The State Octonion: One Ledger, Two Universes

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“A particle is a book of windings kept on two clocks — and the universe never loses count.” — This paper

Abstract. The state quaternion described one universe: a clock and three winding counters. The state octonion is the same construction, doubled — two orthogonal universes, each with its own clock and its own three counters, welded by a multiplication that wakes only when three participants meet. This paper defines the object canonically for the series; reconciles the two dictionaries the series has used for it — components as conserved-quantity slots, and axes as rotation planes — by showing that a ledger component is the winding of the dynamical rotation about that axis; derives charge quantization, including the quark thirds, from winding closure; proposes baryon and lepton number as topological fiber classes rather than octonion axes, with the absolute stability of the proton as the proposal’s falsifier; and poses the colour Schrödinger equation by factoring the inner clock, with SU(3) appearing exactly where U(1) appeared in the outer universe. The dynamics — the running coupling, the octonion field equation, the lifetimes — is deferred to the sequel and named.

1. The State Quaternion, Recapped in Half a Page

In the earlier papers of this series a particle of our universe is a state quaternion: $Q = E + L_x \cdot e_1 + L_y \cdot e_2 + S_z \cdot e_3$. One real axis and three imaginary ones, and the physics is turning. The real axis carries the clock: every particle of mass m rotates internally at the Compton rate $\omega = mc^2/\hbar$ — the shutter, 1.2×10^{20} turns per second for an electron — and what we call energy is the rate of that turning read in energy units; E = hf is the clock read twice, not a law but an identity (Paper 2). The three imaginary axes carry windings: spin is a winding of the double cover, closing only after 4π, which is why fermions exist and why they exclude (Paper 3); orbital angular momentum is a winding of ordinary rotation, closing after 2π, integer for the same reason a circle is; and electric charge, in the field-equation notes of this series, is the winding number of the circle fiber. Quantization is not imposed on any of this. A winding either closes or it does not; the integers of quantum mechanics are the closure conditions of turnings. One clock, three counters: that is a particle, in one universe.

2. The State Octonion Defined

The colour rung doubles the construction (Paper 4). The state octonion of a quark is

$$\mathbf{O = Q\_spatial + Q\_colour = E + L\_x \cdot e_1 + L\_y \cdot e_2 + S\_z \cdot e_3 + E\_conf \cdot e_4 + r \cdot e_5 + g \cdot e_6 + b \cdot e_7} \quad (1)$$

with the axes now named canonically for the whole series: the real axis and e_1, e_2, e_3 are the outer universe (ours); e_4 through e_7 are the inner universe, of identical architecture — e_4 its scalar, (e_5, e_6, e_7) its three-vector. The sum in Eq. (1) is a direct sum: the two universes are orthogonal on every axis, addition is inert, and each quaternion can be recovered exactly by projection at any time (Paper 4, §4.3 and §7.1 — with the Callan–Gross scattering of pointlike quarks as the measured witness that coexistence does not disturb). All coupling between the universes lives in the multiplication: the Cayley–Dickson cross terms, which are the gluons; and by the alternativity of the octonions, those cross terms are silent for any two elements alone and wake only for genuine triples (Artin's theorem; the asymptotic-freedom note). An electron is Eq. (1) with the inner universe identically zero. A quark is the full octonion.

3. The Dictionary Map

The series has spoken about this object in two languages, and Papers 4 and 5 promised the map between them. Here it is.

The **ledger convention** (Papers 4–5) treats each component as a slot holding a conserved quantity: energy on the real axis, charge on e_1, spin on e_2, orbital momentum on e_3, confinement energy on e_4, colour on e_5–e_7. It balances collisions axis by axis and proves the conjugate-twins theorem. The **dynamical convention** (Papers 2–3 and the field-equation notes) treats each axis as the plane of a rotation: the shutter, the double cover, the circle fiber, the cage winding. It derives spectra and equations of motion.

The map: a ledger component is the winding of the dynamical rotation about that axis. Slots that hold energies are *rates* — continuous readings of clocks. Slots that hold charges are *winding numbers* — integers or half-integers, the closure counts of turnings. Conservation of a component is the closure of its winding: a wound loop cannot unwind continuously, so its count survives every smooth evolution.

axis	ledger slot	dynamical reading	type	quantum
1 (real)	energy / mass	outer clock: Compton shutter rate	rate	$mc^2/\hbar$
e_1	electric charge	circle-fiber winding number	integer, topological	±1 (thirds: §7)
e_2	spin	double-cover winding (4π closure)	half-integer	±1/2
e_3	orbital angular momentum	spatial-rotation winding	integer	0, ±1, ±2, …

e_4	confinement energy	inner clock: colour shutter rate	rate	≈ Λ = 2k_B·T_c per quark
e_5, e_6, e_7	colour r, g, b	axis of the inner winding	direction on S^7	singlet ⇔ vector = 0

And now read the table by rows and columns at once, because it contains this paper's first result. **The two scalars are the two clocks. The six imaginaries are the six counters.** Each universe is one clock plus three winding counters — the outer universe ticks at $mc^2/\hbar$ and counts charge, spin, and orbit; the inner universe ticks at $\Lambda/\hbar$ and counts the three colours. The ledger convention is the *book*: the integers the counters hold and the rates the clocks show. The dynamical convention is the *dance*: the turning itself. The two dictionaries were never rivals. Every conservation table in Paper 5 is the book of a dance that Papers 2 and 3 already choreographed.

A worked entry, both ways. The red up quark of Paper 5: $O = 0.007 + (2/3)e_1 + (1/2)e_2 + 0\cdot e_3 + 1.0005\cdot e_4 + 1\cdot e_5$ (units of Λ on the scalars). In the book: bare mass 2.16 MeV, charge +2/3, spin up, one unit of confinement, red. In the dance: an outer clock turning slowly (light quark), a circle fiber holding one-third of a shared winding (§7), a double cover wound once positively, an inner clock turning at the full confinement rate, and the inner winding turning about the e_5 axis. Same particle, book and dance.

4. The Eight Conservation Laws as Winding Closure

Paper 4 (§10.7) proved the conjugate-twins theorem in the ledger: the vacuum can only create O and −O together, because every axis must still sum to what it was. The dynamical translation is more vivid: **the vacuum can only add closed loops, and a closed loop has zero net winding on every axis.** Pair creation is the nucleation of a winding and its anti-winding — a loop pinched into two open ends that carry opposite counts on every counter. Annihilation is the reverse: the ends rejoin, the counters cancel, and everything unwinds onto the scalar axis — a photon, which is a pure clock: energy without a single winding, which is why it is its own antiparticle and why it can be born from and die into anything.

The doors of the ladder enter here. The door price $E = \hbar c/R$ (the 1.022 MeV pair door, the 1474 MeV cage door, the 80.4 GeV weak door) is the cost of the *first winding* on a fiber of radius R: below the price, the loop cannot nucleate and the rung's inhabitants cannot be born; above it, the vacuum pays energy into counters. The deep-inelastic event of Paper 4 §10 reads dynamically now: the electron's clock dumps 1000 MeV into the struck quark's outer clock; the stretched cage converts clock rate into inner-clock tension along e_4; at the pair threshold a loop nucleates — d and d̄, opposite counts on every counter — and the books close because loops always do.

5. Baryon and Lepton Number: Not Axes, but Fiber Classes

Paper 5 flagged it honestly: neither baryon number nor lepton number occupies an octonion slot, yet both are conserved in every observed process. Where do they live?

Proposal: B and L are not Noether charges of the eight axes; they are topological classes of fiber windings. Baryon number is the winding number of the cage itself — the S^7 winding that the triple shares — divided by three: B = (cage winding)/3, one third per quark, integer per baryon, for the same reason as the charge thirds of §7. Lepton number is the winding class of the weak fiber carried by the uncaged fermions. Both are conserved not because a rotation is symmetric but because a winding cannot unwind continuously: they are counts, not currents.

The proposal earns its keep by what it forbids. If B is topological, **the proton is absolutely stable** — it cannot decay unless the cage's winding itself is destroyed, and no smooth process destroys a winding. This is a sharp divergence from grand unified theories, which predict proton decay near 10^{34}–10^{36} years and have driven three decades of searches; every search is null (Super-Kamiokande: $\tau_p > 3\times10^{34}$ years and climbing). The Standard Model conserves B only by accident of its field content; here it is conserved by topology. **The falsifier is explicit: one observed proton decay kills this section.** Hyper-Kamiokande will push the bound another order of magnitude; the proposal predicts it will find nothing, forever. Neutron decay, meanwhile, passes trivially: the cage persists (baryon in, baryon out), one weak-fiber winding rearranges ($n \to p + e^- + \bar{\nu}$, lepton pair with opposite L), and every counter closes — as Paper 5's table showed without knowing why it worked.

Open edges, named and deferred: whether B−L has independent topological standing; whether any analogue of the electroweak sphaleron can unwind these classes at extreme temperature (if so, only above the rung's melting temperature — which would tie baryogenesis to the family law); and the three-generation question. These belong to the dynamics sequel.

6. The Colour Shutter and the Colour Schrödinger

The companion note on Schrödinger factored the outer clock: write the state as envelope times shutter, cancel the balanced frame, and complex quantum mechanics appears, with $U(1) = \mathrm{Stab}(e_3)$ as the symmetry the projection leaves standing. The state octonion invites the same move one universe down. Factor the *inner* clock:

$$\mathbf{O(x,t) = \psi(x,t) \cdot \exp(-e_4 \cdot \Lambda t/\hbar)} \quad (2)$$

with $\Lambda = 2k_B \cdot T_c = 310$ MeV the confinement rate — one confined quark, two melting temperatures (Paper 4, §9.5). The envelope ψ carries everything the inner clock does not: the outer universe entirely, and the colour *direction* (e_5, e_6, e_7). The symmetry that survives the nailing of e_4 is its stabilizer — **SU(3), appearing in the inner universe exactly where U(1) appeared in the outer one.** Gauge structure is not added to this equation; it is what is left of the algebra when a clock is chosen. The slow-envelope equation then reads, structurally,

$$\mathbf{e_4 \cdot \hbar \cdot \partial\psi/\partial t = -(\hbar^2/2m\_eff)\cdot\nabla^2\psi + V\_cage\cdot\psi} \quad (3)$$

the colour Schrödinger equation: dynamics on the inner clock, with the cage as the potential and the inner imaginary unit e_4 playing the role i played upstairs. Its ground state is the lowest winding of the cage — the nucleon, at m_p ≈ 3Λ = 6k_B·T_c = 930 MeV (0.9% from 938) — and its tower is the hadron spectrum as winding closures on S^7, extending the discrete-orbits note from S^3 to S^7. Solving Eq. (3) — m_eff, V_cage from the funnel, the spectrum — is the sequel's work; this paper's claim is the equation's *shape* and the location of its gauge group.

7. Fractional Charge and Confinement: One Fact

Now the centerpiece, and it begins with an apparent contradiction the map of §3 creates deliberately. If electric charge is the winding number of the circle fiber, it must be an integer — windings close or they don't. The electron obeys: ±1. **The quark carries thirds.** Either the map is wrong, or something owns the winding other than the quark.

The series has already answered, three times, without noticing it was answering this question. The asymptotic-freedom note found that the colour charge belongs to the cage's shared winding mode, not to the point (Routes 2–3: that is why the interior is free and the force rises). Paper 4 §7.1 found that the inner universe is one per *cage*, its scalar showing as the hadron's mass. And §5 above needed B = (cage winding)/3. The same fact, a fourth time: **inside a cage, the circle-fiber winding belongs to the triple, not to the individual quark. One integer winding, shared three ways.** A quark's charge of 2/3 or −1/3 is a share certificate in a winding the cage owns whole.

Count what this one sentence pays for. *(i) Why quark charges are thirds:* three shareholders of integer stock. The proton's books: 2/3 + 2/3 − 1/3 = 1 — the cage's windings total to integers, always. The meson case audits it from the other side: u + $\bar{d}$ gives 2/3 + 1/3 = 1, and every meson in the tables carries integer charge, because anti-shares are negative shares of the same stock. **Colour-neutral ⇔ integer charge** — a theorem of share arithmetic that the Standard Model obtains only through the delicate cancellation of anomalies between quarks and leptons. (That the two mechanisms agree is a convergence the sequel should mine.) *(ii) Why no free fractional charge has ever been seen:* a share cannot leave the company. Isolating a quark would mean tearing one-third of a winding off an integer — topologically impossible, not merely energetically expensive. Millikan-style searches for free fractional charge in matter, decades of them, are null; in this picture they must be, to the end of time. **Fractional-charge non-observation and colour confinement are the same fact.** *(iii) Why baryon number is a third per quark:* §5's proposal is this same share structure read on the cage's own winding.

The caveat, in print as always: this is a structural identification, not yet a dynamical derivation. What is owed: the mechanism by which the circle fiber threads the cage such that its winding is necessarily communal — presumably the same Cayley–Dickson weld that makes the gluons cross-couplings — and the demonstration that the sharing is exactly equal (thirds, not arbitrary fractions), which plausibly traces to the tetrahedral symmetry of the triple that Paper 5's closure angle already measures. Both belong to the sequel. But the accounting is too clean to be coincidence: **one geometric fact — the winding belongs to the triple — explains the thirds, the confinement of fractions, and the conservation of baryons.** Three of the quark world's oldest mysteries, one sentence.

8. What This Paper Does Not Do

It does not derive the logarithm: $b_0 = 11 - 2n\_f/3$ from the seven triples — the crossover from Artin-free pairs to caged triples must be shown to run as ln Q when the fields propagate (asymptotic-freedom note, §5). It does not write the octonion field equation — the G_2 connection on the S^7 fiber extending the frame-quaternion field equations. It does not derive the funnel potential V(θ) from curvature, nor solve Eq. (3) for the hadron spectrum. It does not compute the neutron lifetime from the weak seal's permeability — the rate that Paper 5's energetics still lack. And it does not audit the projection reading of quaternionic-octonionic quantum mechanics against entanglement (the tensor-product problem; Adler). Five debts, each named, each pointed at the dynamics sequel.

9. Conclusion

The state quaternion was a clock and three counters — a particle of one universe. The state octonion is two of them, orthogonal on every axis, coupled only in the multiplication, and only in threes. Its book is the ledger of Papers 4 and 5; its dance is the winding dynamics of Papers 2 and 3; and the map between them says: the components are the windings. From that map: charge is quantized because windings close; the vacuum births only twins because only loops can be added; the proton cannot decay because a count is not a current; and a quark's third is a share in a winding its cage owns whole — so the fraction can no more walk free than the cage can stop being three. A particle is a book of windings kept on two clocks. The universe never loses count. It is all one.

References

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