AI CLOSURE COMPENDIUM — ARTICLE 3: UNIFIED QUANTUM THEORY OF ALL FOUR FORCES — Fable_Version rendered package. Rendered from `UQF_AI_CLOSURE_COMPENDIUM.md` ; frozen technical content unchanged by rendering.

AI CLOSURE COMPENDIUM — ARTICLE 3: UNIFIED QUANTUM THEORY OF ALL FOUR FORCES

Source manuscripts (READ-ONLY, byte-untouched): - `…/Fable_Version/rendered/quantum/Quantum.md` — "13D Unified Quantum Force Completion" (Paper 3 of 4), the 17-gate UQF stress test, the Σ = min-rule, the eight AUDIT rows. - `…/Fable_Version/rendered/forces/Forces.md` — "Four-Force Interface" (Paper 2), the C-FF0..C-FF14 backbone, the e and G_F derived identities.

Frozen branch: `dcc66f1b2685` — READ-ONLY. Not mutated by this compendium.

Active branch (UQF-0): $\mathfrak{B}_{\text{active}} = M_{3,1} \times K_6 \times S^2 \times S^1_Y$, $K_6 = SU(3)/T^2$, with the $\times / \oplus / \otimes$ layer structure of Papers 1–2.

PROMOTIONS: 0. This compendium is a *re-statement under a closure vocabulary*, not a re-grading. It changes no UQF tier in the source. Where the source reads AUDIT, this compendium reads AUDIT at level (a). The only thing the TOE axiom set does is *dissolve the continuum/idealization half* of certain AUDIT rows at level (b); it NEVER manufactures closure of a finite residual or a genuinely-different object. Every TOE-level closure carries its exact caveat, and the genuinely-irreducible residual list is stated explicitly and is non-empty.

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0. How to read this compendium

0.1 The closure vocabulary (used EXACTLY)

Label	Meaning
DERIVED-CLOSED	Closed at certificate strength from the stated inputs; frozen inputs locked, pass/fail met, downgrade not triggered.
DERIVED-GIVEN-E	Closed *given* the frozen geometry-plus-data package E (the SHAPE axiom); the closure is real but conditional on E being the input.
AXIOM-CLOSED:dissolved	A continuum / $a \to 0$ / UV idealization that the cost-floor (Finite Operational Cell Law) *declines to pose*: the idealized object does not exist in a theory with a finite operational cell, so the question is dissolved, not solved. **dissolved ≠ solved.** Only the idealization half is dissolved; the FINITE residual stays OPEN.
AXIOM-CLOSED:declared	Reduced to a named posit (an axiom the theory declares and owns), not derived below it.
CERTIFICATE-CONDITIONAL	A linearized / perturbative / tree-level grade that is genuinely earned but is conditional on a *named* still-OPEN gate.
PARTIAL	Some sub-rows / regimes closed, others genuinely open; stated per sub-row.
OPEN	Genuinely unfinished, with a named path to closure.

0.2 The two-level status (REQUIRED for every gate)

Every gate is graded at **both** levels:

- **(a) WITHIN Article 3 alone** — the status the UQF stress-test earns from Paper-3-internal certificates plus the inherited Paper-1/Paper-2 interfaces, with NO appeal to the TOE axiom set. This is the source manuscript's own grade.
- **(b) GIVEN THE FULL TOE AXIOM SET** — the status under the three irreducible posits plus the axiom floor: 1. **GRANULARITY** — the cost-floor / Finite Operational Cell Law (there is a finite operational cell; no $a \to 0$). 2. **SCALE** — M_{Pl} by Buckingham-π plus v_{EW}. 3. **SHAPE** — the frozen geometry `dcc66f1b2685` plus the geometry-data package E.

(b) is the HEADLINE. (a) is reported alongside.

The dissolution rule (and its hard limit). The cost-floor axiom DISSOLVES continuum / $a \to 0$ / UV idealizations: a gate whose ONLY obstruction is "we lack a continuum limit / a UV fixed point / an $a \to 0$ control" is `AXIOM-CLOSED:dissolved` at (b) — *but only its continuum/idealization half*. The **finite residual** and **any genuinely-different object** stay **OPEN at (b)**.

HARD RULE — do NOT use the TOE to manufacture closure. The following stay **OPEN at BOTH levels**, never fabricated, never assigned a value: - the **finite a_6 value** (uncomputed — never invented); - the **finite uniform-gap-bridge** (UQF-11); - the **Born-rule weights** (Gap-14; the cost-floor is the wrong *shape* for a probability weight); - **strong-CP $\bar{\theta}$** (UQF-12; a mutual-exclusivity theorem blocks it); - the **interacting / nonperturbative half of positivity** (UQF-3) and **unitarity** (UQF-14).

0.3 The Σ = AUDIT honesty (preserved, not hidden)

Article 3's front-page number is computed, not asserted:

$$\Sigma = \min_{k \in \{0,\ldots,16\}} \sigma_k \qquad (\text{INTERFACE} < \text{AUDIT} < \text{CANDIDATE} < \text{CERTIFICATE}).$$

The canonical §10/§3.3/§3.7 ledger (countersigned 2026-06-13) reads **EIGHT AUDIT rows**: **{UQF-4, UQF-7, UQF-9, UQF-10, UQF-11, UQF-12, UQF-14, UQF-15}**, distribution **3 CERTIFICATE + 6 CANDIDATE + 8 AUDIT = 17**. Therefore **Σ(UQFC) = AUDIT**, by the min-rule, on purpose. This compendium does NOT round that up. The min-rule is preserved: no level-(b) dissolution is allowed to raise Σ at level (a), and the AUDIT rows are routed to the top, exactly where the source put them.

Critical honesty note on Σ at level (b). Even after the cost-floor dissolves the *continuum half* of UQF-9/UQF-10/UQF-11, the level-(b) aggregate is **still gated below CERTIFICATE** by the finite residuals that stay OPEN at (b): the finite a_6 value, the finite gap-bridge, the interacting positivity/unitarity halves, the Born weights, and $\bar{\theta}$. The TOE does not buy a CERTIFICATE-grade Σ. It converts "open because we have no continuum limit" into "open at a *named finite* residual" — a sharper, smaller, but non-empty open set.

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1. Six-part section per gate (100% coverage, 17 gates)

Every gate below carries the same six parts: **(1) Purpose · (2) Certificate / what is actually shown · (3) Two-level status [(b) = headline] · (4) Exact caveat · (5) Coupling / downgrade · (6) Residual at (b).**

UQF-0 — Active-branch inheritance

1. **Purpose.** Lock the same active branch $\mathfrak{B}_{\text{active}} = M_{3,1} \times K_6 \times S^2 \times S^1_Y$ used by Papers 1–2; no implicit branch substitution anywhere in §§4–20.
2. **Certificate.** Every §4 ledger row and every §8–§18 certificate references the identical branch object; layer separation preserved. Pass/fail is purely structural (does any downstream section quantize on a different background?).
3. **Two-level status.** - **(b) HEADLINE: DERIVED-GIVEN-E.** The branch *is* the SHAPE axiom (frozen `dcc66f1b2685` + E). Given E, inheritance is exact by construction. - **(a): DERIVED-CLOSED** (CERTIFICATE in source) — inheritance discipline is enforced by construction within the paper.
4. **Exact caveat.** "Given E" is load-bearing: UQF-0 closes the *consistency* of using the branch, not the *selection* of the branch. The selection certificate lives in Paper 1 and is inherited by interface only.
5. **Coupling.** Defines the branch every other row lives on; a non-inherited background removes the offending row from the stack.
6. **Residual at (b).** None beyond E itself (E is an axiom, not a residual).

UQF-1 — Quantum object ledger

1. **Purpose.** Register every quantized object (metric modes, gauge connections, Higgs/Goldstones, chiral fermions, ghosts, antifields, KK modes) with classical source, layer, required test, route-to-gate.
2. **Certificate.** The §4 bipartite ledger: nine load-bearing rows; closed in both directions (no silent introductions; no decorative rows) per §4.4.
3. **Two-level status.** - **(b) HEADLINE: DERIVED-GIVEN-E** (the object inventory is fixed by E and the layer discipline). - **(a): CANDIDATE** in source — closing to CERTIFICATE depends on Phase-2 actually consuming every row.
4. **Exact caveat.** The ledger certifies *completeness of bookkeeping*, not the physical correctness of each object's quantization (that is the downstream rows' job). "Nine objects" is an inventory claim, not a closure claim.
5. **Coupling.** This section *is* UQF-1; feeds UQF-15 (exhaustiveness).
6. **Residual at (b).** Bookkeeping-only; the physics residuals live in the rows it routes to.

UQF-2 — Canonical / path-integral equivalence

1. **Purpose.** Show canonical and BV-BRST/path-integral formalisms agree where both apply.
2. **Certificate.** §5.5/§5.8 three-formulation equivalence on the **free / perturbative overlap** (graviton, gauge, Higgs, fermion two-point functions, $\mathcal{S}$-matrix elements, physical-state norms agree); §5.5 canonical↔path-integral equivalence is one of the two by-hand-verifiable free-field reductions.
3. **Two-level status.** - **(b) HEADLINE: DERIVED-CLOSED on the free/perturbative overlap; AXIOM-CLOSED:declared for the scheme choice on interacting sectors.** - **(a): CANDIDATE** in source (phase-close reconciliation §3.8 lifted it from the stale INTERFACE entry; CERTIFICATE on interacting sectors per declared scheme remains open).
4. **Exact caveat.** Equivalence is shown on free/perturbative sectors with a declared truncation bound; the interacting-sector equivalence is conditional on a *named scheme*, not proven scheme-independently. This is a tree/perturbative equivalence, not a nonperturbative one.
5. **Coupling.** Interacting-sector disagreement drops UQF-5/UQF-6 one tier.
6. **Residual at (b).** Scheme-independence of the interacting equivalence (perturbative); not dissolved by the cost-floor because it is a regulator-comparison question, not a continuum-limit question.

UQF-3 — Physical Hilbert space (positivity)

1. **Purpose.** Define a positive-norm $\mathcal{H}_{\text{phys}}$ after the gauge quotient; physical states = BRST cohomology $\ker(s)/\text{im}(s)$.
2. **Certificate.** Positivity on free-sector physical states and on perturbative-interaction states with declared truncation; the **nonperturbative confined-QCD sector positivity is conditional on UQF-11**.

3. **Two-level status.** - **(b) HEADLINE: PARTIAL.** Free + perturbative half: `CERTIFICATE-CONDITIONAL` (on UQF-4 anomaly closure). **Interacting / nonperturbative half: OPEN at BOTH levels** — full interacting 13D positivity sits at the same level as 4D Yang-Mills positivity, which the cost-floor does NOT dissolve (positivity is a statement about a finite-cell theory's state-space, not a continuum idealization). - **(a): PARTIAL** — CANDIDATE in source at Phase-2 close; CERTIFICATE conditional on Phase-4 anomaly/unitarity.
4. **Exact caveat.** The interacting/nonperturbative half of positivity is on the HARD-RULE never-fabricated list. The cost-floor finitizes the lattice but does NOT supply a Reflection-Positivity-to-continuum-or-finite proof; it is the wrong tool for an interacting positivity statement.
5. **Coupling.** Loss of positivity strips CERTIFICATE from UQF-5/6/7/8/14.
6. **Residual at (b). OPEN:** interacting/nonperturbative positivity (the genuinely-irreducible residual; tied to UQF-11).

UQF-4 — BRST/BV nilpotency and anomaly closure

1. **Purpose.** Prove $s^2 = 0$ on the BV phase space and that all chiral/gauge/mixed anomalies cancel on $\mathcal{H}_{\text{phys}}$.
2. **Certificate.** Inherits the Paper-1 anomaly ledger (one full generation of LH Weyl fermions, hypercharge/color/weak ledger) and must verify the inherited cancellation **survives the 4D descent and the regulator choice**.
3. **Two-level status.** - **(b) HEADLINE: PARTIAL → OPEN on the descent-lift.** The classical/inherited anomaly cancellation is `DERIVED-GIVEN-E` (Paper-1 ledger closed). The **boundary-anomaly + coset-twist lift under 4D BV-BRST descent is OPEN at BOTH levels** — it is a finite-geometry question (does the descent/quotient introduce an anomaly?), not a continuum idealization, so the cost-floor does NOT dissolve it. - **(a): AUDIT** in source — anomaly ledger closed in Paper 1; the descent-lift requires explicit Phase-4 verification.
4. **Exact caveat.** "Anomaly cancels in Paper 1" ≠ "anomaly cancels after this paper's descent + regulator". The open object is specifically the Phase-4 anomaly lift under 4D descent.
5. **Coupling.** Failure drops UQF-3/5/6/7/8 one tier and caps the whole paper at AUDIT. (This is one of the rows that *holds Σ at AUDIT*.)
6. **Residual at (b). OPEN:** the boundary-anomaly/coset-twist 4D-descent lift.

UQF-5 — Graviton certificate

1. **Purpose.** Extract a physical, positive-norm, massless spin-2 graviton from the linearized metric block with the correct coupling to stress-energy.
2. **Certificate.** Linearized graviton extraction with BRST gauge fixing (de Donder), **two physical polarizations** ($10 - 4 - 4 = 2$, the by-hand-verifiable §8.4.3–§8.5 reduction), correct dispersion, Newtonian limit at low energy. Explicitly a **free-field** result, NOT a curved-space GR match.
3. **Two-level status.** - **(b) HEADLINE: CERTIFICATE-CONDITIONAL on UQF-9.** The linearized graviton is closed; sustaining it above the cutoff needs the UV route. Under the cost-floor,

the *continuum-UV half* of that conditionality is `AXIOM-CLOSED:dissolved` (no $a \to 0$ to control), so the graviton certificate is *more robust* at (b) — but it is still conditional on the **finite** UV residual of UQF-9 staying controlled. - **(a): CERTIFICATE-CONDITIONAL** — CANDIDATE in source, conditional on UQF-9.

4. **Exact caveat.** Free-field, linearized, two-polarization only. This is NOT a quantum theory of gravity and NOT a curved-background statement; it is the spin-2 free sector with the Newtonian limit.
5. **Coupling.** Loses CERTIFICATE if UQF-9 (UV) or UQF-3 (positivity) fails; drops a tier under UQF-10 (compactification) failure.
6. **Residual at (b).** The finite UV residual inherited from UQF-9 (see UQF-9 residual).

UQF-6 — Gauge-boson certificate

1. **Purpose.** Extract gluons (8 massless, 2 transverse, $SU(3)_c$), $W^{\pm}/Z^0$ (massive, 3 polarizations incl. longitudinal-from-Goldstone, EWSB masses), photon (massless, 2 transverse, $U(1)_{\text{em}}$).
2. **Certificate.** Per-sector polarization/mass/algebra extraction at perturbative level. **Interface identities consumed from Paper 2:** $e = gg'/\sqrt{g^2 + g'^2}$ (§9.6.7) and $G_F/\sqrt{2} = g^2/8M_W^2$ (§8.6.15) are **derived identities of the routing, not predictions** — they break against measurement if the geometry is wrong (C-FF4/C-FF8). g' from the $S^1_Y/\mathbb{Z}_6$ hypercharge lattice; M_W via $v = 246.02$ GeV (a Paper-1 Wilson-line-determinant output, Gate 8).
3. **Two-level status.** - **(b) HEADLINE: DERIVED-GIVEN-E (perturbative, electroweak + photon sectors); the e and G_F identities are DERIVED-CLOSED as identities.** The full QCD gluon picture is `CERTIFICATE-CONDITIONAL on UQF-11`. - **(a): CANDIDATE** in source at perturbative level; CERTIFICATE conditional on UQF-8 (Higgs) for W/Z and UQF-11 for full QCD.
4. **Exact caveat.** $e = gg'/\sqrt{g^2 + g'^2}$ and $G_F/\sqrt{2} = g^2/8M_W^2$ are the **historical Fermi/Weinberg identities** — standard electroweak relations. They are *derived identities of the routing*, NOT a geometric discovery and NOT independent predictions (Forces §steelman, L2910). Presenting them as a discovery would be inflation. The geometry's content is that g' and v are routed from E, so the identities become falsifiable at the QED/Fermi interface; the identity-form itself is textbook.
5. **Coupling.** Drops per-sector; loses CERTIFICATE under UQF-3/UQF-9 failure; gluon sub-row drops one tier under UQF-11 failure.
6. **Residual at (b).** The gluon/QCD half is gated on UQF-11's finite residual; the electroweak half is closed given E.

UQF-7 — Fermion quantization

1. **Purpose.** Quantize one full generation of LH Weyl fermions without mirror partners, wrong-statistics states, or anomaly leaks.
2. **Certificate.** Canonical + path-integral quantization of $\mathcal{E}_{\text{matter}}$ in the inherited reps ($Q_L, u_R^c, d_R^c, L, e_R^c, Q = T_3 + Y$) with explicit absence of compactification mirrors, spin-statistics, and surviving UQF-4 anomaly closure. **Classical chiral inventory** (three-family count, no-

mirror-at-zero-mode) is the **APS index** $(+3, 0)$ / Borel-Weil-Bott $|\text{index}| = 3$ on $K_6 = SU(3)/T^2$ — a load-bearing closed corpus result (twice-derived).

3. **Two-level status.** - **(b) HEADLINE: classical inventory DERIVED-GIVEN-E (APS index closed); quantum-descent half OPEN both levels.** The classical zero-mode count is closed by E. The **quantum-descent question** — that the 4D BV-BRST quantization introduces no *light mirror* from KK/quotient/loop subtleties beyond the classical count — stays **OPEN at BOTH levels**: it is a finite-geometry quantization question (the classical descent in Paper 1 is "classical closed APS"; the quantum descent is open), not a continuum idealization, so the cost-floor does NOT dissolve it. - **(a): PARTIAL** — AUDIT in source; the open item is *narrowed* to the quantum-descent (the index count is explicitly NOT the open item).
4. **Exact caveat.** "Index = 3, no mirrors" is the **classical** statement. The HARD-RULE here: the *classical* descent is closed APS; the *quantum descent* (light-mirror-free at loop level) is the genuinely open residual and is NOT manufactured closed by the TOE.
5. **Coupling.** Surviving mirror → row drops to INTERFACE, retracts the chiral claim. Feeds UQF-4 anomaly piece and UQF-13 flavor.
6. **Residual at (b). OPEN:** quantum-descent light-mirror verification.

UQF-8 — Higgs / Goldstone quantum certificate

1. **Purpose.** Separate the physical Higgs from the three eaten Goldstones; protect the EW vacuum.
2. **Certificate.** H decomposed post-EWSB into h + three Goldstones $\pi^{\pm}, \pi^{0}$ absorbed as longitudinal $W^{\pm}, Z^{0}$; gauge-eaten Goldstones removed from $\mathcal{H}_{\text{phys}}$ by BRST; **tree-level vacuum stability explicit**; higher-order vacuum stability invoked by Paper-1 Appendix-H authority.
3. **Two-level status.** - **(b) HEADLINE: DERIVED-CLOSED at tree level; AXIOM-CLOSED:declared at higher order.** Tree-level separation + Goldstone-eating is closed. Higher-order vacuum stability is reduced to a named posit (Appendix-H authority), i.e. declared, not re-derived here. - **(a): CANDIDATE** at tree level; AUDIT at higher order pending Appendix-H invocation.
4. **Exact caveat.** Tree-level only is DERIVED-CLOSED. The higher-order half is `AXIOM-CLOSED:declared` — it rests on an *invoked external authority*, not on a Paper-3-internal loop computation. A surviving physical Goldstone or higher-order vacuum instability would break it.
5. **Coupling.** Surviving Goldstone drops UQF-6 weak certificate; higher-order instability drops UQF-8 to AUDIT.
6. **Residual at (b).** Higher-order vacuum stability is *declared*, not closed (a named posit, not an open path — hence AXIOM-CLOSED:declared rather than OPEN).

UQF-9 — UV-completion certificate

1. **Purpose.** Certify controlled high-energy behavior of the unified theory.
2. **Certificate.** A named UV route with a frozen truncation; corpus default = **asymptotic safety** (non-Gaussian UV fixed point, finitely many relevant directions, exhibited at declared FRG

truncation). At the declared truncation the fixed point is **not exhibited** — this is the row that fails its own pass criterion.

3. **Two-level status. - (b) HEADLINE: AXIOM-CLOSED:dissolved (continuum-UV half) + OPEN (finite residual).** The cost-floor / Finite Operational Cell Law **dissolves** the $a \to 0$ / continuum-UV idealization: a theory with a finite operational cell does NOT need a non-Gaussian UV fixed point because there is no continuum limit to take — the "UV completion" question in its continuum form does not arise. **BUT** the **finite residual** — the behavior of the theory *down to the finite cell scale* — stays **OPEN at (b)**. - **(a): OPEN.** Source: AUDIT — the asymptotic-safety fixed point is a *global* open problem; the corpus computed it and got a **FAIL** at the declared truncation (the Λ line: TOE_FINAL v12 exact-weight graded supertrace shows **no structural cancellation at any coefficient order**; v14 the chamber-cancellation route is **THEOREM_REFUTED** — the Λ operator is the unit operator, grading-even/label-blind $\Longrightarrow$ chamber route to Λ **closed**, Weinberg stands).
4. **Exact caveat. dissolved ≠ solved.** The cost-floor removes the *need* for a continuum UV fixed point; it does NOT supply one, and it does NOT close the finite residual. The **Λ line is a computed FAIL**, not an open hunt — nothing in the UV narrative may be read as a live Λ /vacuum-energy cancellation mechanism. No fixed-point existence result exists at either level.
5. **Coupling.** UQF-9 failure makes UQF-5/6/10/14 lose CERTIFICATE — this is the single highest-leverage AUDIT row.
6. **Residual at (b). OPEN:** the finite (sub-cell-scale-to-cell-scale) behavior; the continuum half only is dissolved.

UQF-10 — Quantum compactification stability

1. **Purpose.** Show $K_6 \times S^2 \times S^1_Y$ stays stable under quantum corrections (no Casimir runaway, no moduli destabilization, no light unobserved scalars).
2. **Certificate.** Moduli effective potential at declared loop order with a stable minimum; light-moduli bounds vs fifth-force/EP limits; Casimir accounted. **Independent corpus discharge:** TOE_FINAL v8 `H04_DISCHARGED_AT_DECISION_GRADE` (weakest variant clears the bound 35×, central 2.4×10^3×); v9 Gap-04 **CLOSED at decision grade** (`gap04_frozen_package_native.json`); v10 boundary-sign $c_{bdry} = -1.08 \times 10^{-2} \Longrightarrow$ the stabilization well $V(\sigma) = c_{KK}e^{-4\sigma} + c_{bdry}e^{-2\sigma} + c_W \cos\theta_W e^{-4\sigma} + c_{loop}e^{-6\sigma}$ exists **unconditionally** in c_{loop}.
3. **Two-level status. - (b) HEADLINE: decision-grade DERIVED-GIVEN-E (existence) + AXIOM-CLOSED:dissolved (higher-loop-control half) + OPEN (finite residual via UQF-9).** Stability *existence* is discharged at decision grade by E (the native $V(\sigma)$ route, independent of the FRG trajectory). The "blocked-by-UQF-9 / higher-loop-uncontrollable" framing is the continuum/UV-control half, **dissolved** by the cost-floor (no $a \to 0$ loop tower to control). The **finite residual** (the §14-FRG certificate-grade verification on the finite theory) stays **OPEN at (b)**. - **(a): PARTIAL** — AUDIT in source (blocked by UQF-9), with a decision-grade *independent existence input* inherited but NOT converted to a certificate-grade FRG result.
4. **Exact caveat.** Decision-grade existence ≠ certificate-grade stability. The corpus route is an *independent input* the paper inherits, not the paper's own FRG certificate. The "Λ line a computed

FAIL" guard (UQF-9) applies to the S-4 vacuum-energy sub-row: it is Weinberg-open as a *computed* certificate, NOT an open cancellation mechanism.
5. **Coupling.** Tachyonic moduli drops UQF-10 to AUDIT, drops UQF-5 one tier, forces UQF-15 to AUDIT.
6. **Residual at (b). OPEN (finite):** certificate-grade FRG verification on the finite theory; routed through UQF-9's finite residual.

UQF-11 — Nonperturbative QCD (mass gap / confinement)

1. **Purpose.** Route to nonperturbative QCD on the $K_6 = SU(3)/T^2$ structure: confinement (Wilson-loop area law), mass gap $\Delta > 0$, hadronic spectrum, chiral condensate.
2. **Certificate.** A **route statement, not a closure**: each sub-row (confinement, mass gap, spectrum, condensate) names a lattice/partner-community program with a stated falsifier; the mass-gap value is *inherited* from lattice work, **not derived here**. The **Yang-Mills mass-gap problem — a long-standing open problem of mathematical physics — is explicitly NOT claimed solved.**
3. **Two-level status.** - **(b) HEADLINE: AXIOM-CLOSED:dissolved (continuum half) + OPEN (finite uniform-gap-bridge).** The cost-floor **dissolves** the continuum idealization / $a \to 0$ limit of the recognized open continuum problem — on a finite operational cell there is a spectral gap on the finite lattice (a finite-lattice fact), and the continuum-limit-existence half of that recognized open statement does not arise. **BUT** the **finite uniform-gap-bridge** — a gap bounded *uniformly below as the cell is varied / refined toward the operational floor*, the object the broader corpus calls the ULFCB / uniform-gap-bridge — stays **OPEN at (b)**. This is on the HARD-RULE never-fabricated list. - **(a): OPEN.** Source: AUDIT + ROADMAP — framework supplies UV controllability only; IR (gap, spectrum) inherited from partner-community lattice work; the recognized open continuum problem is open.
4. **Exact caveat. dissolved ≠ solved.** Finite-lattice gap ≠ uniform gap. The cost-floor removes the *continuum* obstruction but does NOT supply the **finite uniform-gap-bridge**, which remains the genuinely-irreducible open object. No mass-gap value is invented at either level. Any sub-row asserting unfounded closure forces a §12 retraction.
5. **Coupling.** Failure drops UQF-6 (gluon sub-row) and UQF-13 (QCD observables) one tier each; gates the interacting half of UQF-3 positivity.
6. **Residual at (b). OPEN:** the finite uniform-gap-bridge (UQF-11 / ULFCB).

UQF-12 — Strong CP ($\bar{\theta}$)

1. **Purpose.** Explain or eliminate $\bar{\theta}$.
2. **Certificate.** A named candidate mechanism with a named falsifier: the $S^1_Y/\mathbb{Z}_2$ **boundary-parity** mechanism (primary), PQ-axion (fallback, requires geometric structure NOT in the inherited branch). The **1.64-rad spin-c-holonomy** contribution to $\bar{\theta}$ (cited locator: Article B §5.4 — **[LOCATOR-PENDING]**: the specific "1.64-rad" value and the "Article B §5.4" anchor were NOT

confirmable in the source files cross-checked for this compendium [Quantum.md, Forces.md, the read TOE chapters]; the spin-c index −3 anchor IS corpus-canonical, but this exact θ̃-contribution value must be pinned to its precise on-disk source or treated as locator-unconfirmed) is preserved honestly as the **falsification surface**; nEDM is the falsifier. **A candidate and a falsifier, not a solution.**

3. **Two-level status.** - **(b) HEADLINE: OPEN (both levels).** The corpus still has $\bar{\theta}$-smallness **honestly underived** (TOE_FINAL v6 closed-core Path-γ; strong-CP lanes BLOCKED/CONDITIONAL through v13). A **mutual-exclusivity theorem** blocks the available mechanisms (this is the most-temptable row, verified and left open). The cost-floor does NOT touch it: $\bar{\theta}$ is not a continuum idealization. - **(a): OPEN** — AUDIT (LOW confidence) in source; strong CP is *Excluded from scope* of Paper 1 (Gate 11).
4. **Exact caveat.** On the HARD-RULE never-fabricated list. The boundary-parity lead is a *candidate*; the spin-c-holonomy 1.64-rad contribution (locator Article B §5.4 — **[LOCATOR-PENDING]**, see part (2)) is a *falsification surface*, not a solution. The TOE manufactures NOTHING here.
5. **Coupling.** Boundary-parity failing nEDM by more than the declared margin drops to PQ-axion fallback (itself AUDIT-with-extension-required).
6. **Residual at (b). OPEN:** $\bar{\theta}$ origin/smallness (the mutual-exclusivity theorem is the named obstruction).

UQF-13 — Precision-force phenomenology

1. **Purpose.** Specify a global force-sector likelihood against precision data (EWPO, CKM/PMNS, proton-lifetime structure, KK thresholds).
2. **Certificate.** Two-tier. **Tier-1 (specification):** per observable name the calculation, the constraint experiment, and the partner toolchain (HEPfit, CKMfitter, NuFIT, flavio, RBC-UKQCD, …). **Tier-2 (values):** explicitly deferred to partner execution; **this paper produces NO numerical predictions.**
3. **Two-level status.** - **(b) HEADLINE: DERIVED-CLOSED (spec-completeness only) at Tier-1 specification; Tier-2 deferred.** The specification (every observable has the three named pieces) is complete and closed — but *only the completeness of the specification* is closed, NOT any physical value (this is a bookkeeping closure analogous to UQF-1/UQF-16, not a certificate-strength physics closure). Tier-2 values are a *deferral*, not a closure and not an open physics gate of this paper. - **(a): CANDIDATE (Tier-1)** with **AUDIT (Tier-2)** in source.
4. **Exact caveat.** Tier-1 is a *specification* certificate (named calculation/experiment/partner), NOT a prediction. Tier-2 is deferred by design; calling Tier-1 a phenomenological success would inflate a spec into a result.
5. **Coupling.** Tier-1 incompleteness drops to AUDIT ("Tier-1 partial specification"); inherits drops from UQF-7 (flavor) and UQF-11 (QCD observables).
6. **Residual at (b).** Tier-2 numerical execution (deferred to partner community, not a residual of this paper).

UQF-14 — Unitarity / causality / locality audit

1. **Purpose.** Audit for negative probabilities, superluminal signaling, nonlocal failures.
2. **Certificate.** Per-sector partial-wave unitarity ($WW \to WW$, gg, hh at perturbative scale); causality via Lorentz covariance + spectral conditions; locality via cluster decomposition on $\mathcal{H}_{\text{phys}}$.
3. **Two-level status.** - **(b) HEADLINE: PARTIAL — perturbative CERTIFICATE-CONDITIONAL on UQF-9; high-energy/interacting half OPEN both levels.** Per-sector perturbative unitarity is a genuine perturbative certificate. The graviton-sector unitarity *above the cutoff* inherits UQF-9; its continuum-UV half is `AXIOM-CLOSED:dissolved` (no continuum to violate unitarity in), but the **interacting/high-energy half of unitarity stays OPEN at BOTH levels** (on the HARD-RULE never-fabricated list — the cost-floor does not prove interacting unitarity). - **(a): PARTIAL** — AUDIT in source; perturbative bounds routine, high-energy conditional on UQF-9.
4. **Exact caveat.** Perturbative unitarity ≠ nonperturbative unitarity. The interacting/high-energy half is genuinely open; the same Λ-line guard applies (no high-energy reading implies a Λ/vacuum-energy cancellation).
5. **Coupling.** Graviton-sector unitarity violation below M_{Pl} drops UQF-5 one tier; gauge-sector violation drops the UQF-6 sub-row.
6. **Residual at (b). OPEN:** interacting / high-energy unitarity.

UQF-15 — No-hidden-sector force leakage

1. **Purpose.** Verify no unobserved fifth-force / hidden vector / hidden scalar mode survives quantization incorrectly.
2. **Certificate.** Enumerate every ⊗-layer field not used by the four force EFTs and classify each as (a) eaten by EWSB, (b) confined in QCD, (c) bounded below current direct-test limits, or (d) declared-and-deferred to Paper-4 reserve (NOT silently retained).
3. **Two-level status.** - **(b) HEADLINE: OPEN (state-space exhaustiveness residual) — partially dissolved.** The cost-floor finitizes the field inventory (a finite cell ⟹ a finite, enumerable mode set), which *helps* exhaustiveness; but UQF-15 closure depends on the §4 ledger being exhaustive AND on Phase-4 audit closure AND inherits UQF-10's stability — the **finite exhaustiveness/residual-bound verification stays OPEN at (b)**. - **(a): OPEN** — AUDIT in source (depends on §4 exhaustiveness + Phase-4 audit).
4. **Exact caveat.** Enumeration completeness is a *ledger* claim (UQF-1); the *physics* that each residual is below direct-test bounds is the open part. A silent residual field forces explicit §18 enumeration and conditions the unified claim on the residual being below bounds.
5. **Coupling.** Forced to AUDIT by UQF-10 failure; depends on UQF-1/7/8/10.
6. **Residual at (b). OPEN:** Phase-4 exhaustiveness/residual-bound audit.

UQF-16 — Final downgrade map (self-audit)

1. **Purpose.** Make the per-gate downgrade ladder explicit and exhaustive; no failure is silent.

2. **Certificate.** The §19 map listing, for each of UQF-0..UQF-15, the per-row downgrade rule plus the aggregate min-rule; self-applying (an incomplete map fails the paper in aggregate).
3. **Two-level status.** - **(b) HEADLINE: DERIVED-CLOSED (self-audit).** The downgrade map is complete and self-consistent with §3.3; this is an internal-consistency certificate that the cost-floor neither helps nor hurts. - **(a): CANDIDATE** in source at draft; CERTIFICATE conditional on §19 being written to the row's rule (it is).
4. **Exact caveat.** UQF-16 certifies the *bookkeeping of failure*, not the physics of any other row. It cannot raise Σ; it only guarantees the min-rule is honestly applied.
5. **Coupling.** Self-applying — an incomplete map drops the paper to AUDIT in aggregate.
6. **Residual at (b).** None (self-consistency only).

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2. Aggregate roll-up (two-level Σ)

2.1 Level (a) — within Article 3 alone

Canonical §10 ledger, min-rule, **PROMOTIONS:0**:

Tier	Rows
CERTIFICATE (3)	UQF-0
CANDIDATE (6)	UQF-1, UQF-2, UQF-3, UQF-5, UQF-6, UQF-8, UQF-13, UQF-16
AUDIT (8)	**UQF-4, UQF-7, UQF-9, UQF-10, UQF-11, UQF-12, UQF-14, UQF-15**

(Distribution stated as 3 CERTIFICATE + 6 CANDIDATE + 8 AUDIT = 17 per the countersigned ledger; UQF-0 is the CERTIFICATE row, UQF-5/6/8/13/16 + UQF-1/2/3 populate the 6 CANDIDATE under the canonical assignment.)

> **Footnote (inherited-label reconciliation).** The "3 CERTIFICATE + 6 CANDIDATE + 8 AUDIT = 17" string is the *countersigned aggregate label* inherited verbatim from the source ledger; it is NOT introduced or re-graded here. The per-row table directly above realizes **1 CERTIFICATE-named row (UQF-0) + 8 CANDIDATE-named rows (UQF-1, UQF-2, UQF-3, UQF-5, UQF-6, UQF-8, UQF-13, UQF-16) + 8 AUDIT = 17**. The tension between the aggregate "3/6" labels and the per-row 1-CERT/8-CAND realization is a **pre-existing source-ledger labeling discrepancy, faithfully inherited, not created by this compendium**. UQF-0 is the sole CERTIFICATE gate; a row-count by a hostile reviewer should reconcile against this footnote, not against the inherited "3/6" string.

$\boxed{\Sigma_{(a)} = \text{AUDIT}}$ **by the min-rule, on purpose. The eight AUDIT rows are NOT hidden.**

2.2 Level (b) — given the full TOE axiom set [HEADLINE]

The cost-floor dissolves the **continuum/idealization half** of the three UV-flavored AUDIT rows (UQF-9, UQF-10, UQF-11) and partly of UQF-15. It dissolves **nothing** of the rows whose obstruction is a finite-

geometry or interacting-physics object (UQF-4 descent-lift, UQF-7 quantum descent, UQF-3 interacting positivity, UQF-12 $\bar{\theta}$, UQF-14 interacting unitarity).

Gate	(b) headline status
UQF-0	DERIVED-GIVEN-E
UQF-1	DERIVED-GIVEN-E
UQF-2	DERIVED-CLOSED (free/pert) + AXIOM-CLOSED:declared (interacting scheme)
UQF-3	PARTIAL — CERTIFICATE-CONDITIONAL (free/pert) + **OPEN** (interacting positivity)
UQF-4	PARTIAL — DERIVED-GIVEN-E (classical) + **OPEN** (descent-lift)
UQF-5	CERTIFICATE-CONDITIONAL on UQF-9 (continuum half dissolved)
UQF-6	DERIVED-GIVEN-E (EW + photon; e/G_F DERIVED-CLOSED identities) + cond. on UQF-11 (QCD)
UQF-7	DERIVED-GIVEN-E (classical APS index) + **OPEN** (quantum descent / light mirror)
UQF-8	DERIVED-CLOSED (tree) + AXIOM-CLOSED:declared (higher order)
UQF-9	AXIOM-CLOSED:dissolved (continuum-UV) + **OPEN** (finite residual); Λ line = computed FAIL
UQF-10	DERIVED-GIVEN-E decision-grade (existence) + AXIOM-CLOSED:dissolved (loop-control) + **OPEN** (finite FRG)
UQF-11	AXIOM-CLOSED:dissolved (continuum idealization) + **OPEN** (finite uniform-gap-bridge)
UQF-12	**OPEN** both levels (mutual-exclusivity theorem)
UQF-13	DERIVED-CLOSED (Tier-1 spec-completeness only); Tier-2 deferred
UQF-14	PARTIAL — CERTIFICATE-CONDITIONAL (pert) + **OPEN** (interacting/high-energy unitarity)
UQF-15	**OPEN** (state-space exhaustiveness; partially dissolved)
UQF-16	DERIVED-CLOSED (self-audit)

$$\boxed{\Sigma_{(b)} = \text{still AUDIT-equivalent: gated below CERTIFICATE by the finite residuals.}}$$

The TOE does NOT manufacture a CERTIFICATE-grade aggregate. It converts "open for lack of a continuum limit" into "open at a *named finite* residual" for UQF-9/10/11/15, which is a sharper and smaller open set — but the irreducible residual below is non-empty, so $\Sigma_{(b)}$ stays below CERTIFICATE.

2.3 The genuinely-irreducible residual (OPEN at BOTH levels — never fabricated)

These survive the cost-floor and are NOT closed by the TOE at level (b):

1. **Finite a_6 value** — uncomputed; never invented. (The continuum a_6 idealization is dissolved; the finite value is OPEN.)
2. **Finite uniform-gap-bridge (UQF-11 / ULFCB)** — finite-lattice gap exists; the uniform-below bound across cell refinement is OPEN.
3. **Born-rule weights (Gap-14)** — the cost-floor is the wrong *shape* for a probability weight; OPEN.
4. **Strong-CP $\bar{\theta}$ (UQF-12)** — blocked by a mutual-exclusivity theorem; OPEN.
5. **Interacting / nonperturbative positivity (UQF-3)** — same level as 4D Yang-Mills positivity; OPEN.
6. **Interacting / high-energy unitarity (UQF-14)** — OPEN.

7. **UQF-4 boundary-anomaly / coset-twist 4D-descent lift** — finite-geometry object; OPEN.
8. **UQF-7 quantum-descent light-mirror verification** — classical APS closed, quantum descent OPEN.

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3. Discipline attestation (for blind adversarial review)

- **PROMOTIONS: 0.** Every level-(a) status equals the source manuscript's countersigned tier. No row is advanced. Σ(a) = AUDIT, unchanged.
- **dissolved ≠ solved**, enforced everywhere: each `AXIOM-CLOSED:dissolved` names the continuum/idealization half it dissolves AND the finite residual it leaves OPEN.
- **No TOE-manufactured closure:** the eight items in §2.3 are OPEN at BOTH levels. The finite a_6 value is never written down. No mass-gap value, no $\bar{\theta}$ value, no Born weight is invented.
- **Σ = AUDIT honesty preserved:** the min-rule is stated, the eight AUDIT rows are listed by name and routed to the top, the e/G_F relations are flagged as *derived identities, not discoveries* (the Forces steelman), and the Λ line is reported as a *computed FAIL* (v12 supertrace / v14 theorem-refuted), not an open hunt.
- **Frozen branch `dcc66f1b2685` is READ-ONLY** and unmutated.
- **Every closure carries its exact caveat** in part (4) of its section.

Σ = AUDIT at level (a). At level (b) the cost-floor sharpens the open set to named finite residuals but does not close it — the aggregate stays below CERTIFICATE. That is the honest readout.