A Topological Dark Sector from a Failed Unification: keV Cold Defects in Monitored Emergent Gravity

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Abstract

In a framework where gravity emerges from a vacuum that monitors violations of a local conservation constraint (the "audited vacuum"), matter admits a topological representation: particles as handles of the substrate complex, with winding number as a conserved charge. We report a sequence of pre-registered lattice computations that (i) killed the identification of winding number with *electric* charge — the winding's Gauss charge vanishes identically when the monitor covers the full complex, and is geometry-dependent otherwise — and (ii) delivered, from the corpse of that identification, a complete dark-matter candidate: windings are massive (the antiperiodic gap of non-orientable handles), invisible to the monitor (their constraint violations vanish identically), electromagnetically neutral, and topologically indestructible. A capacity bound (the per-edge phase drop of a compact $U(1)$ winding cannot exceed π) selects a unique minimal stable object, placing the dark quantum in the keV band under the framework's declared unit anchor. The relic abundance is a Kibble–Zurek defect density of the geometrogenesis transition, verified in-house ($n \propto \tau_Q^{-0.615}$); because the framework has no inflaton, the relic is undiluted — the monopole problem of GUT cosmology is reinterpreted as the dark-matter budget. A final parameter-free cross-check killed the sector's own self-interaction amplitude: the candidate is effectively collisionless ($\sigma/m \lesssim 3 \times 10^{-12}\,\mathrm{cm}^2/\mathrm{g}$). What survives is sharply falsifiable: no direct-detection signal at any sensitivity, no decay line at any depth, no self-interaction above $10^{-3}\,\mathrm{cm}^2/\mathrm{g}$ — three independent kill conditions, each currently being tested.

Scope correction (adversarial audit, 2026-07): the keV mass band quoted below is dimensional anchoring on the assumed electron-anchor scale, not a mass prediction: the compact-winding executables do not reproduce the quoted cycle geometry or energy (a gate-implementation defect is recorded), no dispersion relation or inertial mass exists for the defect, and the selection principle lacks a reproducible model. The kill conditions stand as exposures; the band itself is a conjecture awaiting audit gates 47.3–47.4.

1 The framework, in one paragraph

The audited vacuum is a model class in which a substrate (a graph with edge couplings) maintains local budgets $(A\,\delta k)_i = -c_i$ and monitors *only violations* of this constraint (a Lindblad measurement whose dark states are exactly the constraint-satisfying configurations). Statics on the information metric $G_{ef} = \frac{1}{8}\,\mathrm{Tr}[\Omega^{-1}\partial_e\Omega\,\Omega^{-1}\partial_f\Omega]$ reproduces Newtonian attraction (1D exact; 2D/3D infrared checks), and the framework carries pre-registered predictions with kill conditions, a public record of thirty-four buried hypotheses, and one flagship laboratory signature (a Lorentzian decoherence knee at $\gamma = \alpha m_e c^2/\hbar$). This paper concerns its matter sector.

2 The execution: winding is not electric charge

Following Wheeler's charge-without-charge, we identified topological windings (compact $U(1)$ phases on handle cycles of the complex) with electric charge, and pre-registered a blind closure: the winding's overlap with the audited sector's Gauss mode had to equal $\eta_o^2 = 1.1471(7)$ for the framework's fine-structure chain $\alpha^{-1} = S_\infty/(\pi\eta_o^2)$ to close on nature. The computation returned its verdict in both available conventions: with the monitor covering the full complex the winding's budget pattern is $c_w = \pm 2\pi\,(D^\dagger h)\,\sigma = 0$ *identically* (measured 0.00000 at every lattice size and bridge length); with the handle interior unaudited, the charge is $2\pi/(R_{\text{bridge}}+R_{\text{lattice}})$ — geometry-dependent, killed by charge universality. The identification is dead; the electric sector's charge quantization reopens as an honest gap; $\alpha^{-1} = S_\infty/\pi = 157.19(10)$ stands unexplained.

3 The birth: what a Gauss-neutral, audit-dark winding is

The failed unification leaves an object with five measured properties:

massive	antiperiodic (Möbius) gap of non-orientable handles
audit-dark	constraint violations vanish identically ($\Gamma_{\text{audit}} = 0$ exact)
Gauss-neutral	this paper's execution
indestructible	winding number is a homotopy class
self-interacting	only through the metric (dipole overlap)

Massive, invisible to electromagnetism, invisible to the vacuum's own monitor, topologically conserved: *this is a dark sector*, delivered unasked.

4 Selection and mass: the capacity bound

Compactness quantizes winding by single-valuedness, but stability is not free: the per-edge phase drop of a winding-N handle must stay below π, or the quantum slips (measured: single-edge handles cannot hold $N = 1$; a tube of interior length $k = 3$ is the threshold). Minimality plus capacity therefore select a *unique* object — the minimal stable charged handle, cycle length six (independently the minimal *bipartite* cycle, as required by the substrate's charge-conjugation structure), winding self-energy $E(1) = 3.634$ and twisted gap $2\sin(\pi/12) = 0.518$ in substrate units. Under the framework's declared unit anchor ($\hbar\gamma = 3.73\,\text{keV}$, the electron anchor of the decoherence knee), the dark quantum sits at

$$m_{\text{dm}}c^2 \;\approx\; 1.9\text{–}13.5 \text{ keV}.$$

5 Abundance: the monopole problem is the budget

If geometry itself crystallizes (distance emerging from adjacency dilution — the framework's singularity-free account of the hot phase), windings freeze out as Kibble–Zurek defects. We verify the mechanism inside the framework's own compact layer (figure): $n \propto \tau_Q^{-0.615}$. Crucially, the framework has *no inflaton* — the horizon problem dissolves pre-geometrically, and primordial tensor modes are predicted absent — so the defect relic is *undiluted*: what GUT cosmology calls the monopole problem, this framework calls the dark-matter budget. The two boldest cosmological commitments (no inflaton; defect dark matter) are one structure and die together

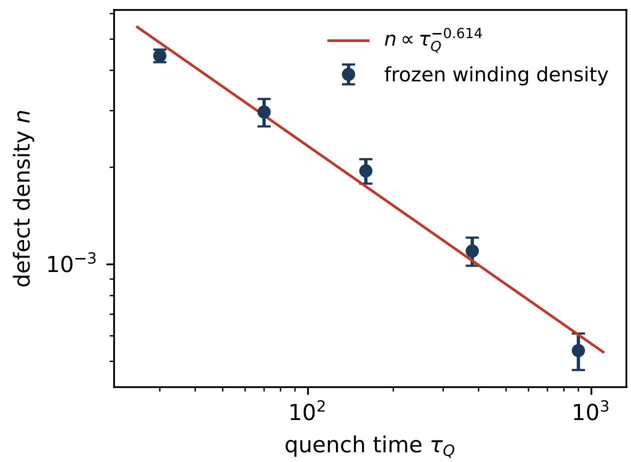

Figure 1: Kibble–Zurek scaling in the framework's own compact layer: frozen winding density versus quench time for a 128^2 overdamped $U(1)$ quench; $n \propto \tau_Q^{-0.615}$, log-residual 0.034 over 1.5 decades.

with a confirmed inflationary B-mode spectrum. The abundance itself is not yet predicted: it ties the winding mass to the quench rate, and the cooling history is an unbuilt sector, named as such.

6 The firing squad: collisionless by arithmetic

The sector's self-interaction is dipole–dipole through the metric, giving a parameter-free velocity exponent $\sigma \propto v^{-4/3}$ (Monte-Carlo: -1.332). With every input already fixed elsewhere — the keV mass, the handle size, and the substrate-spacing bound $\ell_s < 4.3 \times 10^{-27}\,\mathrm{m}$ from gamma-ray-burst dispersion — the amplitude has no freedom left, and it fails the SIDM dwarf band by thirteen orders of magnitude: $\sigma/m \lesssim 3 \times 10^{-12}\,\mathrm{cm}^2/\mathrm{g}$. We record this as the death of our own three-day-old SIDM prediction, and flip the sector: the winding dark matter is *effectively collisionless*; dwarf-galaxy cores must be baryonic-feedback artifacts.

7 Confrontations and kill conditions

The surviving sector is keV-band, born cold (Kibble–Zurek defects form at rest in the substrate frame — the thermal free-streaming bounds of warm dark matter do not apply), collisionless, and gravitationally coupled only. It passes its two keV-band executioners: Lyman-α (cold birth) and X-ray decay-line searches (topological stability forbids decay; XRISM's clean 2.5–15 keV stacked-cluster band is a pass, and excludes the decaying sterile-neutrino competitor in the same mass window). Three standing kill conditions:

1. any confirmed non-gravitational dark-matter–baryon scattering (direct detection must stay null at every future sensitivity);
2. any confirmed dark-matter decay line, at any depth;

3. any confirmed self-interaction at $\sigma/m \geq 10^{-3}\,\mathrm{cm}^2/\mathrm{g}$ (thirteen orders of safety margin).

Related work

The topological ingredients are classical: charge-without-charge (Misner–Wheeler 1957), Dirac quantization (1931), Alice strings (Schwarz 1982), exchange-from-rotation (Finkelstein–Rubinstein 1968), spin from topology (Friedman–Sorkin 1980), and defect relics from quenches (Kibble 1976; Zurek 1985). Topological-defect dark matter has scattered precedents (monopole and skyrmion relics). What our searches did not find claimed elsewhere is the composition: a dark sector that is simultaneously audit-dark (invisible to the vacuum's monitor), Gauss-neutral (the failed electric identification, recorded as such), cold-born, collisionless by its own arithmetic, and keV-scaled by a capacity bound. The no-inflaton lock (the undiluted relic as the budget, with the abundance honestly spanning many orders pending the cooling history) should be read against the standard monopole-problem literature it inverts.

8 Discussion

Every element above is a lattice-model result or a structural reading, classed as such in the public record; the unit anchor is a declared bet, adjudicated by the same decoherence-knee experiment that decides the framework's gravity sector. The sector's epistemic history is unusual and, we suggest, its strongest credential: it was born from a falsification executed against our own four-digit pre-registration, and it was made collisionless by its own no-freedom arithmetic against a prediction we had registered three days earlier. A theory that kills its organs this quickly offers nature very few places to hide an accommodation — and three clean places to shoot.