# Unified Five-Dimensional Cognitive-Geometric Topological Field Theory

*A fifth atemporal conscious geometric dimension with stratified time*

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## Abstract

Reality is hypothesised to be one atemporal, conscious, five-dimensional geometric whole $X^5$. Its large-scale organisation is represented by a global foliation and an infinite mesh of vortons: proposed topological energy–information resonators organised around toroidal structures. The mesh contains six classes (Types 0–5). Type 0 is defined by recursive toroidal nesting: a single outer toroid contains a hierarchy in which each parent toroid has at least two smaller sub-toroids at the next sub-level. These sub-tori lie within and contribute to the boundary wall of each recursive parent toroid; they are not simply concentric rings placed in its central cavity. The sub-tori are oriented perpendicular (90°) to the toroidal layer they collectively form. The pattern repeats inward at successive sub-levels. Its Fractal Toroidal Moment (FTM) denotes the collective electromagnetic and geometric organisation of the entire hierarchy—not a single vortex. Charge separation, multi-axis hydrodynamic shear and energy input are proposed formation conditions; phase singularities, electromagnetic confinement, helicity and an anapole-like non-radiating boundary are proposed structural features. Type 0 is proposed to be potentially scale invariant, in the sense that the same nesting rule recurs at every sub-level; exact scale invariance is not established. Type 0 may be related to the formation of other vorton classes, but that relationship is a hypothesis.

Type 1 is a finite triad of concentric toroids associated, by postulate, with the three fermion generations. Types 2–5 are knotted, linked, helical/twisted and hybrid configurations. A condensate phase selects a global foliation; a rank-one dressing of a positive-definite five-dimensional reference metric supplies a Lorentzian reduced description. Time is stratified into ordering, proper, thermodynamic and observer-experienced readings. Gravity is proposed as the induced response of the gapped mesh-mode sector. The Einstein–Hilbert form and its coefficient arise at one loop only conditional on five explicit postulates, P1–P5, and a stated heavy-mode regime; the trace-free classical field equation is a separate postulate, P6. Local consciousness is modelled as a localised view of the whole; topological solitons and standing electromagnetic waves of the mesh are proposed, by postulate, as the physical link between local consciousness and universal (God) consciousness. The paper distinguishes mathematical consequences within the model from hypotheses, conditional effective-field-theory results and unresolved questions.

The framework's physical claims remain conjectural. The paper does not treat proposed Type 0-5 formation, confinement, stability, matter concentration or regeneration as experimentally established.

### Ontological identifications

- Dark matter = the energy-bearing vorton mesh, with an approximately pressureless effective equation of state.
- Dark energy = a proposed twist stress associated with coherent handedness bias.
- Gravity = the induced geometric response of the gapped mesh-mode sector.

Ontological chain. Timeless whole → global geometric organisation → vorton mesh → gapped mesh-mode sector → covariant one-loop effective action $\Gamma[g]$ → emergent gravitational geometry → four-dimensional spacetime →

matter, gauge fields and observers → localised conscious perspectives. Each arrow denotes dependence or a change of description, not a process occurring in fundamental time.

## 1. Postulates and conventions

C1. Atemporal conscious geometric whole. The fundamental arena $X^5$ is a timeless structure with positive-definite reference metric GAB. It carries a conscious–informational sector ΦC; the identification of the whole with existence, consciousness or God is a philosophical interpretation, not a testable physical result. The proposed physical link between local consciousness and the whole, through vorton topological solitons and standing electromagnetic waves, is stated in §9.1.

C2. Vorton mesh. $X^5$ contains a countably infinite population of vortons of Types 0–5, with locally finite coarse-grained density. Type 1–5 configurations are finite at the level of each vorton. Type 0 is the recursively nested toroidal configuration described in §3.5: each parent toroid has at least two sub-tori at the next recursive level, located within and contributing to its boundary wall, with the sub-tori perpendicular (90°) to the layer they form. No exact contraction ratio, universal total depth or energy law is imposed.

C3. Stratified time. There is no fundamental time. The timeless structure admits four distinct readings, $\lambda \to \tau \to t \to \tau_i$, defined in §4. λ is an ordering label, not a time coordinate.

C4. Recovery of established physics. The reduced four-dimensional description must reproduce the Standard Model, general relativity, ΛCDM cosmology and quantum theory in tested regimes. Deviations must remain below present bounds.

C5. Gravitational assumptions. The induced gravitational sector uses P1–P5 in §6.2. P6 is the independent trace-free field-equation prescription in §6.6.

Conventions. $\varphi = (1 + \sqrt{5})/2$ is the golden ratio; $\hbar = c = 1$ unless stated. $K^1 = S^1/(Z_2 \times Z_2')$ is the compact spatial direction. The symbols ρC and vC denote canonically normalised four-dimensional zero-mode quantities unless a subscript 5 is shown. The theory is a hypothesis and its ontological language is not evidence for the physical mechanisms proposed.

## 2. Arena, condensate and the reading of time

### 2.1 Five-dimensional substrate

$$X^5 \simeq M^4 \times K^1,\ K^1 = S^1/(Z_2 \times Z_2'),\ 0 \le y \le R/2.$$

The reference metric GAB has signature (+,+,+,+,+). All five directions are spacelike; y is not a time coordinate and GAB never changes signature. The compact interval has length LK = R/2. A five-dimensional condensate amplitude $\rho_5$ has mass dimension 3/2; its normalised four-dimensional zero mode is $\rho C = \sqrt{LK}\,\rho_5$, of mass dimension 1, so that $\rho_5^2 = \rho C^2/LK$ for a y-independent profile. The phase Θ and the coherence scale ΛC have dimensions 0 and 1 respectively.

### 2.2 Condensate and foliation

$$\Phi C = \rho C\, e^{i\Theta},\ \rho C \ge \rho\min > 0.$$

The condensate has a global U(1)C phase symmetry and no associated gauge field. It is taken to be independent of y. Its positive Euclidean functional is written with the five-dimensional amplitude,

$$E\Theta = \int d^5X \sqrt{G}\, \rho_5{}^2\, GAB\, \partial A\Theta\, \partial B\Theta \ge 0.$$

Its mass dimension is 3 + 2 − 5 = 0, so EΘ is dimensionless in $\hbar = c = 1$ units. For the y-independent zero mode, integration over $K^1$ gives a factor LK, and the functional is equivalently the reduced four-dimensional functional

$$E\Theta = \int d^4x \sqrt{G_4}\, \rho C^2\, G\mu\nu\, \partial\mu\Theta\, \partial\nu\Theta, \quad \rho C^2 = LK\, \rho_5{}^2,$$

whose integrand has dimension 2 + 2 = 4, matching $d^4x$. EΘ is a Euclidean variational functional that defines the phase boundary-value problem; it is not a canonically normalised action, and an overall constant factor (for example ½) is conventional and does not affect its minimiser or the equation below. The phase obeys a Poisson-type boundary-value equation,

$$\partial A(\sqrt{G}\,\rho_5{}^2\,GAB\,\partial B\Theta) = \sqrt{G}\,J\Theta^{(5)}, \quad \text{equivalently} \quad \partial\mu(\sqrt{G_4}\,\rho C^2\,G\mu\nu\,\partial\nu\Theta) = \sqrt{G_4}\,J\Theta^{(4)},$$

where the five-dimensional source $J\Theta^{(5)}$ has mass dimension 5 and the reduced source $J\Theta^{(4)} = LK\,J\Theta^{(5)}$ has mass dimension 4. For fixed positive amplitude the phase functional is a convex quadratic form. Convexity alone fixes the minimiser only up to the constant phase zero mode $\Theta \to \Theta + \text{const}$ (the global U(1)C), under which EΘ and the source-free equation are invariant. Uniqueness therefore additionally presupposes boundary conditions that remove this zero mode; Dirichlet data for Θ on all, or on a non-empty part, of the boundary are one sufficient choice. Under purely Neumann or periodic conditions the minimiser is unique only modulo an additive constant, which leaves uA and the foliation leaves unchanged. Boundary conditions are chosen so that Θ varies monotonically along a foliation coordinate σ, with $|\partial\delta\Theta| < k\Theta$ for $\Theta = k\Theta\sigma + \delta\Theta$. Then $\partial\Theta \neq 0$ and

$$uA = \partial A\Theta \,/\, |\partial\Theta|G, GABuAuB = 1.$$

The leaves Θ = constant form a global foliation. The phase is not dressed and has no propagating waves in this formulation. The no-saddle condition and the smallness of mesh back-reaction are assumptions about admissible sources, not general theorems.

### 2.3 Reading postulate and Lorentzian dressing

$$\bar{g}AB = GAB - \bar{\beta}\,uAuB, \bar{\beta} = \xi d\langle\rho C^2\rangle/\Lambda C^2.$$

Here ξd is dimensionless and the average is over $K^1$ and a transverse region of radius ℓc. In an adapted frame $\bar{g}$ = diag(1 − $\bar{\beta}$, 1, 1, 1, 1). For $\bar{\beta} > 1$ the signature is (−,+,+,+,+). This rank-one deformation is the reading postulate: it is not derived from EΘ and is not a Wick rotation. Standard-sign reduced kinetic terms are required for consistency but do not establish interacting unitarity.

The coarse-grained dressing is meaningful for wavelengths ≥ ℓc, with ℓc ≥ rw for finite-core vortons. The universality assumption U1 states that all non-phase sectors share the same kinetic tensor $\bar{g}AB$; y-dependent profiles enter only scalar or Yukawa factors. This gives a common characteristic cone at leading order.

### 2.4 Four-dimensional projection

$$PAB = \delta AB - yAyB, g\mu\nu = P\mu\nu\,\bar{g}\mu\nu + h\mu\nu.$$

Projection removes the compact direction. In adapted coordinates, P $\bar{g}$ = diag(−α²,1,1,1), with $\alpha^2 = \bar{\beta}_0 - 1$ and τ = ασ. The negative eigenvalue comes from dressing, not compactification. The physical metric is the projected dressed background plus the emergent gravitational perturbation hμν. Its dynamics are assigned to Γ[g] and P6, not to a five-dimensional curvature term. The four-dimensional effective description applies at L ≫ max(R, ℓc).

## 3. The mesh and taxonomy of vortons

### 3.1 Fractal Toroidal Moment

A Fractal Toroidal Moment (FTM) is the collective electromagnetic and geometric organisation of nested toroidal circulating structures. It is not one magnetic vortex or a mere collection of independent spinning objects. The proposed FTM coordinates circulation across scales, electromagnetic relationships between levels, phase singularities, energy concentration and confinement, and possible mutual stabilisation. In Type 0, the recursion is branching: each parent toroid contains at least two smaller sub-tori at the next sub-level, embedded in and contributing to the parent's toroidal boundary wall.

The model's finite-FTM construction uses nested vortex-loop layers with a common geometric centre, distinct radii, thin cores and approximately orthogonal successive axes. In the calculable Type 1 ansatz, radii contract by φ and axes

rotate by 90°. Type 0 has a distinct recursive geometry: each parent toroid contains at least two smaller sub-tori at the next sub-level, within and contributing to its boundary wall; these sub-tori are perpendicular (90°) to the layer they collectively form. This is not a stack of concentric rings. The minimum branching count does not specify an exact contraction ratio, total depth, core-radius law or infinite limiting construction. Accordingly, φ-scaling is retained as a parameterised construction for finite FTMs and as an optional Type 0 specialisation—not as a defining or established Type 0 law.

| Construction feature | Model statement |
|---|---|
| Nested circulation | Toroids within toroids recur inward. Each parent has at least two sub-tori at the next sub-level; these lie within and contribute to its boundary wall. |
| Orthogonal organisation | The sub-tori are perpendicular (90°) to the toroidal layer they collectively form. The precise orientation pattern within each layer remains to be specified. |
| Common organisation | The FTM describes the collective electromagnetic and geometric behaviour of the recursively branching hierarchy, including relationships between parent and sub-tori. |
| Phase and fields | Carrier-field phase windings may generate phase singularities and toroidal moments; these are distinct from the condensate phase Θ. |
| Confinement and radiation | Anapole-like cancellation may suppress radiation in stationary configurations; driven configurations can radiate. |
| Scale invariance | Type 0 is proposed to be potentially scale invariant: the same nesting rule recurs at every sub-level (§3.5). This is a hypothesis; no exact ratio or depth is specified. |
| Finite-core rule | For Types 1–5, a core radius rw limits the number of resolved layers: Dmax = floor[1 + ln(r/rw)/ln φ]. Type 0 is not assigned this fixed-core cutoff. |

For a finite layer, the model uses $E(\rho) = 2\pi Y\rho + \kappa/\rho$, with equilibrium $\rho\star = \sqrt{(\kappa/2\pi Y)}$, $E\star = 4\pi Y\rho\star$ and positive radial Hessian $2\kappa/\rho^3$. These relations belong to the finite-layer ansatz; they do not by themselves establish the energy or stability of a Type 0 nest.

## 3.2 Vorton descriptors and classes

Each vorton is described by geometry, topology, dynamical state, coupling environment and functional role. A separate scale-support descriptor records whether its ultraviolet and infrared limits are finite. Topology does not uniquely determine frequency, and geometry does not uniquely determine function.

| Type | Morphology and topology | Scale/role in the framework |
|---|---|---|
| 0 | One outer toroid with a recursively branching hierarchy: each parent contains at least two sub-tori at the next level, embedded in and contributing to its boundary wall; sub-tori are perpendicular (90°) to the layer they form. FTM is the whole organisation. | Recursive, toroids-within-toroids archetype; proposed energy confinement and long-lived coherence; potentially scale invariant under repeated nesting (hypothesis); may relate to formation of other types. No fixed φ-law, exact depth, infinite-limit energy sum or spectral law is asserted. |
| 1 | Three concentric toroids on a common centre, each a finite FTM; ready and engine orientations. | Finite, band-limited; hierarchical organisation and proposed three-generation structure. |
| 2 | Knotted structures. | Finite, band-limited; persistent structural information is a proposed role. |
| 3 | Linked structures. | Finite, band-limited; topological coupling. |
| 4 | Helical and twisted structures. | Finite but potentially very extended; lowest infrared scale among finite classes. |
| 5 | Hybrid or multicomponent structures combining other types. | Inherits component scale limits; tritoroidal hybrids can carry the Type 1 generation organisation. |

Type 0 and Type 1 are related through the FTM motif but are not interchangeable. Type 1 is a finite, specifically tritoroidal configuration with a proposed generation role and compact-direction winding assignment. Type 0 is the broader recursively branching toroidal configuration. Its defining emphasis is the collective multi-scale electromagnetic organisation. The proposal that Type 0 can participate directly in the formation of Types 1–5 is retained as a hypothesis, not a demonstrated transition pathway.

### 3.3 Type 1: concentric tri-toroidal vorton

Three toroids Vn (n = 1,2,3) share a centre. In the ready state their axes an are mutually perpendicular. Toroid 1 is outermost, with outer radii r1 > r2 > r3; each is a finite FTM with $\rho_{n,k} = \varphi^{-(k-1)}rn$. Under the additional carrier-winding assumption A-W, the outer boundary layer carries wn = n, while inner layers are neutral companions. The assignment of the three toroids to the three fermion families is a model postulate.

$$rn = r1\sqrt{[(\nu + 1)/(\nu + n^2)]},\ kn = 1/rn,\ \nu = \Upsilon 0/\Upsilon w.$$

For vanishing mass, inter-toroid coupling and ν, the outer-mode frequency ladder approaches 1:2:3. Away from that limit it is corrected by the layer tension and mass terms; it is not a parameter-free prediction. Within a toroid, finite-layer frequencies follow $\omega_{n,k}^2 = \rho_{n,k}^{-2} + m^2$.

Distinct radii and explicit clearance $d_{min} = \min|\rho - \rho'| - 2rw > 0$ are required to prevent overlap. In the ideal confined, perpendicular configuration, mutual inductance between layers or toroids vanishes. Residual coupling from tilt or finite-core leakage requires orientation locking. An optional phase coupling Ξ can mix toroids, but positivity of the full quadratic mode matrix $W^2 = \mathrm{diag}(\omega^2) + L_{ind} + L\Xi$ must be checked at the chosen phase-locked minimum; Ξ ≥ 0 alone does not prove it.

Stability is conditional. A positive single-layer radial Hessian is established by the assumed energy function. Stability of the full nest requires ‖Sind‖ < 1 and a positive quadratic operator. For more than three distinct axes, the dipole-coupling parameter must satisfy gd < 1. These are conditions to be verified, not proofs of nonlinear soliton stability.

The proposed engine state aligns the inner and outer toroid axes while leaving the middle toroid perpendicular. Its axis Gram matrix changes from eigenvalues {1,1,1} to {2,1,0}; the reduced Hessian has eigenvalues {1 + gd, 1, 1 − gd} before corrections. This is a matrix-level consistency check only. The existence and nonlinear stability of the engine-state soliton remain unproved. Its small steady twist energy is proposed as a microscopic source of the twist stress in §§6–7.

The foliation orients the transverse space and defines handedness hn = ±1. A non-degenerate preference for one aligned handedness, ΔE > 0, is assumed; phase-frustration energy is a possible mechanism, not a derivation.

### 3.4 Types 2–5

Type 2 uses knotting to distinguish configurations; Type 3 uses linking; Type 4 uses helical or twisted organisation and may be very large but finite; Type 5 combines features of other classes. Types 2–4 do not independently add further fermion generations. Numerical cutoffs and detailed stability criteria for these classes remain unspecified.

### 3.5 Type 0: nested-toroidal configuration

Definition. Type 0 has one primary outer toroid and a recursively branching interior hierarchy. At every recursive sub-level, each parent toroid contains a minimum of two smaller sub-tori. These sub-tori are located within and contribute to the boundary wall of the parent toroid; they are not merely separate concentric rings occupying the central opening. The sub-tori are oriented perpendicular (90°) to the toroidal layer they collectively form. Each sub-torus is itself a parent for the next recursive level, again with at least two sub-tori, so the architecture is toroids within toroids, with a minimum branching factor of two at each level. The Fractal Toroidal Moment (FTM) names the collective electromagnetic and geometric organisation of the complete hierarchy.

The geometry supports recursive nesting, a minimum of two sub-tori per parent at each sub-level, and the perpendicular relationship between the sub-tori and the layer they collectively form. It does not establish an exact contraction factor, equal spacing, a fixed number of levels, an infinite limiting construction, or a specific core-radius or energy law. The detailed branching beyond the minimum, orientations within a layer, sub-core geometry, scale law and boundary conditions remain open model parameters.

Possible scale invariance. Type 0 is proposed to be potentially scale invariant: because the same rule (at least two perpendicular sub-tori embedded in the boundary wall of every parent) is applied at each sub-level, the organisation seen at one level resembles that seen at the next. If a fixed contraction ratio between levels exists, the invariance

would be discrete (self-similarity under that ratio, as in the discrete-scale invariance of ref. [2]) and could in principle leave log-periodic signatures; if no fixed ratio exists, the self-similarity is only structural. The paper does not establish either case. It does not specify an exact ratio, total depth or infinite limit, and the golden-ratio contraction remains only an optional specialisation. Scale invariance would in any case be broken wherever a finite core, cutoff or boundary condition enters, and Type 0 is not assigned the fixed-core cutoff of Types 1–5. It is stated here as a hypothesis about Type 0 geometry, not as a derived property.

Energy organisation, cores and boundary. The nest is proposed to concentrate, store, redistribute and transform electromagnetic energy rather than merely provide paths through which energy passes. One hypothesis is that appropriately organised fields form closed or circulating Poynting-vector patterns that reduce energy leakage. The Poynting vector describes electromagnetic energy flux; closed energy-flow configurations and their longevity must be demonstrated by solving the coupled field equations and boundary conditions.

Phase singularities—locations where a wave-field phase is undefined—are proposed at nested toroidal cores. They may concentrate magnetic energy, support local electromagnetic coherence and stability, and provide sites where matter could become concentrated. The source describes these as monopole-like or topological-monopole cores; this terminology does not establish the existence of isolated magnetic monopoles.

A spherical outer boundary is proposed as a non-radiating boundary for the whole nested arrangement. The proposed mechanism extends anapole-like cancellation of radiating electric and magnetic multipoles and confinement of toroidal fields. Anapole cancellation is a recognised electromagnetic mechanism only under particular conditions; its extension to a complete Type 0 nest is a hypothesis. It applies, at most, to a stationary configuration. Driven toroidal modes may radiate and must satisfy observational limits.

Feedback, helicity and regeneration. The proposed feedback is that circulation supports coherent cores, the cores concentrate matter and electromagnetic energy, and those interactions help maintain circulation. This is a self-maintaining feedback hypothesis, not a source of unlimited energy: energy conservation still requires accounting for stored energy, losses and any continuing input. Helicity, describing the relation between circulation and field/flow twisting, is proposed as a control parameter that can assist nesting, coherence, stability and phase-singularity formation.

If confinement fails, the structure may release contents and reorganise, collapse, reform or generate new structures. Breakdown and regeneration are proposed behaviours, not established outcomes. Type 0 may be directly related to formation of Types 1–5; the direction, conditions and dynamical mechanism of such a relationship remain to be specified.

### 3.6 Topological charge and toroidal moments

For Type 1, the proposed charge is $Q_{top} = \Sigma_n c_n w_n h_n$, defined only under A-W. Since $K^1$ is an interval, a conserved integer winding is not automatic: a construction must specify carrier-field equivariance on the covering circle, boundary conditions at $y = 0$ and $R/2$, and permitted deformations. $Q_{top}$ is therefore conditional, not derived from the orbifold gauge parities. It is not baryon number. Vacuum charges are assumed to cancel by pairing; the observed baryon asymmetry is not derived.

Each layer has a toroidal moment directed along its axis. The three Type 1 principal moments form an asymmetric chiral triad in the ready state. Type 0 may exhibit a hierarchy of toroidal moments associated with its recursively nested, perpendicular sub-tori; their collective sum and radiation properties depend on the detailed branching and orientation sequence, which remain to be specified.

### 3.7 Mesh finiteness and coarse graining

The vorton population has locally finite coarse-grained number density $n_T(x)$, orientation and handedness fields. The total mesh stress must be finite. This finite coarse-grained stress requirement applies to every population of the mesh, Types 0–5 alike. Finite energy of each individual object is not by itself a finite ensemble mean: the coarse-grained

stress is the population-weighted average of the per-object stress over the number density and the distribution of object sizes and states, and it must be shown to converge for each population separately.

For Types 1–5, finite energy per object follows from finite layer counts, subject to finite energy per layer; finiteness of the coarse-grained stress additionally requires finite density and a convergent average over the object distribution. For Type 0, both the per-object energy and the ensemble average must be established from its actual field configuration and energy functional; no geometric-series argument is assumed. Any Type 0 population must have finite coarse-grained stress and satisfy radiation and cosmological constraints.

## 4. Stratified time

The arrows below denote changes of description, not processes in fundamental time:

$$X^5 \to E^5 \to M^4 \to E^4 \to S^4, \quad \lambda \to \tau \to t \to \tau_i.$$

| Level | Domain | Reading |
|---|---|---|
| 5 | $X^5$, GAB | Timeless whole; vorton mesh; elliptic condensate phase Θ defines uA. |
| 4 | $E^5$, $\tilde{g}AB$ | Foliation read as time; matter and gauge fields have Lorentzian dynamics. |
| 3 | $M^4$, $g\mu\nu$ | Proper time τ; Standard Model gauge group and matter generations. |
| 2 | $E^4$, ρred | Thermodynamic time t from coarse graining and tracing over hidden degrees of freedom. |
| 1 | $S^4(\tau_i)$ | Observer-specific experienced ordering. |

λ labels consistent slices of the whole; it is not a coordinate or fifth time. A unitary relation between reduced Lorentzian states on different λ-slices is a consistency relation, not fundamental evolution. Proper time obeys $d\tau^2 = -g\mu\nu dx\mu dx\nu$; relativity is not modified. Thermodynamic time is associated with ρred = Trhidden ρ, where hidden degrees include the compact sector and unresolved mesh modes. A partial trace alone does not ensure monotone entropy; low-entropy boundary data at one end of the foliation are additionally assumed. $\tau_i$ is the ordering by which a localised observer samples the structure; no coordinate map among $\tau_i$, τ, t and λ is asserted.

## 5. Gauge structure, matter and the Standard Model

### 5.1 Orbifold breaking

On $K^1 = S^1/(Z_2 \times Z_2')$, take P: y → −y and P′: y → R − y. For bulk SU(5), choose $P = 1_5$ and P′ = diag(+,+,+,−,−). The (+,+) components of Aμ retain zero modes for SU(3)C × SU(2)L × U(1)Y; the X,Y gauge bosons have (+,−) parity and no zero mode. Ay has no zero mode. The KK masses are 2kπ/R for (+,+) and (2k+1)π/R for (+,−) and (−,+). Hypercharge is Y = diag(−1/3,−1/3,−1/3,1/2,1/2), with Q = T3 + Y. A bulk 5H with the appropriate intrinsic parity retains the Higgs doublet and projects out the colour triplet by boundary conditions.

### 5.2 Fermions, chirality and generations

One generation is assigned to $\bar{5} \oplus 10$, decomposing into the Standard Model multiplets. Complete multiplets arise from bulk fields with complementary parities or matter localised at the SU(5)-breaking fixed point. Colour is an ordinary gauge charge, not a vorton topological charge. The orbifold projection Ψ(x,−y) = Pγ5Ψ retains a chiral zero mode. The foliation orientation and vorton handedness are proposed to select the surviving chirality.

The three Type 1 toroids are associated with the three fermion families. The vorton index labels position in the mesh, not additional particle species, so an infinite number of vortons does not imply infinitely many generations. The statement that the Dirac operator on a Type 1 background has index 3 is a postulate, not a derivation. Type 0 carries no generation assignment in the model.

### 5.3 Masses, mixing and unification

Yukawa matrices arise from overlap integrals of left- and right-handed profiles with the Higgs profile across $K^1$. Inter-toroid phase coupling $\Xi$ can generate off-diagonal overlaps and flavour mixing; $\Xi \neq 0$ and positivity of the resulting mode operator are assumptions. The observed mass hierarchy and mixing angles are not calculated here.

Non-supersymmetric minimal SU(5) does not unify at one loop without KK, threshold or additional-content corrections. Localised gauge anomalies must cancel through matter content or suitable brane-localised Chern–Simons terms. X,Y exchange mediates proton decay; $\tau p(p \to e^+\pi^0) \gtrsim 10^{34}$ yr typically requires $R^{-1}$ of order $10^{16}$ GeV unless wavefunction overlap is suppressed. Compactification requires a stable minimum $V'eff(R)=0$, $V''eff(R)>0$; the mesh may contribute but does not guarantee it.

## 6. Gravity as the induced response of the mesh

### 6.1 Source and response

The mesh has two distinct roles. Its energy-momentum is a source on the right-hand side of the gravitational field equation; its internal organisation fixes the response coefficient on the left. The theory does not identify energy density with gravitational stiffness.

| Role | Quantity | Function |
|---|---|---|
| Source | $T_{mesh,\mu\nu}$ and $\rho_{mesh}$ | Vorton energy contributes to the stress-energy; it is proposed to account for dark matter with $w \simeq 0$. |
| Response | Organisation O, Neff, $\ell c$ and cR | Sets the induced gravitational coupling; at fixed internal spectrum and cell organisation it is independent of local mesh number density. |

The logical chain is: mesh organisation → gapped mode fields → covariant effective action $\Gamma[g]$ → common geometry for matter and light → gravitational response to total stress-energy. All Standard Model fields are assumed to share the same metric and leading characteristic cone.

### 6.2 Induced-action postulates

Integrating out an elastic energy alone does not derive an Einstein–Hilbert action. The proposed one-loop result is conditional on five postulates:

- P1. Continuum mode fields: at $L \gg \ell c$, the gapped mesh modes are represented by Ns real scalar fields $\vartheta I$ and ND Dirac fields $\psi J$, with mass matrix $M^2 = W^2$ and non-negative eigenvalues.
- P2. Universal covariant coupling: the mode action couples to the same four-dimensional metric $g\mu\nu$, with scalar curvature coupling $\xi I$ and no explicit preferred-frame coupling at leading order.
- P3. Dynamical metric: $g\mu\nu$ is integrated over in the full path integral; $h\mu\nu$ is the slowly varying background around which the modes are integrated out.
- P4. Covariant regulator: the physical cutoff $\Lambda = \hbar/\ell c$ is implemented through a covariant proper-time regulator.
- P5. One-loop adequacy: the one-loop effective action is assumed reliable at $L \gg \ell c$. This is questionable if $\Lambda$ is near the Planck scale.

The classical gravitational equation is not included among these five postulates. It is the separate P6 of §6.6.

### 6.3 Effective action and field counting

$$\Gamma[g] = \int d^4x \sqrt{-g}\,[cR\,R - \rho vac + c1R^2 + c2R\mu\nu R\mu\nu + c3R\mu\nu\rho\sigma R\mu\nu\rho\sigma + \ldots].$$

The local expansion applies only below the masses of the modes integrated out. Light modes below a matching scale $\mu IR$ must remain active or contribute nonlocally; $L \gg \ell c$ alone is insufficient. The matching scale is not fixed. The curvature weight of a real scalar is $wI = 1 - 6\xi I$, and the unweighted count is

$$\mathrm{Neff} = \Sigma I(1 - 6\xi I) + 2ND,$$

with internal multiplicities included. Spin-1 and ghost contributions are not included, so this is not a complete Standard Model count. Neff is a weighted mode count, not automatically an integer or a measured prediction. It is also an unweighted count in the sense that it ignores the mass dependence of each mode's threshold factor; the threshold-weighted count NF that controls the sign and size of the induced coefficient is defined in §6.4, and Neff is its leading small-mass approximation. A purely induced matching choice sets the independent bare Einstein coefficient to zero. If a bare term exists, the formula below describes only the induced contribution. Spectral convergence and a stable compactification radius are additional assumptions.

### 6.4 Induced gravitational coefficient

For a real scalar of mass m and curvature coupling $\xi$, the leading logarithmic approximation of the proper-time result, valid for $m \ll \Lambda$, is

$$cR \approx (1/6 - \xi)[\Lambda^2 - m^2 \ln(\Lambda^2/m^2) + (\gamma E - 1)m^2]/(32\pi^2) + O(m^4/\Lambda^2),$$

where $\gamma E$ is Euler's constant. The finite $O(m^2)$ term $(\gamma E - 1)m^2$ is retained here; dropping it gives the purely logarithmic form $(1/6 - \xi)[\Lambda^2 - m^2 \ln(\Lambda^2/m^2)]/(32\pi^2)$. The exact result for the sharp proper-time regulator retains the threshold factor:

$$cR = (1/6 - \xi)/(32\pi^2)\,[\Lambda^2 e^{-z} - m^2 E1(z)] = (1 - 6\xi)\Lambda^2\, F(z)/(192\pi^2), \quad z = m^2/\Lambda^2,$$

$$F(z) = e^{-z} - z\,E1(z), \quad F(0) = 1, \quad F(z) > 0.$$

Here E1 is the exponential integral. Expanding F for small z reproduces the bracket above, $\Lambda^2 F(z) = \Lambda^2 - m^2 \ln(\Lambda^2/m^2) + (\gamma E - 1)m^2 + O(m^4/\Lambda^2)$. A Dirac field contributes, at leading order, as two minimally coupled real scalars; an exact comparison requires matching masses and the corresponding threshold factors. Summing the modes for the sharp proper-time regulator defines the threshold-weighted count

$$NF = \Sigma I\,(1 - 6\xi I)\,F(zI) + 2\,\Sigma J\,F(zJ), \quad zI = mI^2/\Lambda^2,$$

$$1/(16\pi G4) = cR = NF\,\Lambda^2/(192\pi^2), \quad 1/G4 = NF\,\Lambda^2/(12\pi).$$

For all $zI \ll 1$ one has $F \to 1$ and $NF \to Neff$, which gives the leading small-mass result

$$1/(16\pi G4) = cR \simeq c_{reg}\,Neff\,\Lambda^2/(192\pi^2), \quad 1/G4 \simeq c_{reg}\,Neff\,\Lambda^2/(12\pi).$$

The regulator constant $c_{reg}$ is of order unity and equals 1 for the sharp proper-time cutoff; it changes with the covariant cutoff profile, and so does the threshold function F, whose profile dependence is not computed here. The sharp-regulator expressions above are exact only for the sharp regulator. Mass corrections are small only if the relevant masses are well below $\Lambda$. The numerical values of Neff, NF, $\Lambda$ and $c_{reg}$ are not derived.

Positivity. The physical condition is positivity of the full matched coefficient, $cR > 0$, that is $NF > 0$. The criterion $Neff > 0$ is only the leading criterion, and holds only when the small-mass approximation and the cancellations among weights are controlled. When the weights wI have both signs and the masses differ, Neff and NF need not even have the same sign, because each F(zI) is positive but unequal, so positivity of each F does not remove cancellations between signed curvature weights. As a direct counterexample to a general unweighted sign criterion (not a proposed spectrum for this paper), take scalar weights +2 and −1 at $z = 1$ and $z = 0.01$ respectively. Then $Neff = 2 - 1 = 1 > 0$, whereas the threshold-weighted sum is $2F(1) - F(0.01) = 2(0.148495507) - 0.949670538 = -0.652679524 < 0$. Both modes can be heavy relative to an infrared matching scale chosen well below $0.1\Lambda$. The full spectrum is not specified in this paper and remains unresolved.

An elastic matching route gives $G4 = \gamma s^2/(32\pi\kappa_{mesh})$, or $\kappa_{mesh}/\gamma s^2 = NF\Lambda^2/(384\pi^2)$ when matched to the induced result for the sharp regulator ($c_{reg} = 1$), which reduces to $Neff\Lambda^2/(384\pi^2)$ at leading order. This fixes the transverse-traceless kinetic normalisation only; it does not derive diffeomorphism invariance or the full Einstein equations. Matching the gravitational entropy gives $\eta = c_{reg}\,NF/(48\pi\ell c^2)$, with $G4 = 1/(4\hbar\eta)$, and $NF \to Neff$ at leading order; this is a matching relation, not a microscopic entropy calculation.

### 6.5 Newtonian limit and density independence

For g00 = −(1 + 2Φ/c²), the weak-field limit gives $\nabla^2\Phi = 4\pi G_4\rho$ and $\Phi = -G_4M/r$. The source/response distinction requires:

- G1—Density independence: $\partial G_4/\partial nT = 0$ while the internal spectrum, cutoff and cell organisation remain fixed. This is constitutive, not established for all halo states.
- G2—Universal gravitational coupling: baryons and mesh share one G4 and the same metric gμν, so the mesh falls like ordinary matter in gravitational fields, and all fields share a common leading characteristic cone (U1). This is a statement about gravitational coupling only. Universal metric coupling does not by itself exclude an additional scalar or electromagnetic interaction, so G2 carries no inference about the absence of a fifth force; any such interaction must be excluded or bounded separately (see below and §10).
- G3—Positive response: the full matched coefficient must satisfy cR > 0, that is NF > 0 (§6.4). The criterion Neff > 0 is only the leading criterion in the controlled small-mass regime where threshold corrections and cancellations among signed weights are under control.
- G4—Small back-reaction: changes in the response coefficient from mesh energy are assumed negligible in tested regimes.

Non-gravitational status of the dark component. The model does not assume that the mesh is exactly decoupled from the condensate amplitude and the photon portal of §9.2. It adopts the following working assumption: the same mesh population that supplies Ωmesh may have weak non-gravitational interactions, through the condensate amplitude ρC and the portal terms of §9.2, with strengths bounded by the fifth-force, αem, Lorentz/CPT, direct-detection and cosmological constraints of §10. Exact decoupling is the limiting case in which the mesh couplings to that portal vanish; a distinct dark population is not introduced. The magnitude of any such coupling is not derived. The portal constraints of §10 apply to baryonic matter irrespective of which case holds.

An elastic modulus is a response coefficient, not an energy density. Strain energy vanishes in the unstrained ground state; stiffness and mass density are independent properties. The high stiffness needed for a Planck-scale ℓc is therefore not identified with the observed dark-matter density.

### 6.6 Trace-free gravitational equation (P6)

The classical law is imposed independently of the one-loop action, with restricted variation: the variation of the inverse metric is restricted to δg^μν satisfying

$$g_{\mu\nu}\,\delta g^{\mu\nu} = 0 \quad (\text{equivalently } \delta\sqrt{-g} = 0),$$

so that only the trace-free part of the variational equation is obtained. This restriction is part of the P6 prescription itself; it is not identified with volume-preserving diffeomorphisms, and no common microscopic action for the induced action and P6 is claimed. The equation is

$$R_{\mu\nu} - \tfrac{1}{4}R\,g_{\mu\nu} = 8\pi G_4(\delta T_{\mu\nu} - \tfrac{1}{4}\delta T\,g_{\mu\nu}).$$

Here the pure-trace vacuum term $\bar{T}_{\mu\nu} = -\rho_{vac}\,g_{\mu\nu}$ is separated from non-vacuum stress δTμν. For constant G4, the Bianchi identity gives

$$G_{\mu\nu} + \Lambda_{cc}\,g_{\mu\nu} = 8\pi G_4\,\delta T_{\mu\nu}, \quad \partial_\nu\Lambda_{cc} = 8\pi G_4\,J_\nu,$$

$$J_\nu = \nabla_\mu\delta T_{\mu\nu}, \quad \Lambda_{cc} \equiv \tfrac{1}{4}R + 2\pi G_4\delta T.$$

A pure-trace shift in δTμν is absorbed into Λcc. If Jν = 0, Λcc is constant; if $J_\nu \neq 0$, an explicit hidden-sector stress $T_{hid,\mu\nu}$ with $\nabla_\mu T_{hid,\mu\nu} = -J_\nu$ is required. A mismatch in the condensate-phase equation cannot simply be relabelled Jν. The trace-free law reproduces ordinary GR with Λcc as an integration constant in the appropriate matter sector. It relocates rather than solves the cosmological-constant problem.

### 6.7 Foliation and tensor sector

A global preferred foliation places the reduced theory within the observational class of khronometric/Einstein-aether models. Tensor propagation must satisfy $|c_{GW} - c|/c \lesssim 10^{-15}$, along with preferred-frame, Solar-System and binary-pulsar constraints. These constraints apply only after the induced coefficients are mapped to the standard physical-metric variables. The elliptic $\Theta$ sector has no independent propagating khronon in the stated construction. A massless tensor zero mode with two polarisations is retained; internal mesh shear modes are assumed gapped at $L \gg \ell_c$.

### 6.8 Elastic interpretation and twist stress

At long wavelengths, mesh deformations may be represented by a displacement $d_\mu$ and shear $s_{\mu\nu}$. A pure coordinate displacement is not a physical graviton; only physical shear and incompatibility can be associated with metric deformation. The map $h_{\mu\nu} = \gamma_s\, s_{TF\mu\nu} + \gamma_v\, s\, \bar{g}_{\mu\nu} + \dots$ is interpretive. The dynamics of $h_{\mu\nu}$ come from $\Gamma[g]$, not from an independent elastic-gravity derivation. The restoring response is assigned to inter-vorton couplings, an assumption.

The twist stress $T_{twist,\mu\nu}(p_{twist}, \hat{h}, \nabla\Theta)$ is proposed as the source of dark-energy-like behaviour. It is not pure trace and may have anisotropic components along the foliation. The Type 1 engine-state twist energy is a candidate microscopic origin, but the state's existence and stability are not established. Any twist sector must preserve G1 and satisfy the foliation and energy-accounting constraints.

## 7. Cosmology

$$H^2 = (8\pi G_4/3)\delta\rho + \Lambda_{cc}/3, \quad \ddot{a}/a = -(4\pi G_4/3)(\delta\rho + 3\delta p) + \Lambda_{cc}/3.$$

The mesh is proposed to supply a pressureless component, $w_{mesh} \simeq 0$, with $\Omega_{mesh} \simeq \Omega_{cdm}$. The twist stress is proposed to account for dark energy and must have late-time $w_{twist} \simeq -1$ within observational bounds. In the limit $w_{twist} \to -1$ it is degenerate with the integration constant $\Lambda_{cc}$; the model then proposes an origin for that constant rather than a distinct observable.

An open-sector cosmological extension writes $\dot{\Lambda}_{cc} = 8\pi G_4 Q$, with Q representing exchange with hidden degrees of freedom. Any such exchange requires an explicit compensating stress and a specified timescale. Black-hole modulation and a small evolving twist contribution are qualitative ansätze only; no numerical amplitude is derived. The pressureless/twist split is assumed rather than obtained from the mesh microphysics.

A phenomenological delayed relaxation model may be written $\dot{x} = -a\, x(t) - b\, x(t - t_d)$, where $x = \Lambda_{cc} - \Lambda_0$ and $a,b > 0$. Its stability depends on the characteristic roots and delay. Stability of the equation does not imply monotonic relaxation for arbitrary initial histories. In the atemporal reading, "feedback" and "delay" describe relations among parts of a consistent history, not fundamental-time processes.

## 8. Quantum structure and information

The four-dimensional quantum state is the reduced state of the five-dimensional configuration. Pure states of the whole may appear mixed after tracing over the compact sector and unresolved mesh modes. Decoherence and effective irreversibility arise in reduced descriptions through entanglement and coarse graining; Lindblad dynamics is a possible Markovian limit. Quantum nonlocality remains the standard entanglement structure of quantum theory.

The model aims to preserve no-signalling, but does not prove it. The absence of free waves in an elliptic phase field does not by itself exclude source-dependent signalling. Matter back-reaction on $\Theta$ is assumed small and quasi-static, $O(\varepsilon)$. The coupled condensate system has an elliptic phase sector and a hyperbolic amplitude sector; perturbative iteration is proposed, but existence, uniqueness, convergence, interacting unitarity and causal consistency remain unresolved. The results claimed here are restricted to a fixed-background, decoupled limit.

## 9. Consciousness, electromagnetic portal and experienced time

### 9.1 Localised view

Universal consciousness is an ontological interpretation, not a testable physical result by itself. Individual consciousness is modelled as a localised view of the whole, associated with a finite phase-locked subset of vorton and layer modes in a biological system. For mode phases $\vartheta\iota$, a coherence order parameter is

$$r_i e^{i\psi_i} = |S_i|^{-1} \Sigma_{\iota \in S_i} e^{i\vartheta\iota}.$$

The observer is not treated as receiving a signal from the rest of the mesh; the localised-view correspondence is a postulate.

Solitons, standing waves and the link between local and universal consciousness. The paper proposes that topological solitons (stable, localised, topologically protected vorton configurations) and standing electromagnetic waves (closed, confined toroidal circulation and resonant modes of the mesh) are the physical medium by which local consciousness and universal (God) consciousness are connected. On this proposal the finite phase-locked subset of modes that constitutes a localised view is part of the same mesh of solitons and standing modes that constitutes the whole, so the connection is one of shared membership and phase-locking rather than of signal transmission, consistent with the statement above. The identification of the localised view with such modes, and the reading of the whole as universal consciousness, remain postulates and philosophical interpretation (C1); no dynamical derivation, soliton stability proof or experimental test is claimed.

### 9.2 Electromagnetic portal

$$L_{\gamma C} = -\tfrac{1}{4}(1 + \lambda_{\gamma\varepsilon})\, f_{\mu\nu} f^{\mu\nu} + (g_{h\hat{h}}/4)\, \hat{h}\, f_{\mu\nu} \tilde{f}^{\mu\nu}, \quad \varepsilon = \tilde{\delta}\, \langle \rho_C^2 \rangle / \Lambda_C^2.$$

The amplitude term rescales photon normalisation and acts as a small variation of $\alpha_{em}$; it does not change the leading light cone. It is constrained by atomic-clock and quasar measurements. The chiral term is axion-like and parity even because $\hat{h}$ and $f\tilde{f}$ are pseudoscalars. A constant $\hat{h}$ is a total derivative; gradients can rotate polarisation by an amount of order $g_{h\hat{h}} \Delta\hat{h}/2$. The proposed chiral alignment field is built from the vorton background field strength and the foliation. Its magnitude and coupling are not derived.

The portal is a nonzero non-gravitational coupling of the condensate amplitude to the photon. A common leading light cone (U1, G2) is a different claim from the absence of additional forces and does not exclude this coupling. Whether, and how strongly, the mesh population itself couples to the portal is stated in the non-gravitational status paragraph of §6.5: weak couplings are permitted and bounded by §10, with exact decoupling as the limiting case.

### 9.3 Experienced-time deviation

$$\Delta_i \equiv (\tau_i - \tau)/\tau = \eta_C\, \bar{\varepsilon}_i\, K_{coh}[B_i] + \kappa_{eff}\, H_i + O(\varepsilon^2).$$

This observer-level map is postulated, not derived from the electromagnetic portal. $\eta_C$ and $\kappa_{eff}$ are phenomenological constants; $H_i$ is an observer-window average of a handedness proxy and does not replace the local field $\hat{h}$. The comparison does not alter relativistic proper time or the metric. Illustrative shifts in the original framework are sensitivity targets only, not predictions. Operational definitions of $\tau_i$, calibrated non-behavioural proxies and an identifiable measurement model are prerequisites for a test.

## 10. Constraints and tests

| Sector | Required consistency / test |
|---|---|
| Fifth force and $\alpha_{em}$ | Condensate amplitude must be sufficiently massive; $\lambda_{\gamma\varepsilon}$ must satisfy clock and quasar limits. Universal metric coupling (G2) does not exclude scalar or electromagnetic forces, so these bounds must be met independently, for baryonic matter and for any coupling of the mesh to the amplitude or portal. |
| Lorentz/CPT | Foliation gradients and Standard-Model-sector Lorentz violation must remain below bounds; U1 gives a universal leading cone. |
| Gravity | $c_{GW} = c$ to current precision; satisfy preferred-frame, PPN, binary-pulsar and equivalence-principle bounds. |

| Sector | Required consistency / test |
|---|---|
| Induced gravity | Specify the full mode spectrum, Neff, the threshold-weighted count NF, μIR, spectral convergence, regulator and heavy-mode domain; require full matched cR > 0 (Neff > 0 only as the leading criterion); check one-loop adequacy. |
| Mesh elasticity | Positive shear modulus; internal shear modes gapped at L ≫ ℓc; consistency with sub-millimetre gravity tests. |
| Cosmic parity | Constrain $gh\Delta\hat{h}$ and parity-odd CMB/polarisation correlations. |
| Dark matter | Ωmesh ≃ Ωcdm, w ≃ 0; any weak non-gravitational mesh interaction (§6.5) must remain below direct-detection, fifth-force, αem and cosmological bounds, with no excluded interactions. |
| Proton decay / unification | Meet $\tau_p \gtrsim 10^{34}$ yr; resolve thresholds and fixed-point anomaly cancellation. |
| Vorton structure | Show layer disjointness, mode-matrix positivity, nonlinear stability and acceptable radiation. For every population, show finite coarse-grained stress (§3.7). |
| Consciousness link | Specify which solitons and standing modes form a localised view, give an operational measure of their phase-locking (§9.1), and show that the proposed link is not a signal channel excluded by no-signalling and radiation bounds. |
| Type 0 | Demonstrate recursive toroids-within-toroids geometry (minimum two sub-tori per parent per sub-level), boundary-wall embedding, 90° orientation, confinement, energy finiteness, stationary radiation suppression, and any proposed Type 0-to-other-type pathway. Determine whether Type 0 is scale invariant, and whether the invariance is discrete or continuous. |

### 10.1 Principal tests

| Test | Potential signature | Status |
|---|---|---|
| Chiral polarisation | Coherent polarisation rotation beyond Faraday rotation; cosmic birefringence ∝ $gh\Delta\hat{h}$. | Follows conditionally from portal. |
| αem variation | Small shift near coherent systems, proportional to $\lambda\gamma\varepsilon$. | Constrained by clocks; amplitude unknown. |
| Foliation gradients | Matter-correlated Lorentz-violating effects within existing bounds. | Quasi-static model; no signal theorem. |
| Vorton dark matter | Approximately pressureless halo component with universal gravitational coupling; any weak non-gravitational coupling bounded as in §6.5. | ΛCDM consistency requirement. |
| Transition-front gravity | GR plus an integration constant; excess requires specified hidden-sector exchange. | Null excess expected. |
| Type 1 ladder | Deviation from 1:2:3 as tension and mass corrections grow. | Structural; scale may be inaccessible. |
| Type 0 confinement | Evidence for a recursively branching toroids-within-toroids structure, with at least two sub-tori per parent at each sub-level, embedded in the parent boundary wall and oriented at 90° to the layer they form; test nested-field confinement and stationary radiation suppression. | Speculative; no unique quantitative prediction yet. |
| Type 0 scale invariance | Self-similar organisation across sub-levels; log-periodic signatures if a fixed ratio exists. | Speculative; no ratio specified. |
| Type 0 regeneration | Collapse/reformation or daughter structures following loss of confinement. | Speculative; mechanism unspecified. |
| Observer-map protocol | Separate coherence and handedness coefficients in a mixed model. | Requires operational observer-time definition and calibrated proxies. |

Null results must be interpreted at the level of the relevant sector. A null observer-map result does not by itself falsify the portal, mesh, gravity sector or block reading. Confidence intervals and power analyses are required; a non-significant p-value is not itself falsification.

## 11. Status ledger

### 11.1 Established within the stated mathematics

Given the relevant ansätze, the rank-one dressing has the stated signature for $\bar{\beta} > 1$; the Euclidean phase functional is positive and convex, with a unique minimiser once boundary conditions remove the constant phase zero mode; the dimensions of EΘ and its source are consistent between the five-dimensional and reduced forms; distinct concentric

layer radii give geometric disjointness when explicit clearance is satisfied; the finite Type 1 engine-state matrix has the stated eigenvalues; orbifold parities, KK masses and hypercharge assignments follow from the chosen boundary conditions; the sharp-regulator scalar threshold expression and its small-mass expansion hold as stated in §6.4; and the trace-free identities follow algebraically from P6. These are internal mathematical results, not evidence that the physical ansätze describe nature.

### 11.2 Conditional induced results

Conditional on P1–P5, a covariant regulator, a suitable heavy-mode regime and spectral convergence, integrating out the stated mode fields yields a diffeomorphism-invariant infrared action with Einstein–Hilbert, cosmological and higher-curvature terms. For the sharp proper-time regulator the leading response is $1/G4 = NF\Lambda^2/(12\pi)$, which reduces to $1/G4 \simeq cregNeff\Lambda^2/(12\pi)$ in the small-mass approximation; positivity requires the full matched $cR > 0$. The result is an effective-field-theory statement and not a first-principles derivation from vorton microphysics.

### 11.3 Assumed or postulated

C1–C5; the reading postulate; U1; the FTM recursion and finite-layer parameters; carrier-current structure; orientation locking; positive mode-matrix spectrum; Type 1 generation assignment and Dirac index 3; A-W and Qtop conservation; handedness preference; engine-state existence and twist-stress interpretation; Type 0 formation, confinement, persistence and regeneration mechanisms; the potential scale invariance of Type 0; the proposal that topological solitons and standing electromagnetic waves link local and universal consciousness; localised-view correspondence; low-entropy boundary data; the mesh equation of state and pressureless/twist split; P1–P6 (including the restriction $g\mu\nu\ \delta g\hat{}\mu\nu = 0$ in P6); purely induced matching; density independence of G4; and the working assumption that the mesh has at most weak, bounded non-gravitational interactions through the amplitude and portal (exact decoupling being the limiting case).

### 11.4 Unresolved

Interacting unitarity; causal consistency, existence, uniqueness and convergence of the mixed elliptic/hyperbolic system; a no-signalling theorem; nonlinear stability of vorton solitons and the Type 1 engine state; a conserved carrier-winding invariant on $K^1$; exact Type 0 recursion, core and boundary conditions; Type 0 energy finiteness and spectral properties; proof of stationary non-radiation; whether Type 0 is scale invariant, and whether discretely or continuously; the dynamical identification of the solitons and standing waves that link local and universal consciousness; Type 0 formation and regeneration dynamics; transition maps among classes; the self-consistent count of Neff, NF, $\Lambda$ and R including KK modes; and the matching scale $\mu IR$.

### 11.5 Not derived

Numerical values of Neff, NF, $\ell c$, $\xi I$, creg, $\gamma s$ and $\mu mesh$; the full mode spectrum needed to establish $cR > 0$; the strength of any non-gravitational mesh coupling; the observed value of $\Lambda cc$; the cutoffs of Types 2–5; Type 0 layer ratios, population scale, energy density and spectrum; the vorton-to-continuum-field map underlying P1; the observed baryon asymmetry; and the detailed Standard Model mass and mixing parameters. The central gravity claim remains conditional.

## 12. Conclusion

The theory proposes a timeless five-dimensional geometric whole whose texture is an organised mesh of vortons. The six vorton classes share the FTM idea of toroidal electromagnetic and geometric organisation. Type 0 is defined by one outer toroid containing a recursively branching hierarchy: each parent toroid has at least two smaller sub-tori at the next sub-level, embedded within and contributing to its boundary wall, with the sub-tori perpendicular (90°) to the layer they collectively form. Each sub-torus recursively contains at least two further sub-tori. This is a toroids-within-toroids architecture, not a set of concentric rings, and is proposed to be potentially scale invariant. Charge separation, multi-axis shear and energy input are proposed formation conditions; phase singularities, confinement, helicity,

anapole-like suppression, feedback and regeneration remain hypotheses requiring field equations and experimental tests. The exact scale ratio, total depth, energy law and spectrum are not established.

Type 1 supplies the finite tri-toroidal ansatz associated by postulate with three fermion generations. Local consciousness is proposed to be linked to universal consciousness through the topological solitons and standing electromagnetic waves of the mesh. Types 2–5 extend the taxonomy through knotting, linking, twisting and hybridisation. A condensate phase selects the foliation; the rank-one dressing supplies a Lorentzian reduced geometry; time is stratified into ordering, proper, thermodynamic and experienced readings. The Standard Model and cosmology are proposed as coarse-grained descriptions of this structure.

Gravity is proposed as the induced response of the organised mesh, distinct from the mesh energy that sources it. The one-loop Einstein–Hilbert form follows only conditionally from P1–P5 and a stated heavy-mode domain, with positivity governed by the full threshold-weighted coefficient cR. The trace-free classical equation is the independent P6 postulate. Universal gravitational coupling of baryons and mesh does not by itself exclude additional non-gravitational interactions, which are bounded separately. The map from microscopic vortons to continuum fields, the numerical mode count and the Type 0 dynamics remain open. The framework's testable content lies in its portal, mesh, foliation and gravitational sectors; its ontological interpretation is not itself a physical derivation.

## Appendix A. Signature derivation

With $\bar{g}AB = GAB - \bar{\beta}uAuB$ and $GABuAuB = 1$, the Sherman–Morrison identity gives

$$\bar{g}\text{^}AB = G\text{^}AB + [\bar{\beta}/(1-\bar{\beta})]u\text{^}Au\text{^}B, \quad \bar{g}\text{^}ABuAuB = 1/(1-\bar{\beta}).$$

For $\bar{\beta} > 1$, the dressed unit covector $nA = \sqrt{(\bar{\beta}-1)}uA$ has $\bar{g}ABnAnB = -1$. In an adapted frame $\bar{g} = \mathrm{diag}(-\alpha^2,1,1,1,1)$, $\alpha^2 = \bar{\beta}_0 - 1$. Projection gives the four-dimensional metric $\mathrm{diag}(-\alpha^2,1,1,1)$ and $\tau = \alpha\sigma$. At $\bar{\beta} = 1$ the metric is degenerate; Lorentzian signature requires $\bar{\beta} > 1$. This verifies the algebra given the reading postulate; it does not derive that postulate or interacting unitarity.

## Appendix B. Quadratic sectors

For a fixed foliation and $\rho C = vC + \delta\rho C$, take the canonical convention in which the complex condensate has kinetic term $|\partial\Phi C|^2$, so that $(\partial\rho C)^2$ is the amplitude kinetic term, and the amplitude potential is

$$V(\rho C) = \lambda C\,(\rho C^2 - vC^2)^2.$$

Expanding about $\rho C = vC$ gives $V \simeq 4\lambda C vC^2(\delta\rho C)^2$. The canonically normalised amplitude fluctuation is $\tilde{\rho} = \sqrt{2}\,\delta\rho C$, with $\tfrac{1}{2}(\partial\tilde{\rho})^2$ kinetic term, and it has mass $m\rho^2 = 4\lambda C vC^2$. In $\tau = \alpha\sigma$ the dispersion is $\omega^2 = k^2 + ky^2 + m\rho^2$. (If a different potential or kinetic normalisation is adopted, the value of $m\rho^2$ is an independent assumption and must be restated accordingly.) The phase fluctuation remains governed by the positive Euclidean Laplace operator on G and is a boundary-value problem, not a wave sector.

The long-wavelength transverse-traceless graviton action is

$$S^2TT = -(1/64\pi G4)\int d^4x\,\sqrt{-g}\,g\mu\nu\partial\mu hTT,ij\partial\nu hTT,ij.$$

It follows from the induced $\Gamma[g]$, not from a fundamental five-dimensional curvature term. The mesh-mode mass matrix is $W^2 = \mathrm{diag}(\omega^2 n,k) + Lind + L\Xi$ and is required to be positive semidefinite at the selected equilibrium; this remains an assumption.

## Appendix C. Heat-kernel summary

For a real scalar with $D = -\Box + m^2 + \xi R$, the Euclidean one-loop action is

$$\Gamma E = \tfrac{1}{2}\ln\det D = -\tfrac{1}{2}\int\Lambda^{-2}\infty\,(ds/s)\,\mathrm{Tr}\,e^{-sD}.$$

The heat-kernel expansion begins $\mathrm{Tr}\,e^{-sD} = (4\pi s)^{-2}\int\sqrt{g}\,[1 + s\,a1 + s^2\,a2 + \ldots]$, with $a1 = (1/6 - \xi)R - m^2$. The quadratic coefficient contains curvature-squared terms and total derivatives. Integrating the leading terms gives the $\Lambda^4$

vacuum term and the $\Lambda^2 R$ term. For the sharp proper-time cutoff the exact coefficient is $c_R = (1 - 6\xi)\Lambda^2 F(z)/(192\pi^2)$, with $F(z) = e^{-z} - zE1(z)$ and $z = m^2/\Lambda^2$; it reduces to $c_R = (1/6 - \xi)\Lambda^2/(32\pi^2)$ only for $m \ll \Lambda$, with the next terms $-m^2 \ln(\Lambda^2/m^2) + (\gamma E - 1)m^2$ inside the bracket as in §6.4.

The exact threshold expression is given in §6.4. Dirac fields contribute with opposite statistics and, at leading order, count as two minimally coupled real scalars; an exact comparison requires matching masses and threshold factors. When the weights $(1 - 6\xi I)$ have both signs and the masses differ, the sign of the threshold-weighted sum $N_F$ is not fixed by the sign of the unweighted count $N_{eff}$ (see the counterexample in §6.4), so the physical condition is $c_R > 0$. Higher-curvature coefficients are logarithmic and expected to be suppressed at tested curvatures relative to the Einstein term, subject to the stated mass, coupling and no-cancellation assumptions. A smooth covariant cutoff changes the order-one regulator coefficient and the threshold function. Diffeomorphism invariance follows from covariant regularisation and the covariant field action; the trace-free law remains the separate P6 postulate.

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