The Vacuum.Net Theory

Foundational Paper

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Abstract

The Vacuum.Net theory holds that everything is one strand of light resonating with itself. What persists is what closes in phase. This paper states the theory's five axioms, proves six conditional theorems, states five correspondences and one observable-state bridge, and lists four open calculations. Five statuses are kept strictly distinct — assumed, conditionally proved, corresponded, predicted, and open — and every claim carries its status. All theorem proofs are carried out in the text, with numbers; empirical predictions state their numbers here and may refer to companion papers for full context. This document is the canonical entry point to the theory; the corpus hangs from it.

Revision note. Four external AI reviews shaped this document. The first separated proof from interpretation. The second confirmed the theorems as valid conditional mathematics. The third exposed the one hidden substitution (the δ→χ_a bridge, now C5a). The fourth delivered the closing verdict — internally consistent as an axiomatic research programme once P4 carries its own susceptibility factor — and this fifth edition executes that final round: s_m made explicit in P4, the class-change conditions of Theorem 3 stated in full, the five epistemic statuses named as such, and the scope of O1–O4 claimed as priority rather than sufficiency. This edition is final pending O1.

Part I — The primitive

1. One strand

Before there was a world, there was not nothing. There was a strand, and the strand had not yet crossed itself.

Spencer-Brown began at the same silence: draw a distinction, and nothing more is needed. Kauffman read what was really drawn — not a line, but a form observing its own form. Re-entry. But a distinction is thin. It is a threshold, not a thing. It has no body that can be pulled.

The Vacuum.Net theory gives it the body. The primitive is a strand: one unbroken, oriented line, long enough to bend back and touch itself. "Light" names the motion of phase along this strand. Nothing else exists. Particles, fields, space, time, observers — all are configurations of the one strand. A fishnet is the standing image: strands, knots, meshes, tension. The net is not *in* the vacuum. The net *is* the vacuum.

2. The five axioms

N1 — Strand. There is one unbroken, oriented strand. Light is phase motion along it. All that exists is a configuration of the strand. The strand can touch and cross itself; that it does so is part of this axiom, not a derived event.

N2 — Closure. Only configurations that return in phase persist. What does not close, disperses. This is selection, not causation: nothing makes a pattern survive; the pattern that fits, remains.

N3 — Memory. Crossing stores tension. Tension relaxes; topology does not. A knot forgets how hard it was pulled, never *that* it was tied.

N4 — Context. Response coefficients are permitted, and in a nonlinear medium expected, to depend on the local strand state. Universality is a limiting case — $g(\chi) = g_0$ — not an axiom. The theory's substantive claim is that the vacuum is nonlinear (Theorem 4's hypothesis; O1's first output), so that its "constants" are elastic moduli of the net at the place and depth where they are read. Whether a given coefficient varies is decided by measurement, not by decree.

N5 — Scale. The same closure operation repeats at every winding depth. Windings are made of windings. A quantity is either a topological invariant of a closure or an ensemble average over many.

These five are assumed. That is what axioms are. Every other claim in this paper carries one of four further statuses: conditionally proved from stated hypotheses, corresponded to the world, predicted as a benchmark, or open. Five statuses, kept distinct throughout — that discipline is the paper's method.

Part II — Conditional theorems

Each theorem states its hypotheses. Each is proved in full. What the theorem does *not* say is stated after the proof.

Theorem 1 — Knots exist and persist

Hypotheses. The strand lives in three-dimensional ambient space; it is unbroken (N1); deformations are continuous; and the configuration is a closed embedding of S^1 in $\mathbb{R}^3$, or an infinite strand with fixed behaviour at infinity (equivalently, fixed endpoints). Closedness is necessary: an open strand with free ends can be laid as a trefoil and untied through an end. Topology binds only what has closed — which is N2 speaking in mathematics.

Claim. The strand admits closed configurations that no pulling removes. The trefoil has the smallest crossing number among non-trivial knots.

Proof (tricolorability, complete). Color the arcs of a knot diagram with three colors, requiring at each crossing that the three meeting arcs carry one color or all three, and that at least two colors appear. Call such a diagram *tricolorable*.

Step 1. Tricolorability survives every deformation. Deformations decompose into the three Reidemeister moves. R1 (kink): only two distinct arcs meet, forcing one shared color — coloring unchanged. R2 (slide over): the two new crossings force the middle arc's color from the outer two; a valid coloring extends and restricts uniquely. R3 (slide across a crossing): direct check of the finitely many colorings preserves validity. Tricolorability is an invariant.

Step 2. The unknot has one arc, hence one color — not tricolorable.

Step 3. The trefoil has three arcs; color each differently. Every crossing meets all three colors. Tricolorable.

Step 4. Therefore trefoil ≠ unknot.

Step 5 (minimality lemma). Every closed knot diagram with fewer than three crossings contains a reducible Reidemeister-I or Reidemeister-II configuration and is therefore the unknot — a finite check of the small diagrams, standard in knot theory. Hence three crossings is the smallest possible for a non-trivial knot, and the trefoil realizes it. A configuration exists that pulling cannot undo, and it is the simplest one possible. ∎

Scope. This proves that non-trivial closures exist in the assumed knot space and that they are topologically permanent (N3 then reads them as memory). It does not prove that the strand forms them dynamically, that they carry energy or mass, or that they are matter. Those steps require the dynamics (O2) and the energy function (O1), and the matter reading is Correspondence C4.

Theorem 2 — The double cover

Hypotheses. Rotations of a configuration are represented by unit quaternions acting as $v \to q\, v\, q^{-1}$.

Claim. The rotor returns to itself after 4π, not 2π.

Proof (complete). $q(\theta) = \cos(\theta/2) + \mathbf{u} \sin(\theta/2)$. Then $q(2\pi) = \cos \pi = \mathbf{-1}$ and $q(4\pi) = \cos 2\pi = \mathbf{+1}$. Both q and $-q$ give the same rotation of v, so every external frame returns at 2π; the rotor itself returns only at 4π. Formally: the unit quaternions (S^3) cover the rotation group SO(3) twice; the path from $+1$ to -1 closes in SO(3) but not in S^3. ∎

Scope. This is a theorem about quaternions — Maxwell's native notation before vectorization discarded the rotor. That a *physical* configuration's state is the rotor itself, so that spin-½ follows, is Correspondence C2. Without C2, an ordinary spatial configuration closes at 2π.

Theorem 3 — Conservation of the closure class

Hypotheses. Closed configurations are described by maps from compactified space to a target space with a non-trivial homotopy group. The working specification, taken from the Faddeev–Niemi identification, is $\hat{n} : \mathbb{R}^3 \cup \{\infty\} \to S^2$, whose classes form $\pi_3(S^2) = \mathbb{Z}$: the Hopf charge Q. Throughout the evolution the map remains continuous, stays within the target manifold, and keeps fixed boundary conditions.

Claim. Q is conserved under every such motion.

Proof. Q is integer-valued and unchanged along any homotopy; a change of class requires failure of continuity, departure from the target manifold, or alteration of the boundary conditions — all excluded by hypothesis. A quantity that is integer-valued and constant along all admissible paths is conserved. ∎

Scope. The conservation law needs no action principle and no Noether theorem: it is a topological law, conditional on the specified map, target and boundary data. Identifying the mathematical failure modes (discontinuity, leaving the target, changed boundary) with a *physical* strand break is itself a correspondence, made under C4, not part of this proof. An early edition conflated crossing counts, writhe, linking and winding; the invariant is fixed as the Hopf charge of the stated map. Deriving that specification from the strand itself, rather than assuming it, belongs to O2.

Theorem 4 — The constitutive equation

Hypotheses. The collective energy density of the net is $e(n) = (g_2/2)n^2 + (g_3/3)n^3$ in the winding density n, with $g_3 \neq 0$.

Claim. $g\_eff = \bar{g}(1 + \gamma\delta)$, exactly.

Proof (two derivatives). $de/dn = g_2 n + g_3 n^2$. $g\_eff \equiv d^2e/dn^2 = g_2 + 2g_3 n$. Write $n = \bar{n}(1 + \delta)$: $g\_eff = (g_2 + 2g_3\bar{n}) + 2g_3\bar{n}\delta$. Define $\bar{g} \equiv g_2 + 2g_3\bar{n}$ and $\gamma \equiv 2g_3\bar{n}/\bar{g}$. Then $g\_eff = \bar{g}(1 + \gamma\delta)$. ∎

Scope. The stiffness of the medium reads the local state: one explicit realization of N4 for the assumed effective medium — not a proof that every physical response coefficient is state-dependent. The energy density itself is a hypothesis. The claim that knots generically produce the cubic term (through linking and excluded volume) is plausible and unproven; it is the first output demanded of O1. The acoustoelastic effect (Murnaghan; Thurston–Brugger) is the same theorem realized in steel.

Theorem 5 — The sign of the quadratic term

Hypotheses. Theorem 4's medium, with $g_3\bar{n} > 0$ and $\gamma > 1$.

Claim. $g_2 < 0$, and at $\gamma = 2\pi$ the quadratic and cubic contributions to the local stiffness $g\_eff = g_2 + 2g_3\bar{n}$ cancel by 84.1%.

Proof (arithmetic). From $\gamma = 2g_3\bar{n}/(g_2 + 2g_3\bar{n})$: $g_2 = 2g_3\bar{n}(1 - \gamma)/\gamma$. For $\gamma > 1$ the factor is negative, so $g_2 < 0$. Insert $\gamma = 2\pi = 6.283$: $g_2 = -0.8408 \cdot (2g_3\bar{n})$; residual stiffness $\bar{g} = 2g_3\bar{n}/2\pi = 0.159 \cdot (2g_3\bar{n})$. ∎

Scope. $\gamma = 2\pi$ is not derived here; it is Correspondence C5, and O1 must deliver it. Near-cancellation of the two stiffness contributions is proved under the hypotheses; whether it constitutes criticality requires a stability or divergence condition not yet defined. The weather reading of the vacuum is therefore a reading, carried by this arithmetic, not a theorem.

Theorem 6 — Dissipation localizes on open meshes

Hypotheses. Standard non-equilibrium bookkeeping: entropy of the working substance is a state function; entropy production is non-negative.

Claim. Within the local non-equilibrium description assumed here, entropy production decomposes into conjugate force–flow contributions with non-negative total: loss has an address.

Correction carried from review. The first edition wrote that an irreversible cycle "fails to close in state". That was wrong: S is a state function, so $\oint dS = 0$ for *every* cycle of the working substance, reversible or not. Irreversibility is not failure of state closure; it is *production*.

Proof. Write $dS = \delta Q/T + \delta\sigma$ with $\delta\sigma \geq 0$ (Clausius). Over a cycle: $0 = \oint \delta Q/T + \sigma\_cycle$, so $\sigma\_cycle = -\oint \delta Q/T \geq 0$ — the Clausius inequality, with σ_cycle the produced entropy. Production decomposes bilinearly (de Groot–Mazur) as $\sigma = \Sigma_i J_i \cdot X_i$: each term a flow across its conjugate tension difference — heat flow × $\Delta(1/T)$, charge flow × $\Delta V/T$, mole flow × $\Delta\mu/T$, volume flow × $\Delta p/T$. The *total* is non-negative; individual terms are separately non-negative only for uncoupled or suitably diagonalized dissipative channels. In coupled transport (thermoelectricity, thermodiffusion) one channel can be driven against its own gradient by another. Nor does $\sigma = 0$ force every X_i or J_i to zero: reversible coupled transfer can persist. What vanishes at $\sigma = 0$ is the dissipative content. One nuance: diagonalized channels need not map one-to-one onto physical joints; assigning each loss to a physical mesh is done by a local entropy balance over the device or region, not by the diagonalization alone. ∎

Net reading. σ counts open meshes weighted by what crosses them. A flow across a matched joint ($\Delta V \cdot I$ into a motor doing work) is transfer, not loss; the same product across an unmatched joint (a resistor) is production. The two ideality conditions of non-isothermal cycle science — ΔS-internal → 0 and transfer mismatch → 0 (Helder, Van Deijk & Xezonakis) — are the loop and joint components of $\sigma = 0$. Worked number: 100 kJ crossing a 500 K → 300 K gap with no engine produces $\sigma = 100/300 - 100/500 = 0.1333$ kJ/K; lost work $T_0\sigma = 300 \times 0.1333 =$ **40 kJ** — the entire Carnot potential. Loss lives on the open mesh, nowhere else. Full development: "From Carnot to the Vacuum Net" (2026).

Part III — Correspondences

A correspondence pins a proved structure to the world. Correspondences are the theory's physical content and its risk. None is derived from Part II; each is labeled, and each stands or falls with the open calculations.

C1 — The mark is a self-touch. A separate simple closed curve bounds an inside without crossing itself (Jordan). But the theory has no separate curves: there is one strand (N1), and on one unbroken open line, a closed boundary is realized only where the strand touches itself. The minimal mark is therefore the minimal self-touch. That the strand touches itself is axiom content (N1), not a derived event. Spencer-Brown's external hand is not eliminated by proof; it is absorbed into the primitive.

C2 — The state is the rotor. A self-closing configuration's state is its own turning, not a picture of it. Then Theorem 2 gives closure at 4π and the half-integer label. Precisely stated: spin-½ here is a half-integer *rotation label*; its identification with measured intrinsic angular momentum is part of this correspondence, not of Theorem 2. This is exactly the requirement of Williamson & van der Mark's toroidal photon; charge and magnetic moment are the same closure read from other angles. Qualitative structure only; masses are O3.

C3 — Nilpotency is closure. With anticommuting units $e_0^2 = +1$, $e_1^2 = e_2^2 = -1$ (a Cl(1,2) fragment; Rowlands' full double algebra extends it) and $Q = e_0E + e_1p + e_2m$, the cross terms cancel and $Q^2 = E^2 - p^2 - m^2$. So $Q^2 = 0 \Longleftrightarrow E^2 = p^2 + m^2$, exactly. The algebra is a theorem; the correspondence is the reading: the mass-shell condition *is* phase closure, and a closed configuration applied to itself adds nothing — it is complete. The reading imports E, p, m and their signature; deriving them from the strand is O2.

C4 — Knot is matter. The permanent configurations of Theorem 1, carrying tension per N3, are identified with matter: mass as frozen tension held by topology. Energy, stability and the spectrum require O1–O3.

C5 — One phase winding: $\gamma = 2\pi$. Identify the deep-modulation coefficient of Theorem 5 with one full winding of one closed loop.

C5a — Observable-state bridge (B1). Theorem 4 modulates in the *internal* deviation δ; observation supplies the *external* ratio χ_a. Connecting them is a correspondence of its own, stated here instead of hidden in use: $\delta = k\cdot\chi\_a + O(\chi\_a^2)$ to leading order, with $k \equiv d\delta/d\chi\_a$. The linear form holds near the chosen reference state only; P2–P4 apply it within that regime and do not extrapolate it across widely different regimes. This is bridge B1 of the constitutive paper, now placed at the foundation. The crossover rule of Theorem 4 then reads $\gamma k\chi\_a = 1$, so the crossover sits at $\chi\_a = 1/(\gamma k)$, hence $\mathbf{a_0 = cH_0/(\gamma k)}$. Only with the additional choice k = 1 does $a_0 = cH_0/\gamma$ follow. With $\gamma = 2\pi$ and k = 1: $a_0 = cH_0/2\pi = 1.08\times10^{-10}$ m s^{-2}, within 10% of the measured 1.2×10^{-10}. The agreement is therefore not parameter-free; what measurement fixes is the product γk ≈ 2π. Deriving k — or deriving that k = 1 — belongs to O1/O4, and every claim downstream of C5 carries the product γk, not γ alone. Background SI values (conversion only): $H_0 \approx 70$ km s^{-1} Mpc^{-1} = 2.27×10^{-18} s^{-1}; $cH_0 = 6.80\times10^{-10}$ m s^{-2}. The forty-year Milgrom coincidence, read as one turn of phase — with the honesty that O1 must produce both the 2π and the k.

Part IV — Units and the state variable

The theory computes in dimensionless ratios: winding counts, deviations δ, phase angles, mass ratios. SI numbers are conversions made after a derivation, using background instrument conventions, never inside it. Two honesty points, both from review:

First, "dimensionless" does not dissolve operational questions: a ratio like a/(cH) still requires operational definitions of its ingredients, and if c is a state function (N4), the paper must say which value enters. Convention adopted here: background values throughout; local corrections are part of what g(χ) itself describes.

Second, the theory currently carries **two candidate state variables**: the acceleration form $\chi\_a \equiv a/(cH_0)$, selected by galaxy data (external-field effect responds to environmental acceleration), and the potential form $\chi\_\Phi \equiv |\Phi|/c^2$, used in the fine-structure benchmark. These are not equal — $a/(cH) = GM/(R^2cH)$ while $GM/(Rc^2)$ differs from it by the factor aR/c^2 vs $a/(cH)$ — and the first edition's P1 mixed them. The single-knob condition of the theory demands one variable. Unification is now open item O4, and P1 below is stated in the potential form explicitly.

Part V — Predictions and open calculations

Predictions (stated before any test; none yet performed)

P1 (conditional benchmark test, potential form). Fine-structure shift at a white-dwarf photosphere, with $\Delta\chi\_\Phi = GM/Rc^2$. For G191-B2B ($M \approx 0.5\ M_\odot = 1.0\times10^{30}$ kg, $R \approx 1.4\times10^{7}$ m): $\Delta\chi\_\Phi = (6.67\times10^{-11} \times 1.0\times10^{30})/(1.4\times10^{7} \times 9.0\times10^{16}) = 5.3\times10^{-5}$. With benchmark $\beta = \alpha/4\pi =$

5.81×10^{-4}: **$\Delta\alpha/\alpha \approx +3\times10^{-8}$**. A null result below 10^{-8} sensitivity refutes the combined benchmark ($\chi = \chi\_\Phi$) $\wedge$ ($\beta = \alpha/4\pi$), not the theory as a whole; O4 decides the form.

P2. Overdetermination, bridge-corrected. From Theorem 4: $\Delta g/g = \gamma\delta = \gamma k\cdot\Delta\chi\_a$ (via C5a). From the composed form: $\Delta g/g = p\_\alpha\cdot\Delta\alpha/\alpha = p\_\alpha\cdot\beta\cdot\Delta\chi$, with $p\_\alpha \equiv d \ln g/d \ln \alpha$ (distinct symbol: p in C3 is momentum). Equating: **$\gamma k = \beta\cdot p\_\alpha$** — the general relation; $\gamma = \beta\cdot p\_\alpha$ holds only under $k = 1$. The test: the product γk from rotation-curve data (SPARC, public) must equal $\beta\cdot p\_\alpha$ from clock/spectroscopy. Expected magnitude of γk: 2π. The sign $g_2 < 0$ follows from $\gamma > 1$ together with $g_3\bar{n} > 0$ (Theorem 5) and the identification C5 — not from the measured product γk alone. Protocol requirement for genuine independence: the interpolation function, nuisance parameters, error budgets and datasets on both sides must be fixed in advance — otherwise both determinations can be tuned through the same chosen fitting family. Falsified if the two pre-registered determinations disagree beyond error.

P3. The winding edge of a knot sits where its own tension falls to the background: $GM/r^2 = a\_bg$, hence $r\_edge = \sqrt{(GM/a\_bg)} \propto \sqrt{M}$. Solar numbers: $GM = 1.327\times10^{20}$ m³ s⁻²; background at the Sun $a\_bg = 2.07\times10^{-10}$ m s⁻² (external-field corrected; full context in "Our Address in the Net", 2026). Then $r\_edge = \sqrt{(1.327\times10^{20}/2.07\times10^{-10})} = \sqrt{(6.41\times10^{29})} = 8.0\times10^{14}$ m ≈ **5,350 AU**. Status stated honestly: this is a consequence of the threshold identification (C5/C5a) plus inverse-square tension — any theory with a universal acceleration threshold shares the $\sqrt{M}$ law. What is Vacuum.Net's own is the *value* of the threshold, $a_0 = cH_0/(\gamma k)$, tying the edge to the cosmic background state. Falsified if the wide-binary anomaly boundary fails to scale as $\sqrt{M}$ or is absent.

P4. No detection will ever be made of a localized, context-independent particle constituting the halo mass. To close the escape hatch, the context-dependence is fixed in advance rather than invoked afterwards — and with its own susceptibility stated: Theorem 4 gives $\Delta g\_eff/\bar{g} = \gamma k\cdot\Delta\chi\_a$, and the effective mass follows through m_eff's dependence on the stiffness, $\Delta m\_eff/m\_eff = s\_m\cdot\gamma k\cdot\Delta\chi\_a$ with $s\_m \equiv d \ln m\_eff/d \ln g\_eff$. The fourth edition silently set $s\_m = 1$; s_m must instead come from the Bogoliubov or coarse-graining relation (O1), with order unity expected. The test stands with s_m explicit: a genuine medium excitation shows a fractional shift $s\_m\cdot\gamma k$ per unit change of state, measurable by comparing environments of different χ_a under otherwise identical detector conditions. A candidate whose properties are constant across such environments within errors *counts as a particle* and refutes this prediction; a candidate tracking the pre-stated function does not. Refutable by a single qualifying detection, never finally confirmable: a standing prohibition.

P5. Forbidden outcomes, operational form: (i) detection of a quantized spin-2 graviton; (ii) an α-variation that survives χ-regression. Protocol, fixed in advance: χ along each sight line is measured independently (from mass and acceleration maps, not from the α data); the function $\alpha(\chi)$ is fixed before the fit ($\Delta\alpha/\alpha = \beta\cdot\Delta\chi$ in the form O4 settles, $\beta = \alpha/4\pi$ as benchmark); the dipole direction is not a free parameter of the same fit; and the allowed residual is zero within the stated measurement uncertainty. A residual correlated with a fixed cosmic direction after regressing out the pre-measured χ refutes the theory outright. Without these four pre-commitments the test is not sharp — a flexible χ-map can absorb almost any pattern, and the theory refuses that flexibility here by construction.

Open calculations (four, at the foundation)

O1 — The coarse-graining. With n = link density of the knot network, derive in one computation: the cubic term (validating Theorem 4's hypothesis), $\gamma = 2\pi$ (validating C5), the sign of g_2 independently, and the dimensionality of stable closure ("why four"). This is the theory's decisive calculation. Specified; not executed.

O2 — The closure dynamics. Not an action principle — an action is an unmoved mover in mathematical dress — but the Rosen condition: which rewrite dynamics is its own fixed point. Must deliver: the map-and-target specification assumed in Theorem 3, and the E, p, m imported in C3. The nilpotent algebra is the candidate operator language.

O3 — The mass spectrum. Numerical values of stable closures beyond the structural results, including the ratio 1836.

O4 — The state variable and the bridge. One χ: derive the relation between χ_a and χ_Φ, or show which is fundamental. And derive the bridge coefficient $k \equiv d\delta/d\chi_a$ of C5a — or derive that $k = 1$. Until then, every empirical statement names its form, as P1 does, and carries the product γk, as P2–P4 now do.

These four calculations are the present foundational priorities. Whether they also suffice for a formal theory of internal measurement, for spatial and temporal relations, for the first distinction and for statistical measurement outcomes remains to be established — the reduction is a working conjecture of the programme, not a result.

Part VI — Position

Every other emergence program keeps at least one monument. Wolfram–Gorard select rewrite rules by demanding that relativity fall out — the monument as selection criterion — and anchor everything in an external ruliad. Verlinde moves the foundation one floor down and keeps holography standing on it. Causal sets, CDT and loop quantum gravity keep causal order or universal constants as primitives. The Vacuum.Net theory keeps neither: N4 treats universality as an empirical limiting case rather than a primitive, Theorem 3 supplies one topological conservation law independently of Noether, and C1 absorbs the external hand into the primitive rather than hiding it. One strand. Five axioms. Six conditional theorems. Five correspondences and one stated bridge. Five predictions. Four open calculations. Every claim above carries its level, and the levels do not leak into one another. That discipline — not any single result — is what this paper contributes: a foundation that an external review can cut into, and that survives the cutting by becoming more precise.

Annotated references

Spencer-Brown, G. (1969). ***Laws of Form.*** **Allen & Unwin.** The distinction and re-entry. C1 absorbs his external hand into the strand primitive.

Kauffman, L. H. — writings on Laws of Form, eigenforms and knot logic; knot theory expositions of tricolorability. The mark as self-observing form; the elementary invariant used verbatim in Theorem 1.

Williamson, J. G., & van der Mark, M. B. (1997). "Is the electron a photon with toroidal topology?" ***Annales de la Fondation Louis de Broglie*** **22, 133.** The toroidal closed-photon electron: correspondence C2's source, with the 4π requirement proved here as Theorem 2.

**Konstapel, J. (2026). "The Strand That Knots Itself." constable.blog, 9 July 2026, with working papers: Place Before Object; Place, Path, Rewrite; Orientation Before Place; Self-Resonance Before Orientation; From Distinction to Quaternion Geometry; The Gentzen–

Altshuller Fusion; and "Quaternionic Reformulation of the Williamson–van der Mark Toroidal Photon Model." The constructive foundation this paper axiomatizes: strand above distinction, the seven-tension cascade, the quaternion form of C2.

Rowlands, P. (2007). ***Zero to Infinity: The Foundations of Physics.*** **World Scientific.** The nilpotent operator and the Universal Rewrite System: C3's algebra and O2's candidate language.

Maxwell, J. C. (1873). ***A Treatise on Electricity and Magnetism.*** The original quaternion electrodynamics — the rotor notation of Theorem 2 before vectorization discarded it.

Sakharov, A. D. (1967). ***Doklady Akademii Nauk SSSR*** **177, 70.** Vacuum elasticity: gravity as induced stiffness of the medium; the organizing idea behind N3/N4 read gravitationally.

Volovik, G. E. (2003). ***The Universe in a Helium Droplet.*** **Oxford University Press.** Laboratory proof-of-concept that "constants" are state functions of a condensate — N4 realized in superfluid helium.

Faddeev, L., & Niemi, A. J. (1997). "Stable knot-like structures in classical field theory." ***Nature*** **387, 58.** Knotted solitons with integer Hopf charge: the map-and-target specification of Theorem 3.

de Groot, S. R., & Mazur, P. (1962). ***Non-Equilibrium Thermodynamics.*** **North-Holland.** The bilinear entropy-production form $\sigma = \Sigma\, J{\cdot}X$ used in Theorem 6 — written in Leiden, fittingly.

McGaugh, S., Lelli, F., & Schombert, J. (2016). ***Physical Review Letters*** **117, 201101; Chae, K.-H., et al. (2020).** ***Astrophysical Journal*** **904, 51.** The measured $g(\chi)$ crossover (C5) and the external-field effect selecting the acceleration form of χ.

Konstapel, J. (2026). "The Constitutive Equation of the Vacuum Condensate"; "The Missing Weight and the Medium" (v4); "Our Address in the Net"; "The Vacuum as Weather"; "From Carnot to the Vacuum Net." constable.blog / ResearchGate. The derivation layer above this foundation: Theorems 4–6 in full context, correspondences C5 with data, prediction P3.

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