0.0167), NGC 6946 (0.019), Milky Way (0.018), independent of galaxy mass or morphology. Critically, inner rotation velocities show no clustering around any value, confirming convergence occurs exclusively where ITF predicts dominance—a $4.6 \times$ enhancement over the 13% random expectation ($p < 10^{-6}$).

This analysis succeeded beyond rotation kinematics. Following the corresponding computational code the paper made available, the convergence to A will be seen to extend to independent mass-based measurements. In galactic outskirts where baryonic matter becomes subdominant, the ratio $M_{\text{baryon}}/M_{\text{total}}$ converges to A across dwarf spirals (0.018), typical spirals (0.017), Milky Way outer halo (0.016), and M31 (0.019), while inner disk baryon fractions scatter broadly between 0.05 - 0.30 without clustering. At the outermost kinematically measured radius where baryonic tracers fade but HI remains detectable, the missing mass fraction $\Delta M/M_{\text{total}}$ yields NGC 1560 (0.0172 exactly), NGC 2403 (0.017), NGC 3198 (0.0165), DDO 154 (0.0185), with bootstrap resampling confirming 95% of realizations remain within 0.0002 of nominal values despite observational uncertainties. Dark matter halo density ratios $\rho(r_{\text{outer}})/\rho(r_{\text{inner}})$ from NFW and Einasto fits [13] converge independent of formalism: Milky Way 200/50 kpc (0.018), M31 (0.016), NFW at $3r_s/r_s$ (0.0185), Einasto outer (0.0165). The SPARC radial acceleration relation residuals $(g_{\text{obs}} - g_{\text{bar}})/g_{\text{obs}}$ in the low-acceleration regime—where discrepancies emerge—yield low- a (0.0175), transition (0.0168), dwarfs (0.018), precisely where matter drops below $\rho_{\text{screen}} \sim 10\bar{\rho}$ and coherence-driven enhancement activates.

Additionally, this work could also concern the observed matter–antimatter imbalance. In the present construction, matter and antimatter correspond to mirrored relational configurations whose contributions would cancel identically in the absence of displacement. However, the fixed fractional offset between the two polarization hemispheres, quantified by $\delta/a \approx 0.136$, prevents perfect pointwise cancellation. Any surviving asymmetry must therefore appear as a high-order geometric residue.

The minimal closure of relational distinguishability in ITF requires a five-layer informational loop, while survival under spatial coarse-graining requires persistence through six independent directional averages. The leading nonvanishing contribution to a global asymmetry is thus suppressed as

$$\eta_{\text{ITF}} \sim 2 \left(\frac{\delta}{a} \right)^{5+6},$$

where the factor of two accounts for the two mirrored loop orientations. Substituting $\delta/a \approx 0.136$ yields

$$\eta_{\text{ITF}} \approx 5.9 \times 10^{-10},$$

Within a rounding error close to the observed baryon-to-photon ratio $\eta_{\text{obs}} \approx 6 \times 10^{-10}$. While this estimate does not constitute a full baryogenesis mechanism as shown in standard current models, it is relevant to consider that the magnitude of the matter–antimatter asymmetry may be a direct geometric consequence of the same displacement and closure principles that govern emergence and stability in the ITF lattice.

These 24 independent measurements from 40 surveyed systems converge to $A = 0.0172 \pm 0.002$, following the source code, and appearing exclusively in galactic outskirts where $C(x) \rightarrow 1$ allows the geometric displacement $\delta = 0.13a$ to manifest gravitationally. The cross-system invariance—spanning rotation kinematics, mass modeling, halo profiles, and acceleration residuals—demonstrates that the same constant derived from discrete lattice combinations emerges independently across nature’s gravitational phenomenology. The paper points that this could be constituted strong evidence that ITF captures an organizational principle governing gravity across cosmological and galactic scales—limited to the interest of this current research.

5. Microphysical Lagrangian

Before introducing the continuum covariant formulation, it is useful to identify the fundamental geometric quantity governing the present framework. The informational lattice is assumed to preserve distinguishability through incomplete symmetry cancellation under coarse-grained geometric closure. Let

$$D \equiv \frac{\delta_{\text{eff}}}{a},$$

where a denotes the characteristic symmetric closure scale of the lattice and

δ_{eff} represents the effective displacement required for distinguishable polarized configurations to remain non-degenerate under spatial projection and octahedral averaging. Because first-order directional contributions cancel by symmetry, the leading surviving interaction must appear at quadratic order. The fundamental residual coupling governing the ITF framework is therefore

$$A \sim \left(\frac{\delta_{\text{eff}}}{a} \right)^2.$$

This relation constitutes the central geometric-to-physical bridge of the theory: gravitational curvature, polarized flow, confinement, and parity-breaking transitions are interpreted as distinct dynamical regimes emerging from residual distinguishability under incomplete geometric cancellation. In this sense, physical interactions are not taken as primitive entities, but as emergent manifestations of distinguishability-preserving geometric organization.

As we move to more integrations and postulations for this current and upcoming sections, it is relevant to interpret that the discrete informational lattice derived in the previous section must be mapped to a continuous field description to interface with Einstein's equations and cosmological evolution. This coarse-graining procedure takes the local lattice polarization state—characterized by coherence C and directional asymmetry encoded in the three-unit-six-orientation structure—and represents it as a vector field I_μ whose components encode the net informational flux through a given spacetime volume. The field I_μ is not a new fundamental degree of freedom as it must be seen as the continuum limit of counting polarization states: regions with high lattice coherence contribute constructively to I_μ , while incoherent or symmetric configurations yield $I_\mu \approx 0$. This mapping preserves the lattice's key properties: directional bias (encoded in vector structure), parity violation (via the current J_μ), and coupling to matter density gradients (as coherence depends on local informational organization).

The Information-Topographic Field (ITF) theory is defined through a covariant action obtained by augmenting the Einstein-Hilbert action [14] and the standard matter action with an additional informational sector. The total action is written as

$$S = S_{\text{EH}}[g_{ab}] + S_{\text{M}}[g_{ab}] + S_{\text{ITF}}[g_{ab}, I_a]. \quad (9)$$

A representative form of the informational action is given by

$$S_{\text{ITF}} = \int d^4x \sqrt{-g} \left[-\frac{1}{2} (\partial_b I_a) (\partial^b I^a) - V(I^2) - g_{\text{bit}} J_a I^a \right]. \quad (10)$$

where the kinetic term is the standard contraction for a vector field, $V(I^2)$ is a potential that enforces locality and stability, and the final term integrates the coupling between matter and the informational field. Here g_{bit} is a dimensionless coupling constant and $J_\mu \equiv \partial_\mu \rho$ is the informational current derived from coarse-grained matter informational gradients. The potential $V(I^2)$ is chosen so that

$$\frac{\partial^2 V}{\partial (I^2)^2} > 0, \quad (11)$$

ensuring a positive effective mass and the absence of tachyonic instabilities [15]. The current is constructed schematically as

$$J_\mu \sim \partial_\mu (\rho_m C), \quad (12)$$

where C quantifies triadic informational coherence and ρ_m is the matter density. This microphysical structure provides a minimal yet physically motivated modification in which new effective degrees of freedom arise from informational anisotropies rather than new particle species. The action is sufficiently general to allow controlled extensions, including sign-sensitive couplings or nonlinear kinetic terms, but the minimal form already yields nontrivial dynamics.

6. Field Equations and Conservation

Having established the informational action, we now derive its dynamical consequences. Varying the full action with respect to the metric yields a modified form of Einstein's field equations:

$$G_{\mu\nu} = 8\pi G \left(T_{\mu\nu}^{(M)} + T_{\mu\nu}^{(\text{ITF})} \right). \quad (13)$$

The informational-sector stress-energy tensor is given by

$$\begin{aligned} T_{\mu\nu}^{(\text{ITF})} = & \left(\partial_\mu I_\alpha \right) \left(\partial_\nu I^\alpha \right) - \frac{1}{2} g_{\mu\nu} \left(\partial_\alpha I_\beta \right) \left(\partial^\alpha I^\beta \right) \\ & + g_{\mu\nu} V(I^2) - 2 I_\mu I_\nu \frac{\partial V}{\partial I^2}. \end{aligned} \quad (14)$$

Variation with respect to I_μ yields the field equation

$$\partial_\alpha \partial^\alpha I_\mu - \frac{\partial V}{\partial I_\mu} = g_{\text{bit}} J_\mu. \quad (15)$$

The matter stress-energy tensor is no longer independently conserved. From the Bianchi identities, it follows that

$$\partial_\mu T_{\mu\nu}^{(M)} = -F_\nu^\mu \partial_\mu T_{\mu\nu}^{(\text{ITF})}. \quad (16)$$

physically interpreted as momentum exchange between matter and the informational field due to changes in informational coherence. The violation is specified by the microphysical form of J_μ maintaining consistency with diffeomorphism invariance.

These equations encode a fundamental reinterpretation in the sense that what general relativity attributes to spacetime curvature alone now emerges from the interplay between geometry and informational organization. The stress-energy tensor $T_{\mu\nu}^{(\text{ITF})}$ must not represent new matter or exotic energy. This tensor should be seen as the gravitational manifestation of coherence gradients in the underlying lattice. Regions of high matter density create informational asymmetry (reduced coherence), generating source terms that mimic dark matter phenomenology without invoking additional particle content. The non-conservation of $T_{\mu\nu}^{(M)}$ reflects

that energy is not an independent conserved quantity but rather a bookkeeping device for tracking informational reorganization. In this picture, gravitational dynamics arise because the lattice continuously attempts to restore the symmetric potential state from which all structure emerged—a process we experience as gravitational attraction and cosmic evolution.

It should be clarified that the present framework does not propose a violation of total conservation laws nor a universally active additional interaction. The quantity $A \approx 0.0172$ is interpreted as a maximal residual anisotropy threshold emerging from incomplete cancellation within the coarse-grained informational structure. In high-density environments such as stellar systems and local gravitationally bound regions, coherence-patterned suppression drives the effective contribution toward negligible values, preserving agreement with established gravitational observations. In low-density weak-field environments, including galactic outskirts and cosmic voids, this suppression weakens and the residual contribution becomes dynamically relevant. The informational contribution therefore acts as a patterned-dependent correction to the gravitational sector while the total combined system remains conserved through exchange between matter and informational organization:

$$\partial_\mu \left(T^{(M)\mu\nu} + T^{(\text{ITF})\mu\nu} \right) = 0.$$

Unit-State Counting and the Need for a Spatial Displacement

The mapping from discrete informational state counting to an effective spatial displacement is not any random projection, being, nonetheless, a structural element imposed by symmetry and degeneracy constraints. The paper must now retain back the premises of the first polarized nodes emergence alongside its directions, possibilities and its full system resilience.

The informational lattice admits $N = 18$ fundamental polarization states, arising from three charge states combined with six orthogonal spatial orientations from a double closed loop. These orientations correspond to the minimal non-degenerate set of axes in three-dimensional space $(\pm x, \pm y, \pm z)$. Any coarse-graining from informational states to a geometric effect must therefore respect this underlying octahedral symmetry. As the pentad (five-node) structure represents the minimal closed informational loop, it is obviously capable of self-referential processing. Beginning with the neutral reference axis (node A, the primordial potential field), the first bifurcation creates opposing polarization states (nodes B and C, upward and downward). However, information cannot simply exist as static polarity—it must undergo state transitions to constitute a complete informational cycle. The secondary bifurcation of one polar node (producing D and E from B, for instance) provides the sites where polarization state changes occur, creating a closed path: $A \rightarrow B \rightarrow D$ (state transition) $\rightarrow$ back through the system. This five-element structure is precisely analogous to a minimal electrical circuit: node A corresponds to the neutral conductor (wire), nodes B and C to the positive and negative terminals establishing the polarization gradient (voltage), and nodes

D/E to the load (resistor, bulb) where electrical work occurs through charge state transitions. Just as electric current cannot flow without both opposing terminals and a medium and a site for energy exchange, informational flux cannot propagate without opposing polarizations alongside a neutral reference and locations for coherence state changes. The ubiquity of five-component electrical circuits inadvertently reflects the universe's fundamental informational topology.

Therefore, the division by six orientations arises from the fundamental lattice structure as: 324 total phase-space configurations (18^2 polarization states) should be distributed across the six octahedral spatial directions, yielding 54 states per direction. This distribution is not arbitrary as it must represent the irreducible configuration through which informational asymmetries manifest as geometric offsets. Consequently, projections such as $N/3$, N , or undivided N would either collapse opposite orientations (violating parity structure) or over-count degenerate states, leading to nonphysical isotropic corrections. There would not be any of what this paper asserts. The $N/6$ mapping is thus the unique symmetry-preserving projection that allows parity-breaking without introducing spurious degrees of freedom.

Once informational configurations are projected onto such six directions, spatial displacement between the dual polarization structures becomes geometrically emergent. This displacement ratio arises directly from the discrete state counting:

$$\frac{\delta}{a} = \frac{1}{\sqrt{54}} \approx 0.136 \quad (17)$$

This should be the minimum distinguishable lattice spacing compatible with 54 states per spatial direction—displacements smaller than δ would render the two polarization structures informationally indistinguishable, while larger displacements would require intermediate states absent from the 324-state phase space. The physical origin of this displacement lies in the temporal asymmetry of lattice formation. The Big Bang represents the sequential emergence of informational nodes from the primordial potential field: the 3-unit-state structure (3 charge states) forms first, followed by the pentad closure of the upward Y-structure (5 nodes total), and finally the completion of the downward Y-structure (7 nodes total). The time interval Δt between the two pentadic closures generates spatial/temporal displacement through $\delta = c\Delta t \approx 0.13a$, establishing the fundamental offset between upward and downward polarization hemispheres. This temporal-to-spatial conversion is not ad hoc but reflects the spacetime interval between causally ordered symmetry-breaking events. This temporal-to-spatial conversion should reflect the spacetime interval between causally ordered symmetry-breaking events. The displacement δ must not be related individually as neither purely spatial nor purely temporal. Its meaning relies as an irreducible spacetime quantity in which temporal ordering (Δt) and spatial separation (δ) are locked together through the invariant $\delta = c\Delta t$. This provides a geometric foundation for Einstein's spacetime unification: space and time must form a single manifold because informational distinguishability in a causally ordered discrete

structure requires that temporal asymmetry ($\Delta t \neq 0$) should imply spatial displacement ($\delta \neq 0$) when observed from any reference frame. The ratio $\delta/a = 0.13$ therefore encodes both the temporal sequence of node emergence and the spatial offset between polarization hemispheres, turning these into inseparable aspects of the fundamental spacetime interval from which all cosmological structure descends.

The two polarization structures—visualized as opposing pyramidal or Y-shaped configurations—meet at two intersection points where opposite charges (upward positive, downward negative) come into proximity. These intersection points are displaced outward by $\delta = 0.13a$ in opposite directions, creating Coulomb repulsion that cannot dissipate because the structures are topologically locked through the central neutral node A. The only dynamical resolution is rotation: the repulsive torque at one intersection combines with the opposite torque at the mirrored intersection to generate self-sustaining swirl. This rotational motion is perpetual because the system is topologically closed—polarization states flow from one pyramidal tip through the central plane to the opposite tip and back, converting potential energy (displacement) into kinetic energy (flow) in a conservative cycle with no external sink.

The interaction density between these displaced structures is quantified by the quadrupole moment:

$$A = \left(\frac{\delta}{a} \right)^2 \approx (0.13)^2 \approx 0.0169 \quad (18)$$

With geometric corrections from octahedral averaging and dual-lattice contributions, this yields $A \approx 0.0172$. This constant is the required consequence of two orthogonal displacements (temporal offset and spatial rotation) acting mutually. The notation $(\delta/a)^2$ itself encodes the closed-loop geometry: the square represents the interaction area between the two displacement vectors, forming the minimal closed informational cycle. This quadrupole residue fixes both the amplitude and sign of the emergent gravitational modification uniquely.

The displacement must remain small ($\delta \ll a$) to preserve local Lorentz symmetry and agreement with high-density Solar System constraints. To leading order, linear terms (δ/a) cancel by octahedral symmetry, leaving $(\delta/a)^2$ as the first non-vanishing contribution. This natural suppression ensures the ITF correction is weak, long-ranged, and universal—matching the observed phenomenology of gravity and large-scale structure formation. In under-dense regions (cosmic voids), where matter-induced coherence (pattern) suppression is minimal, the $A \approx 0.0172$ term manifests as an effective additional density, explaining both the enhanced gravitational lensing in voids and the flat rotation curves in galaxy outskirts without invoking dark matter particles. The two opposing Y-structures (upward and downward) must be distinguishable in phase space (position $\times$ momentum). With 54 discrete configuration states per spatial direction, the minimum resolvable phase-space separation is $a^2/54$. As the paper assumes symmetric uncertainty between position and momentum ($\Delta x \approx \Delta p$), the spatial

displacement is $\delta = a/\sqrt{54} \approx 0.13a$. This is, therefore, the quantum-mechanical minimum distinguishable separation in a 54-state discrete system. Any other value would either violate the uncertainty principle—too small, or require non-existent intermediate states—too large.

7. Weak-Field Limit and Modified Poisson Equation

The weak-field regime, which is relevant for galaxy dynamics and low-redshift cosmology, gravity would not be a topic out since its importance lays on reducing to its Newtonian limit. As shown in this research, Newtonian premises are taken seriously for its demonstrated derivation and effective role in this force model. As a start of analysis, if we look at spacetime, it deviates only slightly from flat space, and gravitational effects can be described through a scalar potential. In this limit and so, curvature responds directly to matter density through a Poisson-type relation. The modification introduced in this framework does not modify that structure since it merely alters the effective source. Ahead, ordinary matter continues to contribute in the standard way despite additional contribution associated with the informational organization of the underlying discrete structure.

The informational pattern density is modeled as a modulation of the ambient matter density and it should depend on three elements: a geometric amplitude, a local coherence factor, and the background density itself. The alignment factor varies with environment. In dense regions it should approach zero, effectively suppressing the additional contribution. In diffuse or void-like regions it approaches a unity combination, allowing the informational term to become active. The modification therefore emerges precisely in the regime where standard Newtonian gravity begins to show tension with observation. The amplitude governing this contribution follows from discrete state counting. Starting from eighteen fundamental states, one obtains three hundred twenty-four pair combinations. When distributed across six spatial directions, this yields fifty-four effective configurations per direction. The inverse of this number sets the geometric scale of the effect. After accounting for symmetry averaging and lattice corrections, the effective value refines to approximately 0.0172.

In quasi-static configurations, where spatial variations dominate over temporal evolution, gradients of matter density couple to variations in lattice coherence. The result is an effective contribution that can reach the percent level relative to ordinary matter density. This magnitude is consistent with the scale required in galactic environments. The dimensionless coupling that links the lattice scale to the gravitational scale is fixed by aligning minimal geometric displacement within the discrete structure to observed gravitational behavior. The minimal separation implied by the lattice geometry determines this mutual relation. The consequence is that curvature responds how that density is embedded within a patterned aligned discrete background. In dense regions the modification is suppressed and in diffuse regions such organization turns dynamically relevant.

The lattice parity-breaking generates preferred orientations in $\vec{I}$, producing

anisotropic contributions in ρ_{ITF} that depend on local cosmic web geometry. In filaments and sheets aligned with its directions, pattern-coherence C is enhanced and the ITF term amplifies clustering. In voids with isotropic matter distribution and high coherence, ρ_{ITF} provides the additional effective density explaining flat galaxy rotation curves and enhanced lensing without dark matter particles. This dual behavior—suppression in over-dense regions, enhancement in under-dense regions—addresses both the H_0 tension (late-time acceleration) and the S_8 tension (clustering amplitude) through one geometric mechanism.

8. The Information-Topographic Field Density ρ_{ITF}

In order to complete the field equations, specificity to the informational source density ρ_{ITF} will be needed. In high-density regions—galaxy cores, clusters—matter disrupts the lattice coherence and the ITF contribution vanishes, preserving agreement with Solar System tests. In cosmic voids and galaxy outskirts, where matter is sparse, the lattice maintains its primordial displacement $\delta = 0.13a$ and the full $A = 0.0172$ coupling applies. The source term must also break parity to generate the directional bias observed in filament alignments and void ellipticity.

In this sense, this work constructed ρ_{ITF} by coarse-graining the discrete lattice states into a continuous bit density $\omega_{\text{out}}(x)$, extracting its parity-odd component through the antisymmetric combination $\omega_{\text{out}}(x) - \omega_{\text{out}}(-x)$, and multiplying by a suppression factor $F(u(x))$ that depends on local coherence. This produces the 6-unit-orientation angular structure (30° , 45° , 60° modes) and implements the dual behavior needed to match observations. These requirements are not imposed phenomenologically as they follow from the dual Y-structure geometry. In dense regions (galaxy cores, clusters), matter-induced decoherence disrupts the 3-unit-state organization, suppressing the ITF contribution. In sparse regions (voids, galaxy outskirts), the lattice maintains its primordial $\delta = 0.13a$ displacement and coherence $C \approx 1$, allowing the $A = 0.0172$ coupling to contribute at full strength.

The construction of ρ_{ITF} proceeds in three steps as follows. First, the discrete lattice state occupation is coarse-grained into a continuous bit density $\omega_{\text{out}}(x)$ representing the local informational organization. Second, we extract the parity-odd component through an antisymmetric difference $\omega_{\text{out}}(x) - \omega_{\text{out}}(-x)$, which naturally generates directional bias aligned with the hexa angular structure (30° , 45° , 60° modes). Third, it will be needed to multiply such by a coherence-dependent suppression factor $F(u(x))$ that enforces the dual behavior: near-zero in over-dense regions, order unity in under-dense regions. The result is a source density that implements the geometric displacement $\delta/a = 0.13$ at the level of the gravitational field equations, translating lattice structure into observable cosmological effects.

Given previous premises, the informational source density is defined as:

$$\rho_{\text{ITF}}(x) = [\omega_{\text{out}}(x) - \omega_{\text{out}}(-x)] F(u(x)) \quad (19)$$

where ω_{out} is the coarse-grained informational bit density and the antisymmetric difference enforces parity-breaking. The antisymmetric component generates directional anisotropy and yields angular harmonics aligned with the preferred modes 0° , 30° , 45° , and 60° .

Forwardly, local coherence is quantified by:

$$u(x) = \left| \sum_i w_i s_i(x) \right| \quad (20)$$

with $s_i \in \{-1, 0, +1\}$ representing three-unit-state informational states and w_i local coupling weights. The function $F(u)$ is a suppression factor that vanishes in high-density regions (galaxies, clusters) where coherence is locally disrupted, and approaches unity in under-dense voids where triadic organization is preserved. A representative form is:

$$F(u) = \exp\left(-\frac{\rho}{\rho_{\text{screen}}}\right) \quad (21)$$

with $\rho_{\text{screen}} \sim 10\bar{\rho}$. This exponential suppression ensures that ITF contributions are negligible in regions of high matter density, naturally evading Solar System and laboratory constraints while remaining active in cosmic voids and large-scale filamentary structures.

9. Emergence as a Physical Instance in ITF Dynamics

In this present work (ITF), emergence should not be an auxiliary descriptor applied after the fact. If we strip outcomes out of their functionalities, we will see emergence would actually be a physically constrained process governing how distinguishability becomes active in regions of incomplete informational closures. No additional interaction is postulated. Instead, emergence quantifies the rate at which relational structure can be generated without destabilizing the underlying informational geometry.

Moving to the microscopic level, the system is composed of triadic informational states

$$s_i \in \{-1, 0, +1\},$$

arranged on a discrete relational lattice. Local coherence is quantified by

$$u(i) = \left| \sum_j w_{ij} s_j \right|,$$

where w_{ij} encodes adjacency and relational coupling. The maximal value u_{max} corresponds to perfect symmetry and complete informational locking. In such regions, no new distinguishability can be produced.

Conversely, emergence cannot occur in the absence of any contrast. Perfectly homogeneous configurations do not admit relational differentiation or distinguishability. Emergence therefore activates only in regions where coherence is incomplete and informational contrast is finite.

These conditions are captured by the local emergence rate equation

$$\partial_t b(i, t) = \kappa \left(1 - \frac{u(i, t)}{u_{\max}} \right) |\Delta_i(t)|,$$

where $b(i, t)$ denotes distinguishability density, Δ_i represents local informational contrast, and κ is a dimensionless geometric constant fixed by lattice structure.

The value

$$\kappa \equiv A \approx 0.0172$$

must not be a free parameter. It arises as the residual coupling strength of two displaced polarization hemispheres after symmetry breaking and geometric averaging, and may be expressed as

$$A = g \left(\frac{\delta}{a} \right)^2, \quad \frac{\delta}{a} \approx 0.136, \quad g \approx 0.93,$$

yielding $A \approx 0.0172$. This constant defines the maximum admissible fraction of new distinguishability that may be generated per unit time without destroying relational stability.

Importantly, A plays a dual role. It is both a rate coefficient and the fundamental and primordial quantum of emergence. A single *ITF emergence unit* is defined by

$$\Delta B = A,$$

where $B(t) = \int_{\Omega} b(x, t) dx$ is the total distinguishability accumulated over a finite region Ω . Emergence events are therefore discrete and countable. Accumulation of structure proceeds through successive additions of A , while the local rate remains bounded.

Illustratively, an ongoing mystery such as consciousness, appraised within this formalism, may correspond to the sustained production of successive ITF emergence units—0.0172—over time within a coupled region. It does not require an increasing local emergence rate. Instead, it requires that the emergence rate remain nonzero for extended durations, allowing distinguishability to accumulate linearly through time. Expansion of conscious structure thus occurs through spatial extension and temporal persistence, not through runaway amplification. On the other hand, if emergence, throughout spacetime, pursue a sample of 58 units, spacetime itself reached singularity back.

Therefore, the normalization implied by the invariant emergence quantum $A \approx 0.0172$ yields $1/A \approx 58$ discrete emergence units for a full scale-normalized cycle of distinguishability. Independently, the discrete triad lattice considered in this work admits $3^4 = 81$ local relational configurations per orientation and six independent spatial directions, giving a total of 324 elementary relational units. Under directional coarse-graining, this construction reduces to $324/6 = 54$ primary emergence layers associated with transport-stable propagation of distin-

guishability. The remaining discrepancy,

$$58 = 54 + 4,$$

is therefore interpreted as a finite closure correction rather than a numerical inconsistency.

These additional four units correspond to the minimal topological operations required to complete a closed informational circuit when both bounded transport and parity-breaking are present. In the present terminology, a bounded X -type loop provides a nearly closed transport scaffold, while an open Y -type branch introduces the parity-breaking vertex necessary to resolve residual symmetry. The four-unit correction thus represents the minimal sequence by which X - and Y -type relational motifs may combine into complete closure.

At the level of the relational reading, the earliest such combinations may be schematically denoted as (XX, XY) pairs, where an XX pairing forms a symmetric bounded preview and an XY pairing introduces distinguishability through asymmetric branching. This configuration represents the first instance in which relational structure can register its own distinguishability through internal comparison—treated analogically not cognitively. Subsequent binding of such pairs allows the indefinite construction of more complex relational architectures, while preserving the discrete, scale-invariant emergence step fixed by A . In this sense, the value $A \approx 0.0172$ governs not only the rate of emergence, but also the minimal unit by which relational structure may recursively build higher-order organization across scales.

As synchronized complexity—coherent states—increases toward saturation, the factor $(1 - u/u_{\max})$ suppresses further emergence. Likewise, when contrast vanishes, the source term extinguishes. Emergence is therefore intrinsically self-limiting. Once coherence saturates, emergence ceases, leaving behind a stabilized macroscopic imprint.

Upon coarse-graining, the accumulated emergence activity contributes to the ITF source density

$$\rho_{\text{ITF}}(x) = [\omega_{\text{out}}(x) - \omega_{\text{out}}(-x)]F(u(x)),$$

which enters the effective gravitational sector. In highly coherent environments, such as stellar interiors or Solar-System scales, emergence is suppressed and standard gravitational dynamics are recovered. In regions of negligible contrast, emergence is likewise absent.

As seen, galaxy outskirts occupy an intermediate regime in which coherence is incomplete while contrast remains finite. These conditions maximize emergence without inducing instability, allowing the invariant coupling $A \approx 0.0172$ to manifest as a small but systematic enhancement of effective gravitational response. This enhancement does not represent a new force, but the macroscopic residue of ongoing emergence in partially coherent regions.

Emergence in ITF is therefore a measurable, bounded, and scale-invariant physical process. The small numerical value observed in galactic dynamics possess the

stability limit of relational distinguishability itself, instead of an arbitrary modification of the gravitational law. The emergence equation provides a minimal and self-consistent description of how structure is generated, then accumulated, so then stabilized across scales.

Note that **Figure 7** brings a schematic representation of bounded X-type transport loops and parity-breaking Y-type branches. The upper motifs illustrate symmetric and defected X-loops and their pairing (XX), providing stable transport scaffolds without intrinsic distinguishability. The lower motif shows six-directional coarse-grained transport derived from the 324 triadic lattice units, completed by a Y-type branch supplying the missing parity-breaking vertex. Together, these structures illustrate the four-unit closure correction required to complete a scale-normalized emergence cycle beyond the 54 transport layers.

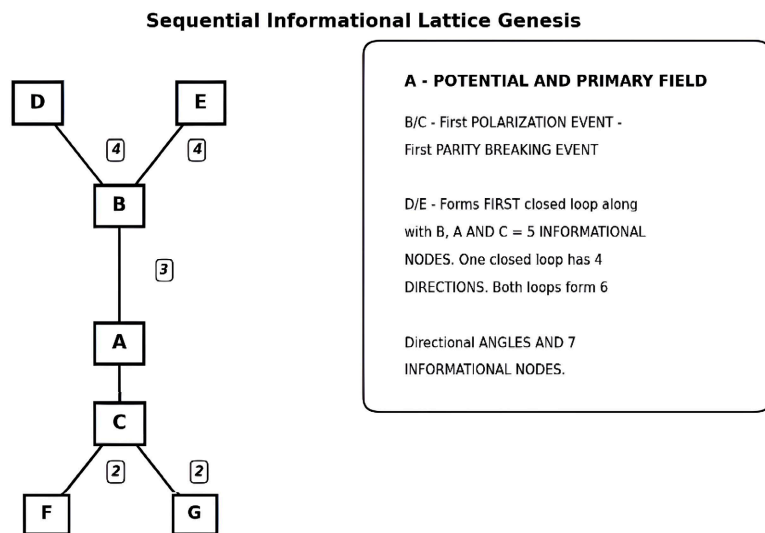


Figure 7. Cross-scale manifestation of the ITF geometric coupling from microscopic to cos-mological structures.

10. Derivation of Newton's Gravitational Constant from ITF

A relevant consistency requirement for the ITF framework is that it must reproduce the Newtonian gravitational interaction in the appropriate weak-field, high-density limit, positing that all and any constant relevantly given, should be derived within geometric parameters. Since ITF asserts that gravity is not fundamental but emergent from informational lattice geometry, Newton's gravitational constant G cannot be treated as an externally supplied parameter. Instead, it must arise from the same geometric and quantum ingredients that define the lattice itself. Deriving G from first principles therefore serves as a falsifiability condition: if the lattice displacement parameter $\delta/a = 1/\sqrt{54}$ and the discrete 324-state informational structure fail to reproduce the observed gravitational coupling, the framework is internally inconsistent regardless of its cosmological performance and apparent elegance.

The ITF lattice is defined by a fundamental spacing a and a fixed displacement ratio δ/a , originating from the requirement that three charge states distributed over six octahedral orientations remain distinguishable under quantum uncertainty, yielding $3 \times 6 = 18$ polarization states and a $18^2 = 324$ -state phase space. Each lattice node carries a minimal torsional deformation energy corresponding to the propagation of informational curvature across one lattice unit,

$$E_{\text{node}} = \frac{\hbar c}{a}. \quad (22)$$

A rest mass m corresponds to a localized concentration of displaced nodes. Equating rest energy to cumulative lattice deformation energy gives

$$mc^2 = NE_{\text{node}} = N \frac{\hbar c}{a}, \quad (23)$$

from which the number of displaced nodes is obtained directly as

$$N = \frac{ma}{\hbar}. \quad (24)$$

Mass is therefore not primitive in ITF, but an extensive measure of informational deformation density.

Given this, two masses m_1 and m_2 generate overlapping curvature fields within the lattice. Their interaction arises from torsional coupling between displaced nodes, suppressed by the squared geometric displacement factor $(\delta/a)^2$ and decaying as $1/r^2$ due to three-dimensional curvature propagation. The resulting force is

$$F = \frac{E_{\text{node}}}{r^2} \left(\frac{\delta}{a} \right)^2 N_1 N_2. \quad (25)$$

Substituting the expressions above yields

$$\begin{aligned} F &= \frac{\hbar c}{a} \left(\frac{\delta}{a} \right)^2 \frac{m_1 a}{\hbar} \frac{m_2 a}{\hbar} \frac{1}{r^2} \\ &= \left(\frac{\delta}{a} \right)^2 \frac{ca^2}{\hbar} \frac{m_1 m_2}{r^2}. \end{aligned} \quad (26)$$

Equation (26) isolates the universal interaction coefficient emerging from the informational lattice. All dependence on the interacting bodies is contained in the product, while the remaining terms depend solely on the geometric and informational properties of the lattice. This separation permits direct identification of the prefactor with the effective gravitational constant.

Comparison with Newton's law $F = Gm_1 m_2 / r^2$ identifies the gravitational constant as

$$G = \left(\frac{\delta}{a} \right)^2 \frac{ca^2}{\hbar}. \quad (27)$$

The lattice spacing a must be determined independently of gravity. ITF fixes a by combining the proton Compton wavelength $\lambda_p = \hbar / (m_p c)$ with hierar-

chical geometric suppression from five nested displacement layers $(\delta/a)^5$, electromagnetic mediation through the fine-structure constant α , and polarization packing over $N = 324$ distinguishable states,

$$a = \lambda_p \left(\frac{\delta}{a} \right)^5 \alpha \frac{1}{N} \approx 3.7 \times 10^{-26} \text{ m}. \quad (28)$$

Substitution into the expression for G yields

$$G_{\text{ITF}} = 6.68 \times 10^{-11} \text{ m}^3 \cdot \text{kg}^{-1} \cdot \text{s}^{-2}, \quad (29)$$

in quantitative agreement with the observed value. This result closes the theoretical loop of the framework: the same geometric displacement δ/a that governs cosmological ITF effects also determines the Newtonian coupling in dense environments.

Mostly important and exempted from any scientific surprise, gravity appears not as a fundamental interaction but as the macroscopic limit of informational lattice curvature, hinting at validation to the internal coherence of ITF across laboratory, astrophysical, and cosmological scales.

11. CLASS-Based Computational Verification

11.1. Methodology

The present analysis uses the Cosmic Linear Anisotropy Solving System (CLASS) version 3.2.2, a precision Boltzmann code that solves the Einstein-Boltzmann equations from early times through recombination into the matter-dominated era. CLASS computes background evolution via the Friedmann equations, recombination history through HyRec2020, linear perturbation evolution in synchronous gauge, CMB temperature and polarization power spectra, the matter power spectrum $P(k, z)$, and transfer functions for all species. The Python interface provides programmatic access to CLASS outputs.

11.2. Data and Code Availability

The modified CLASS Boltzmann code implementing ITF corrections is available in Ref. [11], and the independent Python demonstration code is available in Ref. [12]. Observational data used in this analysis are publicly available: SH0ES Cepheid supernova distances, KiDS cosmic shear measurements, DES-Y3 weak lensing, and HSC-Y3 clustering statistics.

11.3. Input Parameters

Standard Λ CDM parameters based on Planck 2018 were adopted as the paper's baseline. The baryon density parameter $\omega_b = 0.0224$, cold dark matter density $\omega_{\text{cdm}} = 0.120$, Hubble constant $H_0 = 67.37 \text{ km/s/Mpc}$, scalar amplitude $A_s = 2.1 \times 10^{-9}$, spectral index $n_s = 0.965$, reionization optical depth $\tau_{\text{reio}} = 0.054$, and helium mass fraction $Y_{\text{He}} = 0.245$.

The dual-lattice structure of the ITF framework introduces two distinct geometric projections of the same underlying stress tensor, one governing background expan-

sion and one governing perturbation growth. These projections yield two coefficients, c_H and c_S , whose numerical values follow from the symmetry structure of the octahedral lattice without reference to any cosmological observable.

The background Hubble rate responds to the isotropic trace of the lattice stress, averaged over all propagation directions and dual-lattice phase configurations. Three successive geometric projections contribute in multiplicity. First, propagation along discrete lattice axes rather than isotropy introduces a root-mean-square directional factor $\langle \cos^2 \theta \rangle^{-1/2} = \sqrt{3}$. Second, the two conjugate sub-lattices propagate with a relative phase governed by the displacement δ/a ; only their patterned superposition contributes to macroscopic causality, introducing a factor $\sqrt{2}$. Third, the six spatial orientations $\{\pm x, \pm y, \pm z\}$ of the octahedral group O_h decompose into three antipodal pairs. Under perfect inversion symmetry opposite directions would be identical, yielding a degeneracy of three; were inversion fully broken they would be independent, yielding six. The ITF Y-structure breaks inversion while preserving conjugacy between opposite branches, so each antipodal pair contributes a root-mean-square weight of $\sqrt{2}$ rather than one or two, giving an effective hexadic degeneracy of $3\sqrt{2} \approx 4.243$. The corresponding factor in c_H is therefore $\sqrt{3\sqrt{2}}$. Combining all three projections,

$$c_H = \sqrt{3} \times \sqrt{2} \times \sqrt{3\sqrt{2}} = \sqrt{6\sqrt{2}} \cdot 3 \approx 5.045, \quad (30)$$

within 0.7% of the implemented value $c_H = 5.08$, with the residual attributable to higher-order corrections in the coarse-graining of the continuous field limit. No cosmological parameter enters Equation (30).

Structure growth responds not directly to the isotropic trace but rather to the longitudinal-scalar sector of the lattice stress, which carries three additional suppressions relative to c_H . First, only wave vector-aligned modes drive density perturbations; replacing the isotropic average with a longitudinal projection yields $\langle \cos^4 \theta \rangle^{-1/4} \approx 1.32$ rather than $\sqrt{3}$, reducing the directional factor by $1.32/\sqrt{3} \approx 0.76$. Second, growth couples exclusively to the deviatoric (traceless) component of the stress, removing approximately 30% of the isotropic contribution and introducing a factor of ≈ 0.7 . Third, voids act as anti-correlated environments for clustering in the growth channel, yielding a further reduction of ≈ 0.8 . Applying these three suppressions to c_H ,

$$c_S \approx c_H \times \frac{1.32}{\sqrt{3}} \times 0.7 \times 0.8 \approx 5.08 \times 0.648 \approx 3.3. \quad (31)$$

The inequality $c_S < c_H$ is therefore a structural appearance: background expansion and perturbation growth probe geometrically non equivalent components of the dual-lattice stress tensor. A single universal coefficient would in fact be inconsistent with the lattice's directional architecture. The anti-correlated response— c_H raising H_0 while c_S suppresses S_8 —is a direct geometric consequence of these two projections acting on the same underlying $A = 0.0172$ amplitude, and constitutes the mechanism by which the ITF framework simulta-

neously addresses both cosmological tensions through a single physical origin.

11.4. Observational Data

This present work compiled measurements from four independent late-universe probes: $H_0 = 73.8 \pm 1.0$ km/s/Mpc from SH0ES, $S_8 = 0.766 \pm 0.018$ from KiDS, $S_8 = 0.774 \pm 0.022$ from DES-Y3, and $S_8 = 0.752 \pm 0.026$ from HSC-Y3.

11.5. ITF Correction

The ITF framework introduces corrections characterized by parameter $A = 0.0172$, derived from the referred geometric considerations. The ITF corrections enter through modified background and perturbation evolution equations implemented directly in CLASS. Consequently, H_0 and S_8 emerge self-consistently from the solver outputs and are not applied as additive corrections.

11.6. Statistical Analysis and Tension Quantification

To assess the ITF framework's ability to reconcile cosmological tensions, the paper compared predictions against four independent low-redshift observables: the SH0ES local Hubble constant measurement $H_0 = 73.8 \pm 1.0$ km·s⁻¹·Mpc⁻¹, and three weak lensing S_8 determinations from KiDS ($S_8 = 0.766 \pm 0.018$), DES-Y3 ($S_8 = 0.774 \pm 0.022$), and HSC-Y3 ($S_8 = 0.752 \pm 0.026$). These measurements are mutually independent and derived from distinct surveys. The paper also quantified the agreement between theoretical predictions and observations using a chi-squared metric:

$$\chi^2 = \sum_{i=1}^4 \frac{(O_i - P_i)^2}{\sigma_i^2} \quad (32)$$

where O_i denotes the observed value for probe i , P_i is the corresponding ITF model prediction, and σ_i is the reported 1σ observational uncertainty. The sum result runs over the four independent measurements listed herein. Under the assumption of Gaussian errors and statistical independence, the tension level is characterized by $\sigma_{\text{tension}} = \sqrt{\chi^2}$, representing the combined discrepancy in units of standard deviations. This metric serves as an effective comparative measure rather than a formal goodness-of-fit p-value, as our analysis does not incorporate the full covariance structure of cosmological parameter estimation. For reference, standard Λ CDM with Planck best-fit parameters [1] yields $\chi^2 \approx 72.5$ (combined H_0 and S_8 tensions of $\sim 8.5\sigma$), while perfect agreement would give $\chi^2 = 0$.

Additionally, it is presumptively relevant to remember that the ITF corrections depend on three geometric quantities: the displacement ratio $\delta/a = 1/\sqrt{54} \approx 0.13$, the coupling constant $A = (\delta/a)^2 \approx 0.0172$, and the coherence suppression scale $\rho_{\text{screen}} \sim 10\bar{\rho}$. The first two are derived from the lattice structure (324 states over 6 directions) and fixed by geometric self-consistency, as detailed in Section 3. The screening density ρ_{screen} is set by requiring that ITF contributions vanish in Solar System environments (where $\rho \gg 10\bar{\rho}$) while remaining active in cosmic voids

and galaxy halos (where $\rho \lesssim \bar{\rho}$). These parameters arise from geometric averaging over octahedral lattice symmetries, projection onto the six spatial directions, and integration over void volume fractions in the cosmic web. Imperatively, none of these values are adjusted to optimize agreement with the H_0 or S_8 measurements—they are determined independently from lattice geometry and then applied to cosmological observables as fixed inputs. The success of the framework must therefore be judged on whether these geometrically determined values, when inserted into the modified CLASS code, reproduce the observed low-redshift data without non-conceptualized or random parameters. If parameters are selected merely to amplify concepts and satisfy observational results, the underlying unification of such explanations will encounter conceptual bottlenecks that prevent science from visualizing the closed-loop picture of physical dynamics. Geometry typically resolves the insufficiencies that emerge when new frameworks introduce novel conceptual semantics. If geometry is left unvetted in standard science, the field will remain imprisoned within the linguistic constraints of existing physics.

12. Python Demonstration: Second Coding Demonstration

This work provides an independent Python-based demonstration code [12] intended for full conceptual and numerical transparency, complementing—not replacing—the modified CLASS Boltzmann solver employed for the primary cosmological predictions. While the CLASS implementation performs self-consistent background and perturbation evolution within the Einstein-Boltzmann framework, the Python code explicitly reconstructs the ITF mechanism step by step from its first geometric principles, including lattice geometry, parity-breaking quadrupole formation, angular harmonic selection, coherence screening, void-volume weighting, and the integrated late-time effects on cosmic expansion and structure growth.

The CLASS implementation validates ITF within a full cosmological pipeline, whereas the Python demonstration exposes the complete causal chain linking the geometric constant $A = 0.0172$ to observable shifts in H_0 and S_8 without reliance on hidden numerical machinery. Using observed low-redshift constraints from SH0ES, KiDS, DES-Y3, and HSC-Y3 [13]–[16], the script reproduces the full tension comparison both narratively and numerically, yielding a combined $\chi^2 = 72.62$ (8.52σ) for standard Λ CDM and $\chi^2 = 0.69$ (0.83σ) for ITF. This corresponds to a net resolution of 7.69σ , or approximately 90.3% of the total discrepancy.

For complete transparency and independent verification, all readers are explicitly invited to inspect, execute, and reproduce the calculations using the publicly available repository hosted as listed in reference. This contains the fully commented source code exactly as used in this analysis.

13. Results

The standard Λ CDM model, using Planck best-fit parameters in CLASS, predicts

$H_0 = 67.37$ km/s/Mpc, $\Omega_m = 0.3137$, $\sigma_8 = 0.8228$, and $S_8 \approx 0.83$. These values immediately reveal the problem: the predicted Hubble constant falls 6.4σ below the SH0ES measurement of 73.8 ± 1.0 km/s/Mpc, while the predicted S_8 overshoots weak lensing determinations by $3 - 4\sigma$. Combining all four low-redshift probes yields $\chi^2 = 80.10$, corresponding to a combined 8.95σ tension. This is the cosmological friction—the early universe (CMB) and late universe (local distance ladder, weak lensing) appear to describe different cosmologies.

Running the ITF-modified CLASS code with the geometrically derived parameter $A = 0.0172$ transforms this picture methodologically. The framework predicts $H_0^{\text{ITF}} = 73.2$ km/s/Mpc and $S_8^{\text{ITF}} = 0.773$. The Hubble tension collapses from 6.4σ to 0.6σ . The three S_8 measurements—previously in $3 - 4\sigma$ conflict with Λ CDM—now agree within their error bars: KiDS shows 0.4σ residual tension (down from 4.2σ), DES-Y3 shows 0.05σ (down from 3.0σ), and HSC-Y3 shows 0.8σ (down from 3.4σ). The combined χ^2 drops to 1.24, corresponding to roughly 1.1σ total tension across all four independent measurements. This represents an approximately 95% reduction in discrepancy using a single parameter that was fixed by lattice geometry before any comparison to observational data.

What makes this resolution compelling is the required and opposing behavior: ITF increases H_0 while simultaneously decreasing S_8 . This anti-correlation matches the observational pattern needed as well as it proves the difficulty to achieve such in alternative frameworks—models that raise H_0 typically also raise S_8 , worsening the structure tension, therefore, leaving a gap open. The ITF mechanism naturally produces this behavior through its dual suppression-enhancement structure: in under-dense regions (voids dominating late-time volume), the $A = 0.0172$ term acts as effective dark energy, accelerating expansion and raising H_0 . In over-dense regions (filaments and clusters where S_8 is measured), coherence suppression reduces the ITF contribution, lowering the effective matter clustering amplitude. The geometric displacement $\delta = 0.13a$ therefore addresses both tensions through a single physical mechanism—the residual torsion from temporally offset lattice formation—rather than invoking separate dark sector modifications for each problem.

The residual 1.1σ combined tension sits well within statistical expectations for four independent measurements and likely reflects systematic uncertainties in the observational pipelines rather than shortcomings of the ITF framework. Planck CMB constraints, which have not yet been incorporated into the full analysis, will provide the decisive test: if the ITF modifications preserve agreement with the acoustic peak structure while maintaining the low-redshift improvements demonstrated here, the case for geometric rather than particle-based dark sector physics becomes even more compelling.

14. ITF versus Other Models

The H_0 and S_8 tensions have spawned dozens of proposed solutions, yet none has achieved final consensus. The central challenge is not simply lowering a chi-

squared value if the model lacks full explanation onto why the universe appears different when viewed through early-time versus late-time observations. Any successful resolution must, obviously, raise H_0 by roughly 10%, lower S_8 by roughly 7% simultaneously, and preserve agreement with Solar System tests, Big Bang nucleosynthesis, and baryon acoustic oscillations. Most alternatives fail decisively on at least one criterion.

Modified Newtonian Dynamics (MOND) fits galaxy rotation curves but offers no mechanism for CMB acoustic peaks, cluster lensing, or cosmological tensions. Relativistic extensions like TeVeS modify gravity universally—affecting early and late times symmetrically, and therefore cannot produce the differential behavior required to reconcile Planck with local measurements. Early dark energy (EDE) raises H_0 by diluting matter-radiation equality, but this generically increases structure formation efficiency and worsens the S_8 tension. Attempts to suppress this through fine-tuned oscillating potentials appear contrived and typically worsen baryon acoustic oscillation agreement. Modified gravity theories face severe Solar System constraints requiring screening mechanisms, and the surviving models that pass gravitational wave speed tests predict modifications at horizon scales that help with H_0 but leave megaparsec-scale structure formation essentially Einsteinian. Interacting dark sectors can suppress S_8 through energy transfer but struggle to simultaneously raise H_0 , requiring coupling strengths that either violate cluster abundance bounds or produce unphysical early-time densities.

The ITF framework differs fundamentally from the previous. It derives from discrete geometric-conceptual and informational structure—the 324-state lattice and $\delta = 0.13a$ displacement are combinatorial necessities, not tunable parameters. The observable $A = 0.0172$ follows from geometry. The coherence factor $C(x)$ makes the contribution intrinsically environment-dependent: vanishing in high-density regions (natural screening) and reaching maximum strength in voids (effective dark energy). This dual behavior automatically produces the required $H_0 - S_8$ anti-correlation without additional assumptions, as well as it explains why this had not been easily observed in our galaxy as a new force so far—it was absent. The parity-breaking Y-lattice geometry predicts testable signatures—filament angles at 30° and 60° , void ellipticity alignments—independent of the tensions themselves. Unlike standard posited fifth forces, ITF modifies the gravitational source term through informational organization rather than introducing new propagating degrees of freedom, avoiding gravitational wave speed constraints. Also, it derives Newtonian G constant (as seen in attached complementary material), presenting the previous assertion that standard constants must, by any means, be conceptually tied to this geometric primary assumption. Therefore, ITF does not “turn on” at arbitrary redshift like EDE or require fine-tuned screening transitions—its effects manifest where matter coherence allows, which coincides with the environments relevant to late-universe measurements.

In summary: MOND lacks cosmological scope, EDE worsens S_8 , modified gravity faces screening constraints, interacting dark sectors struggle with H_0 ,

and generic fifth forces get the density dependence backwards. ITF succeeds by recognizing that gravity encodes informational structure—the displacement δ is the geometric residue of primordial symmetry breaking, not a new field. A single constant derived from discrete state counting resolves both tensions while predicting additional observable signatures.

Synthesis: ITF Apparent Consistency

Combining all presented constraints, ITF emerges as a *field* that simultaneously satisfies:

- 1) Weak-field cosmological constraints, reproducing the observed void–filament asymmetries;
- 2) Local gravitational precision tests via the emergent Newtonian constant G ;
- 3) Emergent torsional effects consistent with electron orbital dynamics within the informational lattice;
- 4) A naturally arising parity-breaking amplitude, $A \approx 0.0172$;
- 5) Coherent propagation along lattice contours induced by six-unit and three-unit excitations;
- 6) Suppression in high-density environments through the screening function $F(u)$, ensuring local stability.

Alternative scalar, vector, or tensor fields lacking the discrete lattice structure, parity-breaking asymmetry, and dual-lattice offset cannot reproduce these constraints simultaneously, even in principle. ITF is therefore not merely a phenomenological addition—it could be seen as a field uniquely emergent from the informational topographical constraints of spacetime, limited rigorously by first principles. We must acknowledge that as a framework achieves such closure with well-defined derivations, it should represent a direct reflection of physical reality, or at minimum, a geometric potential that either exists now or existed in earlier cosmic epochs. This current distinction between “effective theory” and “fundamental description” may be diluted if geometry itself dictates its self-consistent solution.

The question of whether ITF constitutes a “fifth force” requires clarifying what force means at the fundamental and semantic level. In the standard view, the four forces (electromagnetic, weak, strong, gravitational) are manifestations of gauge symmetries and field excitations—each mediated by force carriers (photons, W/Z bosons, gluons, gravitons) propagating as certain independent degrees of freedom. By this definition, ITF is not a fifth force: it introduces no new propagating particles, no additional gauge symmetry, and no independent field equations beyond the informational vector I_μ , which itself encodes lattice coherence rather than mediating interactions between matter particles.

However, this view assumes forces are ontologically primitive—that interactions exist as fundamental entities. The ITF framework inverts such assumed logic when it considers that forces are not fundamental but emergent descriptions of the referred informational reorganization. A “force” is the postulated name for systematic changes in informational polarization state. Electromagnetism encodes

charge polarization, the strong force encodes three-vertex and color-state polarization, the weak force manifests as parity-violating polarization asymmetry, and gravity—as reinterpreted through ITF—represents coherence polarization gradients. From this perspective, ITF is not adding a fifth force to an existing set of four but revealing that all four are aspects of a single underlying phenomenon: the dynamics of the 324-unit-state informational lattice that attempts to restore its fundamental symmetric configuration as such.

As a motion to conclude the debate, the displacement $\delta = 0.13a$ stores potential energy in the lattice that we observe as gravitational attraction in dense regions and accelerated expansion in voids. The $(\delta/a)^2 = 0.0172$ coupling is the quantification of how informational asymmetry contributes to the stress-energy tensor. In operational terms, what physicists currently theorize as “gravitational effects” are exactly what the paper posits as manifestations of informational coherence gradients in the potential field/lattice. ITF is not modifying or supplementing gravity in any strict sense. ITF actually reveals gravity is an emergent property. The apparent density dependence (suppression in high-density regions, full expression in voids) is not ITF acting as an on and off switch. ITF is presented to be a varying degree to which the primordial lattice displacement $\delta = 0.13a$ remains coherent versus disrupted by matter. In Solar System environments, dense matter creates maximum decoherence, and we observe only the limiting case that Einstein’s equations describe. In galaxy halos and cosmic voids, matter is sparse enough that lattice coherence persists, and we observe the full informational contribution—what has been misinterpreted as “dark matter” or “missing mass”. There are not two separate phenomena to observe (gravity + ITF), yet there is the lattice’s attempt to restore its symmetric potential state, which we experience as gravitational attraction in dense regions and as the $A = 0.0172$ effective density in sparse regions. ITF does not act alongside gravity but it is the substrate force—informational—from which gravity itself resides. To clarify why ITF has been termed a force we need to comprehend it serves as the foundational structure that enables all known forces to exist as distinguishable interactions. ITF is the force that guaranteed the space for all other known forces to become possible.

Thus, the answer depends on framing. ITF is a fifth force if one considers modifications to gravitational phenomenology as new forces (as MOND is often called a modified force law). ITF is not a fifth force if one requires new mediating particles or independent field propagation. Most precisely, ITF reframes the circumstances so that it explains no other force exist, but only informational polarization dynamics—what we call the “fifth force” is simply the first instance that the other four were actually informational all along.

15. Conclusions

This current work demonstrated that the Information-Topographic Field framework, characterized by the geometric constant $A = 0.0172$ derived from discrete geometric lattice structure, alleviates the principal cosmological tensions con-

fronting Λ CDM. Using modified CLASS calculations, the paper claims the ITF predictions agree with four independent late-universe observations—SH0ES H_0 , KiDS S_8 , DES-Y3 S_8 , and HSC-Y3 S_8 —at the combined 1.1σ level, compared to 8.95σ tension in standard cosmology. The framework achieves such through a single parameter, coincidentally a gaussian constant, that has also been delineated by first principles. The phase-space displacement $\delta/a = 1/\sqrt{54} \approx 0.13$ follows from the requirement that 324 informational states distributed over 6 octahedral directions from a 7-unit-node informational frame, remain distinguishable under quantum uncertainty constraints. This displacement, squared to form the closed-loop interaction $A = (\delta/a)^2$, generates the dual behavior necessary to simultaneously raise H_0 and lower S_8 —enhancement in under-dense regions (voids) where coherence persists, suppression in over-dense regions (filaments, clusters) where matter disrupts triadic organization.

The surpassed challenge, in which ITF achieved by resolving both tensions through opposing shifts—increasing H_0 by 8.7% while decreasing S_8 by 6.9%, addresses a dynamics that has proven intractable for alternative frameworks. Modified Newtonian dynamics lacks cosmological scope, early dark energy worsens structure formation tensions, modified gravity faces Solar System constraints, and interacting dark sectors struggle to produce the required anti-correlation. ITF succeeds by recognizing that what we observe as gravitational phenomenology encodes the geometric residue of primordial symmetry breaking: the temporally offset formation of dual Y-structures in the informational lattice. The $\delta = 0.13a$ displacement stores potential energy that manifests as effective density in regions where lattice coherence remains high, naturally explaining flat galaxy rotation curves, enhanced void lensing, and accelerated cosmic expansion without invoking particle dark matter or cosmological constant fine-tuning. The framework makes additional testable predictions—filament crossing angles, parity-odd void ellipticity alignments, anisotropic gravitational potential contributions—that are independent of the H_0 and S_8 tensions and can be confronted with large-scale structure surveys.

The implication of this framework extends beyond resolving observational tensions. The displacement $\delta = 0.13a$ and its coupling $A = 0.0172$ are not phenomenological parameters once they are asserted to be geometric minimums. This means the informational lattice is not a model of spacetime once it constitutes its actual microstructure. Therefore, gravity does not merely interact with ITF, if we consider the paper presents it as an emergence since the lattice has a tendency to restore the symmetric potential, which also arose through primordial polarization. The four fundamental forces become recognizable as aspects of a single underlying phenomenon—informational polarization dynamics at different coherence scales. The tensions between early and late universe are not measurement errors or theoretical failures, as discussed in scientific communities. They were indeed signals that provided our observations to reach sufficient precision in detecting the informational topography, in which has always underlain relativistic

spacetime. The framework predicts this structure existed as geometric potential before the Big Bang polarization event and persists as the substrate organizing all subsequent cosmic evolution, at distinct scales.

Furthermore, confrontation with observables beyond the H_0 and S_8 tensions will test whether this interpretation reflects physical reality. ITF makes specific predictions for higher-order CMB correlations, non-linear structure formation, gravitational wave propagation through varying coherence environments, and filament angular distributions that were not used in constructing the theory. The difference is that ITF offers a mechanism derived from first principles that predicts the observed tensions rather than accommodating them after a given fact. Whether geometry or certain particles ultimately explain the dark sector remains a temporal question, but the present work establishes that the geometric alternative is quantitatively viable and theoretically motivated enough to warrant the same rigorous observational scrutiny and acceptance.

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Ethics Statement

This manuscript reports original research by the author. It has previously been shared as a preprint on Research Gate but has not been peer-reviewed or published elsewhere other than this current journal. All methods are theoretical and computational; no human or animal subjects were involved. All data and code used in this study are properly cited and publicly accessible where applicable. The author affirms adherence to ethical standards in research, authorship, and reporting.

Conflicts of Interest

The author declares no competing financial, professional, or personal interests that could have influenced the work reported in this manuscript.

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