The Direction

Artist's Proof 19

Forces and Constants

SU(3) colour from the gauge freedom of the break direction

Contents

Artist’s Note

What this paper does — and why.

This is Artist’s Proof 19 of The 420 Code. It is the fifth chapter of Notebook IV (Forces and Constants). AP15 derived U(1) electromagnetism from the Born rule’s phase symmetry. AP27 derived the unbroken electroweak gauge group SU(2) × U(1)_Y from Axiom S’s two-sector structure. AP16 derived electroweak symmetry breaking from Axiom B. AP19 takes the last step in the gauge programme: it derives SU(3) — the gauge group of the strong force — from the freedom of the manifold to orient around the break.

The argument is a single move. The four axioms {S, B, R, C} are non-derivable from one another (AP20 §4.2, fenced KS-P.2). Three of them — C, S, B — each express one face of the spatial manifold (R is the temporal face). The three faces have fixed functional identity but no fixed spatial assignment: the axioms determine what each face expresses, not which spatial direction it occupies. When ε breaks the 1:1, the manifold orients around the break. Which face aligns which way is not determined by anything. That freedom — unitary, complex, local — is a gauge symmetry. The algebra gives U(3); factoring out the orientation’s global phase (Born-rule redundancy, AP09) leaves SU(3). Eight generators. The gauge group of the strong force.

Three identifications follow. Colour is orientation: a quark’s colour is how the manifold aligned around its break. The conjugate representation is anticolour; σ acts on orientation by complex conjugation. Confinement is the manifold enforcing isotropy: the substrate stiffness $\lambda \approx 2.15 \times 10^{46}$ (AP15) resists macroscopic anisotropy, so coloured states are confined to colour-neutral combinations. SU(3) is exact because Axiom B asserts the existence of ε but contains no clause selecting a preferred orientation — it says “I exist,” not “I point this way.” The gluons are massless. Three structural identifications. One mechanism.

The electron resolves the question the structure invites. ε is the minimum viable splinter (Axiom B) — the lowest energy configuration in which a break can exist. Colour requires anisotropy; anisotropy costs energy (Proposition 2). Therefore the minimum break is necessarily isotropic, and an isotropic orientation state is invariant under SU(3). The electron is an SU(3) singlet because it is the ground state of the break. Not a different kind of object from a quark — both are localised breaks — but the lowest energy configuration. Quarks are higher-energy excitations that sustain a colour charge.

Three new kill switches engage. KS-48c (orientation = colour) is LIVE — EMPIRICAL: colour is never directly observed (confinement), but the identification of internal SU(3) with face-space orientation is testable through lattice QCD. KS-49b (confinement from isotropy) is LIVE — EMPIRICAL: consistent with deconfinement at high temperature (quark-gluon plasma) and with the observed colour-neutrality of all hadrons. KS-50 (SU(3) from non-derivability) is LIVE — HARD: to fire this switch you must defeat the independence of the axiom set (the minimality obligation at AP20 §4.2, KS-P.2). Three structural debts are named openly — D1 (quantitative confinement / string tension from {S, B, R, C}), D2 (generation mass hierarchy $m_e : m_\mu : m_\tau$), D3 (running coupling $\alpha_s(Q^2)$). None is claimed closed; each is testable.

Orientation

Where AP19 fits

AP19 is the fifth chapter of Notebook IV (Forces and Constants). AP06 opened NB IV by grounding ε in the leakage framework; AP15 derived U(1) electromagnetism; AP27 derived the unbroken electroweak gauge group SU(2) × U(1)_Y; AP16 derived electroweak symmetry breaking via Axiom B. AP19 takes the third freedom of ε — spatial-orientation freedom — and shows that it is gauged. The result is SU(3), the strong-force gauge group, and with it the full Standard Model gauge structure SU(3) × SU(2) × U(1). The three-gauge-groups-from-three-freedoms-of-ε triad closes: phase freedom → U(1) (AP15); sector-relationship freedom → SU(2) × U(1)_Y (AP27); spatial-orientation freedom → SU(3) (AP19).

AP19 depends on Notebook I (axioms {S, B, R, C}, their independence carried at AP20 §4.2, fenced KS-P.2); AP10 (N = 3 spatial dimensions from {C, S, B}); AP05 (actualisation creates g, c, time); AP09 (complex Hilbert space, Born rule, and the fermion/boson distinction; identification of ε with the electron via The Lock); AP11 (the spin SU(2) double cover — context only, not the gauge SU(2)); AP15 (the gauge U(1) from Hilbert-space phase freedom, and substrate stiffness $\lambda \approx 2.15 \times 10^{46}$, which sets the quantitative scale for isotropy enforcement); AP27 (the gauge SU(2) × U(1)_Y); and AP16 (Higgs mechanism = Axiom B context, for the breaking pattern SU(3) must coexist with).

AP19 feeds the rest of Notebook IV and beyond. AP24 (Residual) treats the six faces of ε and the structural status of α_{em}; the three-orientation conjecture of §9 connects directly to the generation structure AP24 addresses. AP14 (The Correction) treats Planck-scale corrections that must be consistent with SU(3) being unbroken. AP28 (Constant) derives G via channel counting; the channel count includes the 6 × 3 spatial face-projections that this paper grounds in the three-face structure.

Reading order within AP19

Front to back. Section 1 names the problem: every other gauge group of the Standard Model has been derived in the corpus; SU(3) is the last piece. Section 2 establishes the three-face structure with the load-bearing distinction between functional identity (fixed by the axiom) and geometric assignment (free). Section 3 walks the silent pop — the break, the orientation around it, the quantum superposition before collapse — and names the local-vs-global freedom in section 3.4 (the wave/particle reading) so the gauge promotion in section 4 lands cleanly. Section 4 promotes the global symmetry to a local symmetry and proves SU(3) (Lemma + Proposition 1). Section 5 identifies colour with orientation and proves colour neutrality (Proposition 2); section 5.4 closes the apparent paradox of ε = electron carrying no colour (Proposition 4). Section 6 treats confinement and asymptotic freedom qualitatively. Section 7 lists the full gauge structure. Section 8 enumerates the derivation chain. Section 9 names the three-generations conjecture explicitly as conjecture. Section 10 lists the kill switches in Claim/Test/Status/Recovery form.

How to read this paper

The paper carries two voices. The structural narrative speaks directly — the central facts (three faces; orientation is gauge; colour is orientation; SU(3) is exact because B does not specify direction) are stated in plain language and held visible. The formal sections — Lemma, Propositions 1–4, the derivation chain, the kill-switch register — speak in the precision the structure requires. Where the argument depends on a result derived elsewhere in the corpus, the provenance is named at the point of use.

Three subsections are structurally distinct from the others. Section 3.3 (endless possibilities) is non-load-bearing synthesis: it interprets the local freedom across many actualisations and should not be read as adding new structural content. Section 3.4 (two views of the same now) is load-bearing for the quantum character of the orientation — the Lemma in §4.2 rests on the orientation being a property of a quantum event, and that rests on §3.4. Section 9 (three generations) is conjectural — it identifies a structural site for the generation count but does not derive the mass ratios; the epistemic-status tag CONJECTURE is held throughout.

A note on notation

Symbol firewall, applied throughout. α_1, α_2, α_3 in this paper are complex amplitudes of the orientation state $|\varepsilon\rangle \in \mathbb{C}^3$ — they are NOT the fine-structure constant α_em or the substrate-stiffness α of AP06. λ in this paper is the substrate stiffness derived in AP15 ($\lambda \approx 2.15 \times 10^{46}$), NOT a wavelength. The eight SU(3) generators are denoted T^a ($a = 1, \ldots, 8$) rather than the conventional λ_1–λ_8, to avoid collision with λ = stiffness.

“Orientation” in this paper means orientation in face-space — the internal index space {C, S, B} — not physical-space rotation. Face-space is an internal degree of freedom, like isospin. It is not SO(3) spatial rotation. The gauge group SU(3) acts on the internal face-state, not on spacetime coordinates. The fundamental representation $\mathbb{C}^3$ is the orientation state space; the conjugate representation $\mathbb{C}^{\bar{3}}$ carries antiquarks; the eight gauge bosons (gluons) carry colour–anticolour pairs in the adjoint.

0 — Dependency and Scope

0.1 — What this paper does

AP19 derives the SU(3) gauge symmetry of the strong force from the gauge freedom of the manifold's orientation around the break. The argument: the three axioms {C, S, B} each express one face of the spatial manifold (R expresses the temporal face); each face has a fixed functional identity (propagation, exchange, break) but no fixed geometric assignment; when ε breaks the 1:1, the manifold orients around the break, and which face aligns which way is undetermined; the non-derivability of {C, S, B} (AP20 §4.2, fenced KS-P.2) ensures no face is preferred; the per-event orientation promotes the global symmetry to a local one; the gauge group of a local unitary symmetry on $\mathbb{C}^3$ is U(3); factoring out the orientation's overall phase — unobservable by the Born rule (AP09) — leaves SU(3).

The paper makes three structural identifications. First: colour is orientation — a quark's colour is which face aligned with the break at its actualisation. Second: confinement is the manifold enforcing isotropy — the substrate stiffness λ (AP15) resists macroscopic anisotropy, so coloured states are confined into colour-neutral combinations. Third: ε (the electron) is an SU(3) singlet because the minimum break is necessarily isotropic (Proposition 4) — not a different kind of object from a quark but the ground state of the break.

What the paper does not derive: the colour-flux-tube energy and string tension (D1); the generation mass hierarchy $m_e : m_\mu : m_\tau$ (D2); the running coupling $\alpha_s(Q^2)$ (D3). The paper offers structural explanations for confinement and asymptotic freedom from isotropy plus substrate stiffness; these are qualitatively grounded but not quantitatively computed from {S, B, R, C}. The three-generations identification of §9 is named explicitly as conjecture, not derivation.

0.2 — Dependencies

AP19 depends on the following derived results.

Notebook I (Premise). The four axioms {S, B, R, C}. AP20 §4.2 (fenced KS-P.2): the independence of the four axioms — no one is derivable from the others. Load-bearing for the global symmetry of §4: non-derivability of the faces is what guarantees no face is preferred.

AP05 (The Break). Actualisation creates g, c, and time — the manifold and metric emerge from the break. Load-bearing context for §3.1: the break creates direction as a concept, not within a pre-existing geometric arena.

AP09 (The Break — Empty Set). The complex Hilbert space $\mathcal{H}$ and the Born rule. Load-bearing for the Lemma in §4.2: the orientation state is in $\mathbb{C}^3$ (not $\mathbb{R}^3$), which forces SU(3) (not SO(3)).

AP10 (The Dimension). N = 3 spatial dimensions from the three independent axioms {C, S, B}. Load-bearing for the three-face structure of §2.

AP09 (The Break — Quantum Mechanics). The fermion/boson distinction; the identification of ε as the unique unpaired element. Load-bearing for the electron-as-minimum-break reading of §5.4.

AP11 (The Spin). The spin SU(2) from $Z_2 = \pi_1(SO(3))$ and the double cover — this is the spacetime spin SU(2), NOT the gauge SU(2) of the weak force. Context only for §7; the gauge structure assembled there draws the weak SU(2) × U(1)_Y from AP27 and the U(1) from AP15, not from AP11.

AP15 (The Connection). Two roles. (i) The gauge U(1) from the phase freedom of the complex Hilbert space — provides the U(1) factor of the assembled gauge structure in §7 (and note: the U(1) factored out of U(3) in Proposition 1 is the orientation's own global phase, removed by Born-rule redundancy from AP09, NOT this electromagnetic U(1)). (ii) The substrate stiffness $\lambda \approx 2.15 \times 10^{46}$ — load-bearing for Proposition 2 (colour neutrality as the ground state) and §6 (confinement is isotropy enforced by stiffness).

AP27 (The Harmonics). The gauge SU(2) × U(1)_Y from the freedom in the sector relationship. Supplies the weak gauge factor of the full structure assembled in §7 — distinct from AP11's spin SU(2).

AP16 (The Break — Electroweak). Higgs mechanism = Axiom B. Load-bearing context for Proposition 3: AP16 establishes that Axiom B breaks SU(2) × U(1)_Y → U(1)_em; AP19 establishes that the same axiom does not break SU(3). One axiom, two consequences.

AP20 (The Proof). The Embedding Hypothesis. Load-bearing for the identification of the algebraic orientation state with the manifold-level internal SU(3) index space.

The Lock (Edition 04). The identification of ε with the electron at the chemical-biological scale. Load-bearing for §5.4: the SU(3)-singlet status of ε explains why the electron is colourless.

0.3 — Axiom mapping

The four axioms map to AP19 as follows.

Axiom S. The two-sector structure (ℓ, $\mathcal{P}$) and the involution σ. σ acts on the orientation state by complex conjugation, giving antiquarks the conjugate representation $\mathbb{C}^3$. Provides the paired/unpaired distinction that underwrites the "three faces are interchangeable in spatial expression" claim of §3.4.

Axiom B. The break direction. ε breaks along one face; which face is the gauge freedom. Axiom B asserts $\varepsilon \in \ell$ with no σ-image and $\nu(\varepsilon) = 1$, but contains no clause selecting a preferred face among {C, S, B}. This is what makes SU(3) exact (Proposition 3): B says "I exist," not "I point this way."

Axiom R. Time — the only irreversible axiom. Provides the temporal face (the − direction); not directly load-bearing for SU(3), which acts on the three spatial faces.

Axiom C. Finite propagation. One of the three spatial faces — the propagation face. Provides one of the three orientations in face-space {C, S, B} that SU(3) rotates among.

0.4 — Epistemic status per section

§1. *SYNTHESIS.* The gauge programme so far. Recapitulates the gauge SU(2) × U(1)_Y (AP27), U(1) (AP15), the electroweak unification (AP16). Names SU(3) as the remaining piece.

§2. *DERIVED (AP10; independence at AP20 §4.2, fenced KS-P.2).* Three faces of one manifold: functional identity fixed by the generating axiom, geometric assignment free. Co-arising; not reducible.

§3.1–3.3. *DERIVED / SYNTHESIS.* The break creates direction as a concept. The manifold orients around the break. §3.3 is non-load-bearing synthesis.

§3.4. *DERIVED (AP09).* Two views of the same now. Before collapse: all orientations coexist (wave). After collapse: record history selects one orientation (particle). Load-bearing for §4's quantum Lemma.

§4. *DERIVED.* Lemma: orientation state $\in \mathbb{C}^3$ (from AP09). Proposition 1: gauge group is SU(3) (norm-preserving on $\mathbb{C}^3$ is U(3); factor out the orientation's global phase by Born-rule redundancy). Eight generators.

§5.1–5.3. *DERIVED / STRUCTURAL.* Colour = orientation (DERIVED). Proposition 2 (colour neutrality from isotropy + substrate stiffness): STRUCTURAL — the energy functional is not computed from {S, B, R, C} (D1). Gluons as gauge bosons of SU(3): DERIVED.

§5.4. *DERIVED.* Proposition 4: ε is an SU(3) singlet because the minimum break is necessarily isotropic. Closes the apparent paradox that ε = electron is colourless.

§6. *STRUCTURAL.* Confinement and asymptotic freedom explained qualitatively from isotropy + substrate stiffness. Proposition 3 (SU(3) is exact) DERIVED: Axiom B does not specify orientation; no Lagrangian term can break SU(3). The quantitative running coupling and string tension are open (D1, D3).

§7. *DERIVED.* Full Standard Model gauge structure SU(3) × SU(2) × U(1) assembled from this paper, AP27 (gauge SU(2) × U(1)_Y), and AP15 (U(1)). Lie algebra structure derived; global quotient not addressed here.

§8. *SYNTHESIS.* Derivation chain enumerated step by step.

§9. *CONJECTURE.* Three generations from three orientations of ε. Named explicitly as conjecture; mass ratios not computed (D2). Architecture provides the structural site only.

§10. *REGISTER.* KS-48c, KS-49b, KS-50 in Claim/Test/Status/Recovery form.

0.5 — Kill switch summary

Three kill switches are engaged by AP19. Identifiers per the Master Kill Switch Registry: KS-48c and KS-49b carry the "c" and "b" suffixes to resolve collision with AP23 (which holds KS-48a Correlation timing, KS-48b No-signalling, KS-49a Hidden variables — Bell + Axiom R, CLOSED). The KS-48/49 identifiers in earlier AP19 drafts have been renumbered accordingly. KS-50 is unchanged.

KS-48c — Orientation = colour. LIVE — EMPIRICAL. The identification of internal SU(3) face-space orientation with colour charge.

KS-49b — Confinement from isotropy. LIVE — EMPIRICAL. Confinement is the manifold enforcing isotropy via substrate stiffness λ.

KS-50 — SU(3) from non-derivability. LIVE — HARD. The derivation rests on the independence of {C, S, B} (AP20 §4.2, fenced KS-P.2). To fire this switch you must defeat the independence of the axiom set.

0.6 — Structural debts owed

Three debts are named openly. None is claimed closed; each is testable; the paper provides the structural ground from which the quantitative computation should follow.

D1 — Quantitative confinement. Derive the colour-flux-tube energy and the string tension from {S, B, R, C} plus AP15 substrate stiffness. The structural mechanism (Proposition 2 + §6.1) is named; the energy functional has not been computed from axioms.

D2 — Generation mass hierarchy. Compute $m_e : m_\mu : m_\tau$ from the three-face structure. The architecture of §9 provides the structural site (three orientations of ε) but not the ratios.

D3 — Running coupling. Derive $\alpha_s(Q^2)$ from the stiffness/isotropy mechanism to reproduce asymptotic freedom quantitatively. The qualitative argument of §6.2 is structurally grounded; the negative β-function value has not been derived from axioms.

0.7 — Items held open without claiming debt status

The global structure of the Standard Model gauge group (SU(3) × SU(2) × U(1))/$\mathbb{Z}_6$ is not addressed here. AP19 derives the Lie algebra structure su(3) ⊕ su(2) ⊕ u(1) (this paper plus AP27 plus AP15). The discrete quotient is a separate question; the corpus does not yet treat it. Downstream of AP24 (Residual) and the Notebook V matter sector.

The detailed group-theoretic representation content of quarks (fundamental triplet) and antiquarks (conjugate triplet) is stated as a direct consequence of

SU(3) acting on $\mathbb{C}^3$ but the full embedding of quark flavour structure into the three-generations conjecture (§9) is held open as part of D2.

0.8 — Structural relationships

AP10 (The Dimension): N = 3 from three independent axioms {C, S, B}. Three faces of one manifold. AP19 takes the three faces and shows that the freedom to assign them to spatial directions is a gauge symmetry. SU(3) is the gauge group of that freedom.

AP11 (The Spin): SU(2) from $Z_2 = \pi_1(SO(3))$ in N = 3 spatial dimensions and the double cover SU(2) → SO(3). This is the spacetime spin SU(2) — NOT the weak gauge SU(2). The weak gauge factor comes from AP27, and U(1) from AP15. AP19 adds SU(3) from orientation freedom; together with AP27 and AP15, the full Standard Model gauge group assembles.

AP16 (The Break — Electroweak): Axiom B breaks SU(2) × U(1)_Y to U(1)_em. AP19 (Proposition 3) shows that Axiom B does NOT break SU(3). One axiom, two consequences: it breaks the symmetry of whether the sectors are distinguishable; it does not break the symmetry of how the manifold orients around the break.

AP15 (The Connection): substrate stiffness λ. AP19 uses λ as the quantitative scale for isotropy enforcement (Proposition 2). Without λ, colour neutrality would have no energy scale; with λ, anisotropic configurations carry a quantifiable (though not yet computed) energy penalty.

1 — The Problem

You have watched the gauge structure assemble piece by piece. The gauge SU(2) × U(1)_Y from the freedom in the sector relationship (AP27). U(1) from the phase freedom of the complex Hilbert space (AP15). The electroweak unification derived, with the Higgs mechanism identified as Axiom B (AP16).

One piece remains. SU(3) — the gauge group of the strong nuclear force. The last piece.

This paper derives it. And once you see where it comes from, you will wonder how it could have come from anywhere else.

2 — Three Expressions of One Manifold

You already know the three-face structure from AP10. N = 3 spatial dimensions from the four axioms {S, B, R, C}. R expresses the temporal direction (−). It is the only irreversible axiom. Time.

The three remaining axioms each express one face of the spatial manifold.

C — the propagation face. Axiom C gives finite propagation. On the manifold, this expresses one mode of the spatial structure: the mode along which signals travel. The character of c.

S — the exchange face. Axiom S gives the two-sector structure and the involution σ. On the manifold, this expresses one mode of the spatial structure: the mode across which the sectors are mapped. The character of exchange.

B — the break face. Axiom B gives the break ε. On the manifold, this expresses one mode of the spatial structure: the mode through which the break acts. The character of the splinter.

Critical distinction: functional identity vs geometric assignment

Each face has a fixed functional identity — what it expresses (propagation, exchange, break). The identity comes from the axiom that generates it.

But no face has a fixed geometric assignment — which spatial direction it occupies. The labels C, S, B name what each face is, not where it points. The functional identity is intrinsic. The spatial assignment is free.

These three faces are intrinsically linked. They are expressions of the same conditions of reality. C, S, and B co-arise. You cannot have one without the others. The manifold is one structure and these are three faces of it — not three separate pieces assembled together.

But they are distinct. No axiom is derivable from the others (AP20 §4.2, fenced KS-P.2). Linked but not reducible. Knowing one does not tell you another. Three faces of the same thing, each saying something the others cannot say.

Hold that. Three faces. Linked but independent. The functional identity fixed. The geometric assignment free. Everything that follows grows from this.

3 — The Silent Pop

3.1 — Before the break, there is no direction

Before the break, the pre-state is the 1:1. Perfect symmetry. No preferred axis. No "this way" versus "that way." Direction requires asymmetry. To point, you need a distinction — somewhere that is different from somewhere else. In the 1:1, nothing is different from anything else. The concept of direction is meaningless in perfect symmetry.

The break is what makes direction a sensible concept. Axiom B: one element $\varepsilon \in \ell$ with no σ-image in $\mathcal{P}$. Valuation $\nu(\varepsilon) = 1$. The minimum viable splinter. The splinter pops off. Now there is a distinction: the splinter and the remainder.

Now "this way" means something. Now direction exists.

The actualisation creates the conditions: g, c, time (AP05). The record is written within these constraints. But more fundamentally: the actualisation creates the possibility of direction itself.

3.2 — The manifold orients around the splinter

The splinter does not fall into a pre-existing structure. There is no pre-existing structure with labelled slots waiting for the break to choose one. The splinter pops, and the entire structure orients itself around the splinter.

The break is the reference point. The origin. The fixed fact. The three faces of the manifold — C, S, B — crystallise around the break. The manifold does not exist first and then receive the break. The break and the manifold co-arise. But the break is the event. The manifold is the description of the event. The event is fixed. The description arranges itself around it.

The splinter leaves the 1:1. The manifold organises around it. The fact that the break occurs is physically meaningful — it is everything, it is actualisation itself. But how the manifold arranges itself around the break — which face aligns which way — is not determined by anything. The break does not care. It just broke.

That is the silent pop. And if you have been following the geometry, you can already feel what comes next. If the orientation is free — if nothing determines which face points which way — then that freedom must have consequences.

3.3 — Endless possibilities

[Synthesis — non-load-bearing.]

Locally — within one actualisation event — the manifold orients around the break. The orientation is what it is. The record is written. Over many actualisations — over cycles, over the full accumulation of records — there are endless possibilities. Every orientation is explored.

Not because some metaphysical principle demands it, but because there are so many cycles, so many pops, so many records, that everything gets visited. What could be interpreted as freedom is simply the vastness of the possibility space over cyclical actualisation.

The local orientation is the quark's colour. The cyclical isotropy is confinement. Both are derived below.

3.4 — Two views of the same now

Before collapse (the wave). All orientations of {C, S, B} around the break coexist simultaneously. Not metaphor — full superposition. Every possible arrangement of the three faces around the break is a real branch of the quantum state. The orientation state $|\varepsilon\rangle \in \mathbb{C}^3$ lives here. The complex amplitudes are real because this IS quantum superposition (AP09).

After collapse (the particle). The record history — the accumulated structure of all prior actualisations — orientates the axioms. One orientation manifests. A quark with a definite colour. The collapsed wave.

Wave and particle are not different things. They are different views of the same now. You have seen superposition before — in AP09, in the Born rule. Here it appears again, doing the same work it always does: holding every possibility until the record collapses it into one.

Three critical questions resolve.

Why the orientation is quantum ($\mathbb{C}^3$, not $\mathbb{R}^3$). Before collapse, the faces carry no spatial assignment. They exist in superposition across all possible geometric arrangements. The complex amplitudes of $\mathbb{C}^3$ describe this superposition. A classical orientation ($\mathbb{R}^3$, SO(3)) would describe a manifold that already has a definite spatial arrangement — but that is the post-collapse particle view, not the pre-collapse wave. The orientation is quantum because the break is a quantum event.

Why the faces are interchangeable in their spatial expression. No axiom carries a built-in spatial tag. The functional identity (propagation, exchange, break) is fixed by which axiom generates the face. The geometric assignment (which spatial direction the face occupies) is determined at each actualisation by the record history — not by anything intrinsic to {C, S, B}. The axioms determine what the faces express. The record history determines where they point. Functional identity fixed. Geometric arrangement free.

Why the freedom is total. Within the universal constraints (the axioms themselves), all orientations are possible — and over many actualisations, all are necessary. Every arrangement is realised. The possibility space is ergodically filled. Not a hypothesis about the dynamics — a consequence of the superposition being real and the actualisations being many.

4 — The Gauge Freedom

Now watch the algebra fall.

4.1 — The physics does not depend on the orientation

The break happens. The manifold orients around it. But the physics — the probabilities, the field equations, the observables — does not depend on the orientation.

The reasoning follows from the non-derivability of the axioms. The three faces of the manifold are expressed by C, S, and B. These are intrinsically linked but no face is derivable from another (AP20 §4.2, fenced KS-P.2). Knowing one face does not determine another. Therefore no arrangement of faces around the break is preferred over any other. Rotating the orientation — reshuffling which face aligns which way around the break — does not change any observable.

Step 1: Global symmetry from non-derivability. The non-derivability of {C, S, B} (AP20 §4.2, fenced KS-P.2) means no physical principle selects one face over another. The Lagrangian/action cannot contain terms that distinguish faces, because the axioms provide no basis for such terms. The action is invariant under relabelling the faces. A global symmetry.

Step 2: Local symmetry from per-event orientation. The orientation is defined per actualisation event (§3.4). Each break has its own orientation, determined by the local record history. Different events can have different orientations. The freedom to choose the face-assignment independently at each spacetime point promotes the global symmetry to a local symmetry.

Step 3: Local symmetry → gauge theory. A local internal symmetry requires a connection — a gauge field that compensates for the variation of the orientation between neighbouring events. Standard: local SU(N) invariance implies an SU(N) gauge connection $A_\mu = A_\mu^a T^a$, with gauge bosons mediating the interaction. The gauge field is not postulated; it is forced by the locality of the symmetry.

The orientation is a gauge degree of freedom — not merely a relabelling convention, but a local internal symmetry with a dynamical connection. The gauge bosons of this connection are the gluons (§5.3).

You have just watched the same pattern that produced U(1) in AP15 and the gauge SU(2) in AP27: a freedom that cannot be removed, promoted to a local symmetry, forcing a gauge field into existence. The axioms do not postulate forces. The axioms produce freedoms. The forces are consequences.

4.2 — The gauge group is SU(3)

Lemma (Orientation state). The orientation of a quantum event among n distinct outcomes is a state vector in $\mathbb{C}^n$, not a classical configuration in $\mathbb{R}^n$.

Proof. (1) The break is a quantum event (AP09: actualisation produces quantum states in a complex Hilbert space $\mathcal{H}$). (2) The orientation of the break among the three faces {C, S, B} is a property of this quantum event — it is determined at collapse, not before (§3.4). (3) Before collapse, all orientations coexist in superposition (§3.4). A quantum property with n distinct outcomes is described by a state vector in $\mathbb{C}^n$ with complex amplitudes (AP09, Born rule). (4) The break and the manifold co-arise (§3.2). The manifold's orientation is not a classical rotation applied to a pre-existing structure; it is a property of the quantum break event itself. (5) Therefore the orientation state is $|\varepsilon\rangle \in \mathbb{C}^3$, not a vector in $\mathbb{R}^3$.

[If the orientation were classical (three real axes, classical rotation), the gauge group would be SO(3), not SU(3). The complex Hilbert space of AP09 is load-bearing: it promotes the orientation to a quantum state, giving U(3) and hence SU(3). Without AP09, the derivation yields the wrong group.]

The Lemma is doing quiet, decisive work. If the Hilbert space were real, you would get SO(3). The complex structure of AP09 — derived, not assumed — is what forces SU(3). The wrong Hilbert space gives the wrong gauge group. The right Hilbert space gives the right one.

The orientation state is:

$$|\boldsymbol{\varepsilon}\rangle = \boldsymbol{\alpha_1|e_1\rangle + \alpha_2|e_2\rangle + \alpha_3|e_3\rangle}$$

where e_1, e_2, e_3 are the three faces; α_1, α_2, α_3 are complex amplitudes; and $|\alpha_1|^2 + |\alpha_2|^2 + |\alpha_3|^2 = 1$ (Born rule, AP09). A vector in $\mathbb{C}^3$.

Proposition 1 (Gauge group). The gauge group of the orientation freedom is SU(3).

Proof. (1) The orientation state $|\varepsilon\rangle \in \mathbb{C}^3$ (Lemma; three faces, complex amplitudes). (2) Gauge transformations are unitary transformations of $\mathbb{C}^3$ that preserve the norm (§4.1: physics is invariant under local reorientation). (3) The group of norm-preserving transformations on $\mathbb{C}^3$ is U(3). (4) U(3) $\cong$ (SU(3) × U(1))/$\mathbb{Z}_3$. The U(1) factor is the overall phase of the orientation state: $|\varepsilon\rangle \to e^{i\theta}|\varepsilon\rangle$. By the Born rule (AP09), the overall phase of any quantum state is physically unobservable — probabilities depend on $|\varepsilon\rangle$ only through $|\alpha_i|^2$, which is invariant under $|\varepsilon\rangle \to e^{i\theta}|\varepsilon\rangle$. The orientation state inherits this global-phase redundancy, so the overall U(1) is not a physical degree of freedom of the orientation. Factoring it out leaves SU(3) as the gauge symmetry specific to the orientation. (5) SU(3) has $3^2 - 1 = 8$ generators.

[Note on global structure: the full Standard Model gauge group has global structure (SU(3) × SU(2) × U(1))/$\mathbb{Z}_6$, not a simple product. This paper derives the Lie algebra structure su(3) ⊕ su(2) ⊕ u(1). The global quotient is a separate question, not addressed here.]

Sit with that. Three independent faces of one manifold. One quantum event. The freedom to orient. And the algebra says: SU(3). Eight generators. The gauge group of the strong force. Not postulated. Not fitted. Derived from the fact that three faces cannot tell you which way to point.

Representation. The orientation state $|\varepsilon\rangle \in \mathbb{C}^3$ transforms in the fundamental (defining) representation of SU(3) by construction — SU(3) is the group that acts on $\mathbb{C}^3$. Quarks, as localised break events, carry colour in the fundamental 3. Antiquarks (σ-images) carry the conjugate $\bar{3}$.

SU(3) is derived. It is the gauge symmetry of the manifold's orientation around the break.

5 — Colour

5.1 — What colour is

A quark's colour is how the manifold oriented around its break.

Red. The C-face aligned with the break.

Green. The S-face aligned with the break.

Blue. The B-face aligned with the break.

These labels are arbitrary — the assignment of colour names to faces is a gauge choice. What matters is that there are three faces, they are distinct but linked, and the physics is symmetric under rotations among them. You could call them anything. The structure does not care about your labels. It cares about the number three.

An antiquark's anticolour is the conjugate orientation — the complex conjugate representation $\bar{3}$ of SU(3). Under the involution σ (Axiom S), the σ-image of a quark state maps to the anti-triplet: σ acts on the orientation state by complex conjugation of the amplitudes, giving the conjugate representation.

[Why the electron — itself a localised break (AP09: ε = electron) — is an SU(3) singlet despite being a break event: see §5.4.]

5.2 — Colour neutrality

A colour-neutral state is one where no face is preferred. Isotropic orientation. No preferred alignment.

Proposition 2 (Colour neutrality — structural). The only stable macroscopic states are colour-neutral (isotropic in orientation).

Proof. (1) The manifold is isotropic at macroscopic scales (AP10: three spatial dimensions from three axioms, no preferred direction). The ground state of the manifold. (2) The orientation of the manifold around the break is a degree of freedom of the manifold (§4). A macroscopic state with a preferred orientation (locked colour) would be a macroscopic anisotropy in the manifold. (3) The substrate resists macroscopic anisotropy with stiffness $\lambda \approx 2.15 \times 10^{46}$ (AP15). The energy cost of maintaining a macroscopic orientation anisotropy grows with the volume of the anisotropic region. (4) Therefore the ground state of the orientation at macroscopic scales is isotropic: all three faces equally represented, no preferred alignment. Colour neutrality. (5) Any state that is not colour-neutral at macroscopic scale carries an energy penalty proportional to the anisotropic volume × λ. Such states relax to colour-neutral configurations.

[Note: structural proposition, not quantitative derivation. The precise energy functional and resulting string tension are not yet computed from the axioms — see D1.]

Red + green + blue = white. All three faces equally represented in the orientation around the break. The ground state of the manifold.

You see the pattern. The manifold insists on isotropy. Not because a law commands it, but because the substrate is stiff and anisotropy costs energy.

A proton is three quarks — one red, one green, one blue — combined to make white. A meson is a quark-antiquark pair — colour plus anticolour — combined to make white. All observed hadrons are colour-neutral. An empirical fact — and a structural consequence of Proposition 2.

5.3 — Gluons

The gauge bosons of SU(3) are the gluons. There are 8 (from the 8 generators of SU(3)).

A gluon is a quantum of the gauge field that rotates the manifold's orientation around the break. It carries a colour-anticolour pair (e.g., red-antigreen). It mediates the strong force by exchanging orientation between quarks.

Gluons are bosons (paired elements, σ-image exists, AP09). Gluons are massless (SU(3) is not broken; see §6.3). Gluons carry colour charge themselves (unlike photons, which are charge-neutral). SU(3) is non-Abelian: the generators do not commute. The gauge bosons interact with each other.

5.4 — Why the minimum break ε is an SU(3) singlet

Here is a question you should already be asking. The electron is ε — the minimum viable splinter (AP09, Edition 04: The Lock). The electron is a localised break. But the electron does not carry colour. Why?

Proposition 4 (Minimum break singlet). The minimum break ε is an SU(3) singlet. Its orientation state is isotropic (colour-neutral).

Proof. (1) ε is the minimum viable splinter (Axiom B). It is the lowest possible energy state in which a break can exist (AP09: "the smallest possible piece the fabric could release"). (2) Colour is a preferred orientation of the manifold around the break in face-space (§5.1). A "red" state has the C-face aligned; a "blue" state has the B-face aligned. Any state with a preferred face-alignment is anisotropic. (3) Anisotropy costs energy (Proposition 2, §5.2). The substrate resists anisotropy with stiffness $\lambda \approx 2.15 \times 10^{46}$ (AP15). Any state with a preferred orientation has higher energy than the isotropic (colour-neutral) state. (4) The minimum energy break must therefore be isotropic. A coloured state would not be the minimum — it would carry additional energy from the anisotropy. The minimum break has no preferred face-alignment. (5) An isotropic orientation state is invariant under SU(3). It is a singlet.

The electron is colour-neutral because it is the ground state of the break. Not a different kind of object from a quark. Both are localised breaks. But the electron is the minimum break — the lowest energy configuration — and the lowest energy orientation is isotropic. Quarks are higher-energy excitations that sustain an anisotropic orientation (a colour charge).

[Scope: this is a claim about colour orientation only — isotropic (the electron, an SU(3) singlet) versus anisotropic (a quark, carrying colour). It carries no implication about electric charge. Why the electron carries charge −1 while quarks carry ±1/3 or ±2/3 is a separate matter — the structure of electric charge, including quark fractional charge, is handled in AP24 (the six faces of ε), not here. "The same kind of object" means same kind of break, not same charge.]

The mass gap between the electron (~0.511 MeV) and the lightest quark (up quark, ~2.2 MeV) is consistent: the quark carries additional energy from its colour anisotropy.

[No contradiction: AP09 identifies ε = electron as a localised break, yet the electron carries no colour. The resolution is that colour requires anisotropy, and anisotropy requires energy above the minimum. The minimum break is necessarily isotropic. No import required — follows from Axiom B (minimum) + Proposition 2 (anisotropy costs energy).]

You see what happened. The same argument that explains why hadrons are white also explains why the electron is colourless. One mechanism. Two consequences.

6 — Confinement

6.1 — Why you never see a lone quark

[Structural explanation — qualitative, not quantitative. Confinement is explained from isotropy + substrate stiffness, but the flux tube energy is not derived from {S, B, R, C}. See D1.]

A lone quark would be a break whose manifold orientation is locked to one face at macroscopic scale. An anisotropic eye.

The manifold is isotropic. Three linked faces, no preferred one. At macroscopic scales — many records, many actualisations — the manifold insists on isotropy. The substrate is stiff ($\lambda \approx 2.15 \times 10^{46}$). It restores isotropy. It does not tolerate macroscopic anisotropy.

A lone colour charge is an orientation that has not been cancelled by its complementary alignments. At short distances — inside the hadron — the anisotropy is local and tolerable. One record can orient one way without violating the manifold's large-scale isotropy.

At large distances — trying to separate a quark from its partners — the anisotropy would become macroscopic. The substrate resists. The energy stored in the anisotropy grows with distance.

The colour flux tube — the region between separated quarks where the orientation field is stretched, resisting the separation, storing energy proportional to the distance.

Eventually, the energy in the flux tube is enough to create a new quark-antiquark pair. The pair pops into existence (Axiom B: the break has minimum size ε; new breaks can occur). One new quark joins the separated quark. The other joins the remnant. Two colour-neutral hadrons where there was one. The quarks are never free.

Confinement is the manifold's isotropy enforced by the substrate's stiffness.

You cannot pull a quark free any more than you can stretch a rubber band forever. The manifold snaps back. Not because a force holds the quark in place — because the shape of the room does not permit macroscopic anisotropy.

[Quantitative derivation of the flux tube energy / string tension from the axioms is an open problem (D1). Here is how to destroy this claim: derive the string tension from {S, B, R, C} and show it contradicts lattice QCD measurements. The argument hands you the weapon.]

6.2 — Asymptotic freedom

[Structural explanation — qualitative. See D3.]

At short distances — inside the hadron, at high energies — the quarks behave as if they are free. The strong force gets weaker at short range. Asymptotic freedom (Gross, Wilczek, Politzer, 1973; Nobel Prize 2004).

At short distances, the orientation is local. One record, one alignment. The anisotropy is confined to a single Planck cell or a few cells. The substrate does not need to enforce isotropy at this scale — the anisotropy is already microscopic. The restoring force is negligible. The quarks move freely.

As the distance increases, the anisotropy grows. The substrate notices. The restoring force strengthens. The coupling increases. The quarks are pulled back.

Asymptotic freedom at short range. Confinement at long range. The same mechanism: the substrate's response to anisotropy in the orientation. Weak when the anisotropy is small. Strong when the anisotropy is large. You are watching one mechanism produce both behaviours — not two forces, one.

[In standard QCD, this behaviour is captured by the negative β-function of non-Abelian gauge theory. D3 is to reproduce the running coupling $\alpha_s(Q^2)$ from the stiffness/isotropy mechanism.]

6.3 — Why SU(3) is not broken

SU(2) × U(1) is broken by Axiom B (AP16). The break distinguishes the sectors. SU(2) is broken. U(1) survives.

SU(3) is NOT broken. Why?

You already know the answer. You have been watching it build since §2.

Proposition 3 (SU(3) is exact). Axiom B breaks SU(2) but does not break SU(3). The strong gauge symmetry is exact and the gluons are massless.

Proof. (1) SU(2) is the symmetry of whether the sectors are distinguishable. Axiom B ($\varepsilon \in \ell$ with no σ-image in $\mathcal{P}$) creates a distinction between the two sectors. Breaks SU(2) (AP16). (2) SU(3) is the symmetry of how the manifold orients around the break (§4). It acts on the orientation state $|\varepsilon\rangle \in \mathbb{C}^3$ — the arrangement of three faces around the break event. (3) Axiom B asserts the existence of ε (the break happens) but contains no clause selecting a preferred orientation. B says: $\varepsilon \in \ell$, $\nu(\varepsilon) = 1$, no σ-image. None of these conditions distinguish one face from another. (4) The non-derivability of {C, S, B} (AP20 §4.2, fenced KS-P.2) guarantees that no axiom can induce a preference among the faces. If one face could be preferred, it would imply a derivability relation between axioms. (5) Therefore no term in the action/Lagrangian can break SU(3). The gauge symmetry is exact. The gauge bosons (gluons) acquire no mass.

Two words do different work. SU(2) is the symmetry of whether the break exists. Axiom B breaks it. SU(3) is the symmetry of how the manifold arranges around the break. Axiom B does not break it. The break says “I exist.” It does not say “I point this way.”

SU(3) is exact. Unbroken. The gluons are massless.

7 — The Full Gauge Structure

The complete internal gauge symmetry is now derived.

$$\mathbf{SU(3) \times SU(2) \times U(1)}$$

SU(3). From the gauge freedom of the manifold's orientation around the break, across three distinct but linked expressions of the manifold (this paper).

SU(2). The weak gauge SU(2), from the freedom in the relationship between the two sectors (AP27). This is distinct from the spacetime spin SU(2) of AP11.

U(1). From the phase freedom of the complex Hilbert space, expressed on the manifold as the electromagnetic connection (AP15).

The symmetry breaking pattern.

SU(3) is exact (the orientation is free). Gluons are massless. Colour is confined.

SU(2) × U(1) is broken to U(1) by Axiom B (the break exists). W^+, W^-, Z^0 are massive. The photon is massless.

The gauge structure of the Standard Model. Derived from {S, B, R, C}.

Step back and look at what you are holding. Four axioms. One governing relation. And the full gauge structure of the Standard Model — the structure that took a century of experiment and theory to discover — falls out as a consequence of the freedom the axioms cannot remove.

8 — Derivation Chain

AP10 → three spatial dimensions from three axioms {C, S, B} → three faces of one manifold. Functional identity fixed, geometric assignment free.

Axiom B → the break creates direction as a concept → the manifold orients around the break.

Before collapse: all orientations coexist in superposition (§3.4) → orientation is quantum, not classical.

Non-derivability of {C, S, B} (AP20 §4.2) → no face preferred → global symmetry. Per-event orientation → local symmetry → gauge theory with connection.

Complex Hilbert space (AP09) → orientation state $|\varepsilon\rangle \in \mathbb{C}^3$ (Lemma) → gauge group SU(3) (Proposition 1, not SO(3)).

Isotropy of manifold (AP10) + substrate stiffness (AP15) → macroscopic orientation isotropic → colour neutrality (Proposition 2). Confinement.

B fixes existence, not orientation (AP20 §4) → SU(3) unbroken (Proposition 3) → gluons massless.

Minimum break (Axiom B) + anisotropy costs energy (Proposition 2) → ε is isotropic → electron is SU(3) singlet (Proposition 4).

9 — Three Generations

[Conjecture — not a derivation. See D2.]

A note on three generations, which this derivation illuminates. You will recognise the structure immediately.

The three faces of the manifold come from three axioms: C, S, B. Each axiom has different physical character.

C is propagation. The most external, the most accessible face. The lightest.

S is sector-crossing. Intermediate. The exchange face.

B is the break itself. The most internal, the most fundamental face. The heaviest.

If ε actualised with the manifold's C-face aligned is the electron (lightest generation), and ε actualised with the S-face aligned is the muon (middle generation), and ε actualised with the B-face aligned is the tau (heaviest generation), then the three generations are ε with three orientations.

Same break. Different arrangement. The mass hierarchy follows: C is the lightest face (propagation is the most accessible mode), B is the heaviest (the break face is the most internal, the most fundamental). Mass increases with the depth of the face.

A conjecture, not a derivation.

The mass ratios $m_e : m_\mu : m_\tau$ are not yet computed. But the architecture provides the structural site: three generations from three orientations from three distinct but linked expressions of one manifold.

Disambiguation: colour vs generation

The generation conjecture concerns which face dominates the orientation at the moment of actualisation — a different degree of freedom from the continuous SU(3) orientation that defines colour.

A first-generation quark can carry any colour; its generation is determined by which face's alignment carries the largest weight.

Colour and generation share a common origin (three faces of one manifold) but are distinct: colour is the full SU(3) quantum number, generation is a structural index determined at actualisation. A red up quark and a red charm quark both exist — same colour, different generation.

Three colours and three generations from the same three faces. SU(3) and the generation structure share a common origin: {C, S, B}.

10 — Kill Switches

Three new kill switches engage in AP19. Each is testable. Each has a specified recovery position — if the kill switch fires, the paper reverts to a named earlier position rather than collapsing entirely. Identifiers per the Master Kill Switch Registry: KS-48c and KS-49b carry the “c” and “b” suffixes to resolve collision with AP23 (KS-48a Correlation timing, KS-48b No-signalling, KS-49a Hidden variables — Bell + Axiom R, CLOSED). KS-50 is unchanged.

KS-48c — Orientation = colour

Claim. The internal SU(3) index space of QCD is identified with the manifold’s face-space — the three-dimensional internal orientation space of the break event in {C, S, B}. A quark’s colour is which face aligned with its break at actualisation.

Test. If the SU(3) coupling exhibits dependence on spatial direction in an isotropic background, or if lattice QCD reveals SU(3) structure inconsistent with a three-dimensional internal orientation origin, the identification fails. Run the lattice calculation. Show the inconsistency.

Status. LIVE — EMPIRICAL. Colour is never directly observed (confinement). All observations are consistent with SU(3) as an internal symmetry. The identification with internal face-space orientation adds structure but does not contradict any observation. Structurally secure.

Recovery. If KS-48c fires, the orientation-as-colour identification fails and an alternative internal grounding for the SU(3) index must be found. The structural results of §2 (three faces of one manifold) and §4 (orientation is a gauge degree of freedom) remain intact; only the specific identification of the SU(3) representation with face-space would need alternative grounding.

KS-49b — Confinement from isotropy

Claim. Confinement is the manifold enforcing isotropy via substrate stiffness λ (AP15). Coloured states carry anisotropic orientation; the substrate resists macroscopic anisotropy; isolated colour charges are forbidden as ground states; colour-neutral combinations are the only stable macroscopic configurations.

Test. If confinement persists in a fundamentally anisotropic spacetime, or if deconfinement occurs at conditions where the manifold remains isotropic, the mechanism is wrong. Find the counterexample.

Status. LIVE — EMPIRICAL. Deconfinement is observed at high temperatures (quark-gluon plasma), where the record density is so high that local anisotropy is negligible. Consistent: high temperature = many records = isotropy restored locally = quarks free. Structurally secure.

Recovery. If KS-49b fires, the isotropy mechanism for confinement fails and an alternative mechanism must be found. The structural results of §4 (SU(3) is the gauge group) and Proposition 3 (SU(3) is exact) remain; only the specific dynamical explanation of confinement would need alternative grounding (e.g., direct dual-superconductor or holographic mechanisms).

KS-50 — SU(3) from non-derivability

Claim. The derivation of SU(3) rests on the non-derivability of the three spatial axioms {C, S, B} (AP20 §4.2, fenced KS-P.2). If one axiom could be derived from the others, the gauge freedom would be reduced and SU(3) would not follow.

Test. Defeat the independence of the axiom set — exhibit a derivation of any one of {C, S, B} from the other two plus R (the minimality obligation at AP20 §4.2, KS-P.2). Failure: the basis for SU(3) collapses.

Status. LIVE — HARD. Non-derivability is carried at AP20 §4.2 as a stated result with proof sketch; its full formalisation is the open obligation KS-P.2. KS-16 (completeness of the axiom set) is CLOSED (contingent on KS-P.1). To fire KS-50, you must defeat the independence of the axiom set.

Contingency on N = 3. The 3-ness of SU(3) — three colours, eight gluons — inherits the spatial dimension count N = 3 (AP10), which is itself contingent on KS-D.3 (the dimension kill switch). If KS-D.3 fires and N ≠ 3, the strong-force gauge group would be SU(N), not SU(3). This is not a weakness but a prediction: AP19 forces colour-count = spatial-dimension-count, both 3 from the same source. In a universe with a different spatial dimension, the strong-force gauge group would differ. The dependency is disclosed, not hidden.

Recovery. If KS-50 fires — if one axiom is shown to be derivable from the others — the entire gauge programme of Notebook IV requires reassessment, not just AP19. The full structural consequence is that the three-faces architecture would reduce to a two-faces architecture, and the gauge group of the orientation freedom would reduce from SU(3) to SU(2) or U(1). Recovery would proceed by restating the corpus from the smaller axiom set; no result of NB IV is preserved without modification.

Claim Summary

Section-by-section structural enumeration with epistemic-status labels.

1 (The Problem). *SYNTHESIS.* The gauge programme so far. Gauge SU(2) × U(1)_Y (AP27), U(1) (AP15), electroweak unification (AP16). SU(3) is the last piece.

2 (Three Expressions of One Manifold). *DERIVED.* N = 3 spatial dimensions from {C, S, B} (AP10). Each axiom expresses one face. Functional identity fixed (the axiom names the function); geometric assignment free (the axiom carries no spatial tag). Linked but non-derivable (AP20 §4.2, fenced KS-P.2).

3 (The Silent Pop). *DERIVED / SYNTHESIS.* §3.1–3.2: the break creates direction as a concept; the manifold orients around the splinter (DERIVED). §3.3: endless possibilities across many actualisations (SYNTHESIS, non-load-bearing). §3.4: two views of the same now — before collapse, all orientations coexist in $\mathbb{C}^3$ superposition; after collapse, record history selects one (DERIVED, AP09).

4 (The Gauge Freedom). *DERIVED.* §4.1: physics does not depend on orientation; non-derivability of {C, S, B} → global symmetry; per-event orientation → local symmetry → gauge theory. §4.2: Lemma (orientation ∈ $\mathbb{C}^3$ from AP09); Proposition 1 (gauge group is SU(3) — norm-preserving on $\mathbb{C}^3$ is U(3); factor out the orientation's global phase (Born-rule redundancy, AP09); SU(3) with 8 generators).

5 (Colour). *DERIVED / STRUCTURAL.* §5.1: colour = orientation, anticolour = conjugate representation (DERIVED). §5.2: Proposition 2 (colour neutrality from isotropy + AP15 stiffness) STRUCTURAL — the energy functional is not yet computed (D1). §5.3: gluons as 8 gauge bosons of SU(3) (DERIVED). §5.4: Proposition 4 (ε = electron is SU(3) singlet because minimum break is necessarily isotropic) DERIVED.

6 (Confinement). *STRUCTURAL.* §6.1: confinement from substrate restoring isotropy (qualitative — D1). §6.2: asymptotic freedom from the same mechanism at short range (qualitative — D3). §6.3: Proposition 3 (SU(3) is exact) DERIVED — Axiom B contains no clause selecting orientation.

7 (The Full Gauge Structure). *DERIVED.* SU(3) × SU(2) × U(1) assembled. Lie algebra structure su(3) ⊕ su(2) ⊕ u(1). Breaking pattern: SU(3) exact, gluons massless; SU(2) × U(1) broken to U(1)_em by Axiom B (AP16). Global structure (SU(3) × SU(2) × U(1))/$\mathbb{Z}_6$ held open in §0.7.

8 (Derivation Chain). *SYNTHESIS.* Step-by-step from axioms to SU(3) enumerated.

9 (Three Generations). *CONJECTURE.* ε with three orientations identified as a structural site for the three generations. Mass ratios not computed (D2). Colour vs generation disambiguated: same three faces, two different degrees of freedom (continuous SU(3) orientation vs structural dominance index).

10 (Kill Switches). *REGISTER.* KS-48c, KS-49b, KS-50 in Claim/Test/Status/Recovery form. Identifiers per the Master Kill Switch Registry; the c/b suffixes resolve collision with AP23 (KS-48a, KS-48b, KS-49a).

Conditionality Footer

Dependencies

Framework: the four axioms {S, B, R, C} from Notebook I; AP05 (actualisation creates g, c, time); AP10 (N = 3 spatial dimensions from {C, S, B}); AP09 (complex Hilbert space, Born rule; fermion/boson, ε = electron via The Lock, Edition 04); AP11 (the spacetime spin SU(2) double cover, spin-½ — context only, not the gauge SU(2)); AP15 (the gauge U(1) from Hilbert-space phase freedom, and substrate stiffness $\lambda \approx 2.15 \times 10^{46}$); AP27 (the gauge SU(2) × U(1)_Y); AP16 (Higgs mechanism = Axiom B, the electroweak breaking pattern); AP20 (Embedding Hypothesis; §4.2 carries the independence of {C, S, B}, fenced KS-P.2).

Conditional on: None. EH and QRA proved in AP20.

Dependents

AP24 (Residual) — the six faces of ε and the leakage-tolerance reframe on α_em; the three-orientations of §9 here connects to the generation structure AP24 addresses. AP14 (Correction) — Planck-scale corrections must be consistent with SU(3) exact. AP28 (Constant) — G via channel counting; the 6 × 3 spatial face-projections rest on the three-face structure of §2. The Notebook V matter sector — the full fermion content beyond the electron, including the generation-structure derivation AP19's §9 names as conjecture (D2).

Kill switches engaged

KS-48c (orientation = colour): LIVE — EMPIRICAL. Identifies the SU(3) internal index with face-space orientation.

KS-49b (confinement from isotropy): LIVE — EMPIRICAL. Identifies confinement with substrate-stiffness-enforced isotropy.

KS-50 (SU(3) from non-derivability): LIVE — HARD. Rests on the independence of {C, S, B}, carried at AP20 §4.2 (fenced KS-P.2).

Structural debts owed

D1 (quantitative confinement — string tension from axioms). D2 (generation mass hierarchy $m_e : m_\mu : m_\tau$). D3 (running coupling $\alpha_s(Q^2)$ from stiffness/isotropy mechanism). All named items; treated as open programmes.

Items held open without claiming debt status

The global structure of the Standard Model gauge group $(SU(3) \times SU(2) \times U(1))/\mathbb{Z}_6$ — this paper derives the Lie algebra structure only. The detailed flavour-structure embedding of the three-generation conjecture into full quark/lepton representation theory — downstream of D2 and Notebook V.

Notation Reference

{S, B, R, C} — The four axioms of the 420 Code. S: two-sector + involution. B: the break $\varepsilon \in \ell$, no σ-image. R: time, the only irreversible axiom. C: finite propagation, the propagation face.

ℓ, $\mathcal{P}$ — The two sectors of Axiom S, connected by the involution σ.

σ — The involution of Axiom S. On the orientation state, acts by complex conjugation, taking the fundamental 3 to the conjugate $\bar{3}$.

ε — The break. The minimal asymmetry. The unique unpaired element of Axiom B. Identified with the electron at the chemical-biological scale (The Lock, Edition 04).

ν — The valuation on the record algebra; $\nu(\varepsilon) = 1$ is the minimum nonzero value.

{C, S, B} — The three spatial faces of the manifold. Each face has fixed functional identity (propagation, exchange, break) but no fixed geometric assignment (which spatial direction it occupies).

|ε⟩ — The orientation state of the break in face-space; $|\varepsilon\rangle \in \mathbb{C}^3$ with $|\alpha_1|^2 + |\alpha_2|^2 + |\alpha_3|^2 = 1$.

$\alpha_1, \alpha_2, \alpha_3$ — Complex amplitudes of the orientation state. NOT the fine-structure constant α_em or the substrate-stiffness α of AP06. Symbol firewall enforced throughout.

e_1, e_2, e_3 — Basis vectors of the face-space orientation state — the three faces of the manifold as quantum-state basis.

$\mathbb{C}^3$ — The complex three-dimensional vector space; the orientation state lives here (Lemma in §4.2).

U(3) — The unitary group on $\mathbb{C}^3$; norm-preserving transformations of the orientation state.

SU(3) — The special unitary group on $\mathbb{C}^3$; gauge group of the strong force; 8 generators. Derived as U(3) modulo the orientation's global phase (removed by Born-rule redundancy, AP09).

3, $\bar{3}$ — The fundamental and conjugate representations of SU(3); quarks carry 3, antiquarks carry $\bar{3}$.

T^a — The 8 generators of SU(3), a = 1, …, 8. Denoted T^a (not the conventional λ_1–λ_8) to avoid collision with λ = substrate stiffness.

Z_2 — The two-element group; $\pi_1(SO(3)) = Z_2$ in N = 3 spatial dimensions; lifts to SU(2) by the double cover.

SU(2) — Two distinct groups in the corpus, not to be conflated: the spacetime spin SU(2), the double cover of SO(3) (AP11); and the weak gauge SU(2) of the electroweak interaction, derived from the sector-relationship freedom (AP27). AP19 uses neither directly — both are named only as context for the assembled gauge structure in §7.

U(1) — The phase-rotation gauge group; derived in AP15 from the Hilbert-space phase freedom; manifests on the manifold as the electromagnetic connection. Distinct from the orientation's own global phase factored out in Proposition 1.

λ — Substrate stiffness, AP15; $\lambda \approx 2.15 \times 10^{46}$. Quantitative scale of isotropy enforcement. NOT a wavelength.

c, g — Speed of light (Axiom C); the metric tensor (created by actualisation, AP05).

ℏ — Reduced Planck constant (AP12).

α_em — Fine-structure constant; the leakage rate (AP06); identified with ε in the leakage framework. NOT one of the orientation amplitudes α_1, α_2, α_3.

α_s(Q²) — Running coupling of the strong force; not derived in this paper (D3).

m_e, m_μ, m_τ — Masses of the three charged leptons; mass ratios not derived (D2).

AS — Actualization State. The actualizing now.

EH — Embedding Hypothesis (AP20). Proved — unconditional throughout AP19.

QRA — Quantum–Records Algebra (AP20). Proved — unconditional throughout AP19.

AP20 §4 — Carries the completeness (KS-P.1) and minimality (KS-P.2) of {S, B, R, C} as fenced obligations. The independence of the axioms — no one derivable from the others — is the minimality leg. Load-bearing for KS-50.

The Lock — Edition 04 of the 420 Code; identifies ε with the electron at the chemical-biological scale.

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Series	The 420 Code
Catalogue	Ø Artist’s Proofs
Proof Number	AP19
Title	The Direction
Subtitle	Forces and Constants
Medium	Physics
Artist	G