

AI CLOSURE COMPENDIUM — ARTICLE 2: QUANTUM THEORY OF GRAVITY — Fable_Version rendered package. Rendered from QG_AI_CLOSURE_COMPENDIUM.md ; frozen technical content unchanged by rendering.

AI CLOSURE COMPENDIUM — ARTICLE 2: QUANTUM THEORY OF GRAVITY

Discipline header. PROMOTIONS: o. Frozen branch dcc66f1b2685 READ-ONLY (no geometry, coset, radius, code-distance, or boundary datum is altered by this document). This compendium RE-EXPRESSES the existing, frozen UQF/Gap status ledger in a closure vocabulary; it derives no physics, computes no number, and advances no tier. Every gate's underlying status text is the one already banked in Quantum.md §3.3 / §10 / §11 and the TOE gap docs. Where this document says "AXIOM-CLOSED:dissolved," it is a STATEMENT ABOUT THE TOE'S COST-FLOOR AXIOM, not a new result: the cost-floor declines (does not solve) a continuum/ $a \rightarrow 0$ /UV idealization. **dissolved $\neq$ solved.** The finite residual and any genuinely-different object stay OPEN even at the TOE level.

Source of truth. Quantum.md (Paper 3, "13D Unified Quantum Force Completion"), headline $\Sigma =$ AUDIT (min over 17 gates), plus the TOE gap docs under rendered/TOE/ (gap_01, gap_13, gap_02, gap_03). EXACT paths cited per gate in the evidence lines.

0. Closure vocabulary (used EXACTLY)

- **DERIVED-CLOSED** — closed from the geometry+axioms with no remaining named gate.
- **DERIVED-GIVEN-E** — closed given the frozen geometry data E (the embedding/index data).
- **AXIOM-CLOSED:dissolved** — a continuum / $a \rightarrow 0$ / UV idealization that the cost-floor (Finite Operational Cell Law) DECLINES. The infinite-refinement question stops being a live demand because the theory has a finite operational cell. **dissolved $\neq$ solved.** Only the continuum/idealization HALF is dissolved.
- **AXIOM-CLOSED:declared** — reduced to a single named posit, accepted as an axiom.
- **CERTIFICATE-CONDITIONAL** — a linearized/perturbative-grade certificate, conditional on a named OPEN gate.
- **PARTIAL** — partly closed, partly open, both halves named.
- **OPEN** — genuinely unfinished, with a named path; no fabricated number.

0.1 The three irreducible TOE posits (the level-(b) axiom set)

1. **GRANULARITY** — the cost-floor / Finite Operational Cell Law: physics is evaluated on a finite operational cell; there is no free $a \rightarrow 0$. This is the axiom that DISSOLVES continuum/UV idealizations.
2. **SCALE** — M_{P1} set by Buckingham- π dimensional closure + v_{EW} .

3. **SHAPE** — the frozen 13D geometry `dcc66f1b2685` + the embedding/index data E.

Plus the ordinary axiom floor (the BRST/positivity/measure axioms of the construction).

HARD RULE. The TOE is NOT used to manufacture closure. A gate OPEN at level (a) becomes AXIOM-CLOSED:dissolved at level (b) for its continuum half ONLY; its finite residual and any genuinely-different object stay OPEN at BOTH levels. The following are NEVER fabricated and stay OPEN at both levels: the **finite** `a6` **VALUE**, the **finite uniform-gap-bridge** (UQF-11), the **Born-rule weights** (Gap-14), the **strong-CP** $\bar{\theta}$ (UQF-12), and the **interacting/nonperturbative half** of positivity (UQF-3) and unitarity (UQF-14).

THE 12 QG GATES

GATE UQF-5 — Graviton certificate

(i) REQUIREMENT. Extract a physical, positive-norm, massless spin-2 graviton from the linearized metric block `G{μν}`: two physical polarizations, correct dispersion, correct Newtonian limit, BRST/de-Donder gauge fixing; higher-curvature corrections enumerated; the interacting/UV route named.

(ii) STATUS ALONE (a): CERTIFICATE-CONDITIONAL (banked tier CANDIDATE). The linearized analysis is straightforward and reproduces textbook results; the certificate is conditional on UQF-9 (UV completion).

(iii) STATUS GIVEN TOE (b): CERTIFICATE-CONDITIONAL — same. The two-polarization count and Newtonian limit hold at the linearized level; the interacting graviton routes to UQF-9, whose continuum-demand half is AXIOM-CLOSED:dissolved by the cost-floor but whose finite `a6` residual is OPEN. So the headline is unchanged: a linearized certificate gated on a residual that the TOE does not close.

(iv) ARGUMENT (the certificate). In 4D de-Donder gauge the construction reproduces the standard helicity-mode expansion; the polarization count is the textbook reduction `10 - 4 (gauge) - 4 (residual) = 2` transverse-traceless modes (a fast check verifiable by hand). The dispersion is massless and the Newtonian limit is recovered. This is a genuine, free-field certificate — the "surveyed-street" match where the construction touches known physics. It is FLAGGED CERTIFICATE-tier at the linearized level (§8.6) and states plainly what it does NOT cover (the interacting, nonperturbative graviton, routed to UQF-9). The TOE does not upgrade this: the cost-floor dissolves the demand for a continuum UV fixed point, but the finite consistency coefficient (`a6`) the interacting graviton needs is uncomputed.

(v) EXACT CAVEAT. Linearized only. The certificate is CONDITIONAL on UQF-9; if UV completion fails, UQF-5 loses CERTIFICATE tier (§3.4.2 coupling). The interacting graviton is NOT certified. No claim about graviton scattering above the cutoff.

(vi) EVIDENCE. `Quantum.md` §8 / §8.4.3–§8.5 / §8.6; §3.3 UQF-5 (CANDIDATE, "CERTIFICATE conditional on UQF-9"); §3.4.2 coupling row "UQF-9 → UQF-5 loses CERTIFICATE"; reader on-ramp

"the linearized graviton (§8.4.3–§8.5)".

GATE UQF-9 — UV-completion certificate

(i) REQUIREMENT. A named UV-completion route with a frozen truncation (corpus default: asymptotic safety — a non-Gaussian UV fixed point with finitely many relevant directions), exhibited at declared truncation, with flow back to observed low-energy physics.

(ii) STATUS ALONE (a): OPEN. Banked tier AUDIT. The asymptotic-safety non-Gaussian fixed point existence is a GLOBAL open problem; the paper does not claim closure.

(iii) STATUS GIVEN TOE (b): AXIOM-CLOSED:dissolved (continuum UV-fixed-point demand) + OPEN (finite a_6 consistency residual). This is the HEADLINE for this gate and the canonical illustration of the dissolution mechanism.

(iv) ARGUMENT (dissolution + residual). The standard UV-completion DEMAND is: show the theory is well-defined at *arbitrarily high* energy via an $a \rightarrow 0$ continuum fixed point. The cost-floor axiom (GRANULARITY) DECLINES exactly this demand: with a finite operational cell there is no free $a \rightarrow 0$ limit to take, so "is there a continuum non-Gaussian fixed point?" stops being a live consistency requirement — it is dissolved (NOT solved; the fixed point is not exhibited, the question is removed). **But the FINITE residual survives.** Even with a cost-floor, the theory must pass its finite heat-kernel consistency coefficient — $\text{tr}[a_6(L_{\text{grav}}^{d=13, \text{de-Donder}})]$ projected onto the cubic-curvature basis with $K_6 \times S^2 \times S^1$ holonomy — and that coefficient is UNCOMPUTED. The gap doc reifies UV completion into this ONE named finite object and grades it "[S] — perturbative but heavy" (Gilkey 1995 Th. 3.3.1; Avramidi 2000 Ch. 4). The TOE therefore removes the infinite half and leaves the finite half OPEN. **The a_6 VALUE is never invented here.**

(v) EXACT CAVEAT. dissolved $\neq$ solved: no UV fixed point is exhibited; the cost-floor only removes the continuum-limit DEMAND. The finite a_6 is a definite-but-heavy symbolic computation (machine lane after Gap-04 infrastructure), NOT done. Falsifier rides on it: if computed a_6 violates positive-definiteness for physical-Hilbert closure, Gap 01 is refuted at decision grade. The corpus Λ -line guard applies: nothing in the UV narrative may be read as a live Λ / vacuum-energy cancellation (TOE_FINAL v12 supertrace FAIL, v14 chamber route THEOREM_REFUTED; Λ stays Weinberg-open).

(vi) EVIDENCE. Quantum.md §14, §3.3 UQF-9 (AUDIT), §11.3 "UQF-9 correctly AUDIT", §11.2 Λ -row; rendered/TOE/gap_01_uv_quantum_gravity/00_decomposition.md (the a_6 object, "perturbative but heavy," walled at field grade); .../subsystems/S2_a6_universal_machinery.md (universal template; "must be CITED and verified, never invented").

GATE UQF-3 — Physical Hilbert space (positivity)

(i) REQUIREMENT. A positivity certificate: $\langle \psi | \psi \rangle \geq 0$ for all $|\psi\rangle \in H_{\text{phys}}$, equality only for the zero vector; physical states = BRST cohomology $\ker(s)/\text{im}(s)$ on the BRST-extended Fock-like space.

(ii) STATUS ALONE (a): PARTIAL. Banked tier CANDIDATE. Positivity holds on free-sector physical states and on perturbative-interaction states with declared truncation; pass on the nonperturbative confined-QCD sector is conditional on UQF-11.

(iii) STATUS GIVEN TOE (b): linearized/perturbative CERTIFICATE-CONDITIONAL; interacting half OPEN even given the TOE. The free + perturbative positivity is a CERTIFICATE-CONDITIONAL on UQF-4 (BRST nilpotency) and UQF-9. The nonperturbative half is NOT dissolved by the cost-floor: full interacting 13D positivity sits at the same level as 4D Yang-Mills reflection positivity — a genuinely-different object the cost-floor does not supply — so it stays OPEN at level (b).

(iv) ARGUMENT. On the free sectors, the BRST quotient yields positive-norm states and the ghost/antifield rows are removed from H_{phys} — a real perturbative certificate. The cost-floor does NOT manufacture interacting positivity: reflection positivity of a nonperturbative measure is a constructive-QFT object (OS-2), and granularity (a finite cell) does not by itself prove the finite-cell measure is reflection-positive. That is the same hard core as the mass-gap problem's MO-2. So the honest split: perturbative positivity = CERTIFICATE-CONDITIONAL; interacting positivity = OPEN at both levels.

(v) EXACT CAVEAT. Perturbative/truncation grade only. Conditional on UQF-4 and (for the QCD sector) UQF-11. If a negative-norm physical state survives the quotient, UQF-3 drops to INTERFACE and UQF-5/6/7/8/14 each lose CERTIFICATE. The interacting positivity certificate is NOT supplied by the TOE.

(vi) EVIDENCE. Quantum.md §6, §3.3 UQF-3 (CANDIDATE; "pass on the nonperturbative confined-QCD sector is conditional on UQF-11"), §11.3 "UQF-3 (physical Hilbert space, full interacting) — correctly AUDIT ... same level as 4D Yang-Mills positivity"; §3.4.2 coupling rows.

GATE Gap-01 — $\text{tr}[a_6]$ (the Seeley-DeWitt coefficient)

(i) REQUIREMENT. Compute $\text{tr}[a_6(L_{\text{grav}}^{d=13}, \text{de-Donder})]$ — the Seeley-DeWitt a_6 heat-kernel coefficient at $d=13$ on the de-Donder graviton+ghost operator, projected onto the cubic-curvature basis with $K_6 \times S^2 \times S^1$ holonomy — and verify its positive-definiteness functional for physical- Hilbert-space closure.

(ii) STATUS ALONE (a): OPEN. The corpus states it "is not computed"; walled at field grade.

(iii) STATUS GIVEN TOE (b): OPEN at BOTH levels for the finite VALUE. The "is the theory UV-complete?" CONTINUUM question is AXIOM-CLOSED:dissolved by the cost-floor (same dissolution as UQF-9), but the FINITE a_6 VALUE is a definite, finite symbolic computation that is simply UNCOMPUTED — the cost-floor does not compute it. So the headline is OPEN: **the finite a_6 value is never invented.**

(iv) ARGUMENT (why OPEN at both, no fabrication). The a_6 functional EXISTS and is universal (Gilkey Th. 3.3.1 / Avramidi Ch. 4): a finite linear combination of a fixed ~46-term cubic- curvature basis with KNOWN rational coefficients. What is missing is its SPECIALIZATION to the $d=13$ graviton+ghost operator on the frozen geometry and the heavy fiber trace + basis projection (gap doc nodes $S_1 \rightarrow S_3.3$, the wall). This is graded [S] — "set-up-able but must not be claimed to run"; fabricating any entry "would be the worst outcome." The cost-floor removes the question of whether infinitely many higher coefficients

must also be finite (the continuum half), but a_6 itself is one finite coefficient that must be evaluated and checked for positivity. No amount of TOE axiom supplies that number.

(v) EXACT CAVEAT. The a_6 VALUE is NOT computed and is NOT invented here. Owner = the machine lane (after Gap-04 infrastructure). Decision-grade FALSIFIER: if computed a_6 violates the positivity functional $P(a_6) \geq 0$, Gap 01 is refuted. A separate scope question (S6, [O]/[X]): even a finite, positive a_6 is ONE consistency coefficient — whether it *constitutes* UV completion is an owner/field judgment the corpus has NOT made (a_6 is the missing object *for* UV completion, not *the* UV completion).

(vi) EVIDENCE. rendered/TOE/gap_01_uv_quantum_gravity/00_decomposition.md (the gap as stated; the 12-leaf tree; "No part of Gap 01 is AI-closeable"; S3.3 = the wall; S6 = scope question);
 .../subsystems/S2_a6_universal_machinery.md ("coefficients are literature values — never invented");
 Quantum.md §14 / UQF-9 (downstream consumer).

GATE Gap-13 — BH entropy / Page curve

(i) REQUIREMENT. (a) A geometry-native microstate-counting theorem giving $\log N(A) = A/(4G) + \text{subleading}$ for the right reason; (b) a unitary-evaporation (Page-curve) mechanism for the radiation entanglement entropy.

(ii) STATUS ALONE (a): PARTIAL. A value-match consistency datum is banked at DIAGNOSTIC tier (the 4D zero-mode sector reproduces $A/(4G)$ to 0.0028% — a DIAGNOSTIC value-match only (asserts NOTHING about a microstate count), under freeze-before-compare); the microstate COUNT and the Page MECHANISM are explicitly NOT claimed (PC-1/PC-2/PC-3).

(iii) STATUS GIVEN TOE (b): UV leg AXIOM-CLOSED:dissolved; microstate-count + Page-mechanism OPEN. The "need a UV-defined evaporation/continuum" leg (the Gap-01 cascade) has its CONTINUUM half dissolved by the cost-floor; but the geometry-native degeneracy theorem and the Page-turnover mechanism are genuinely-different objects the cost-floor does not supply, so they stay OPEN at level (b).

(iv) ARGUMENT. The banked datum is a number-matching-a-number consistency check, correctly graded DIAGNOSTIC — it asserts NOTHING about *why* there are that many states (no count) or about *unitary evaporation* (no Page curve). The state-counting theorem (S2.c) would have to be a geometry-native count over the M_{GUT} degrees of freedom (Strominger–Vafa analog), gated on Gap 01 (Hilbert space) and a source+activation gate; graded [O]/[X] — "a genuine theorem, not a finite computation ... not even AI-setup-able until the Hilbert space (Gap 01) exists." The Page mechanism (S3) is doubly downstream — Gap 01 AND Gap 14 (system-bath split on the 13D fields) — and the corpus claims NONE (PC-3). The cost-floor dissolves only the continuum-UV leg that flows in through Gap 01; the count and the turnover curve remain open objects with named paths.

(v) EXACT CAVEAT. The 0.0028% match is a DIAGNOSTIC consistency over-determination, NOT a derivation of BH entropy; PC-1/PC-2 forbid reading it as a microstate count. No Page-curve mechanism is claimed (PC-3); Gap 13 has "no falsifier of its own yet" precisely because the disclaimers forbid a premature claim. No microstate number is invented.

(vi) EVIDENCE. rendered/TOE/gap_13_bh_entropy_page/subsystems/S1a_consistency_claim.md (DIAGNOSTIC value-match, asserts no count/no Page); .../S2c_counting_theorem.md (geometry-native degeneracy theorem OPEN, [O]/[X], gated on Gap 01); .../S3_page_curve_mechanism.md (Page mechanism OPEN, double cascade Gap 01 + Gap 14, PC-3).

GATE UQF-10 — Quantum compactification stability

(i) REQUIREMENT. Show the compact factors $K_6 \times S^2 \times S^1_Y$ are stable under quantum corrections: effective potential at declared loop order with a stable minimum at inherited volumes, no tachyonic moduli, no light moduli violating fifth-force/EP bounds, Casimir accounted.

(ii) STATUS ALONE (a): PARTIAL. Banked tier AUDIT; the §3.3 row defers to UQF-9 ("without a UV-completion certificate the moduli effective potential at higher loops is not controllable").

(iii) STATUS GIVEN TOE (b): DERIVED-CLOSED (decision-grade) for stability EXISTENCE; certificate still gated by the UQF-9 finite residual. This is the strongest QG headline: the corpus's native three-layer stabilization object discharges the stability-EXISTENCE question at DECISION grade independent of asymptotic safety; what remains is the paper's own certificate-grade FRG verification, which inherits the UQF-9 finite- a_6 residual.

(iv) ARGUMENT. TOE_FINAL v8 H04_DISCHARGED_AT_DECISION_GRADE (weakest variant clears the operative bound $35\times$, central 2.4×10^3); v9 Gap 04 CLOSED at decision grade (D15-native runner PASS, package gap04_frozen_package_native.json); v10 boundary-sign event $c_{bdry} = -1.08\times 10^{-2} \Rightarrow$ 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} (the c_{loop} window vacated; self-caught). This is a decision- grade EXISTENCE discharge by a route the paper did NOT use — making UQF-10's "blocked-by-UQF-9" framing too pessimistic. Hence DERIVED-CLOSED (decision-grade) for the existence question. It is NOT a promotion: the paper inherits this as a decision-grade INPUT (the background is stable) but does not convert it into its own certificate-grade FRG-6 result, which remains gated by the UQF-9 finite residual.

(v) EXACT CAVEAT. Decision-grade EXISTENCE only, via the corpus stabilization object — NOT the §14 FRG-6 trajectory this paper's certificate is conditioned on. The paper's tier stays AUDIT (zero promotion); certificate-grade FRG verification remains the paper's open obligation, carrying the UQF-9 finite- a_6 residual.

(vi) EVIDENCE. Quantum.md §15, §3.3 UQF-10 (AUDIT), §11.2 UQF-10 row (v8/v9/v10 discharge; "AUDIT — unchanged tier ... cited as an independent route ... but does not convert into its own certificate").

GATE UQF-14 — Unitarity / causality / locality

(i) REQUIREMENT. Per-sector unitarity bound check (partial-wave on $WW \rightarrow WW$, gg, graviton-graviton at perturbative scale); causality via Lorentz covariance + spectral conditions; locality via cluster decomposition on H_{phys} .

(ii) STATUS ALONE (a): PARTIAL. Banked tier AUDIT. Per-sector bounds are routine where the sector is perturbative; the graviton-sector unitarity ABOVE the cutoff is conditional on UQF-9.

(iii) STATUS GIVEN TOE (b): perturbative CERTIFICATE-CONDITIONAL; high-energy half OPEN. The below-cutoff per-sector unitarity is a perturbative CERTIFICATE-CONDITIONAL on UQF-3/UQF-4. The above-cutoff (graviton-sector) unitarity inherits the UQF-9 dissolution: the continuum-completion demand is dissolved by the cost-floor, but the finite high-energy unitarity statement is a genuinely-different object the cost-floor does not certify, so it stays OPEN at level (b).

(iv) ARGUMENT. Where the sector is perturbative, the partial-wave/Lorentz/cluster checks are routine and constitute a real conditional certificate. Above the cutoff the graviton-sector unitarity needs the UV completion; the cost-floor removes the $a \rightarrow 0$ demand but does not deliver a finite proof that high-energy graviton amplitudes are unitary — that proof is the same finite residual class as a_ϵ /interacting positivity. So: perturbative half certified-conditional; high-energy half open.

(v) EXACT CAVEAT. Perturbative/below-cutoff grade only. High-energy graviton-sector unitarity is OPEN (gated on UQF-9). Λ -line guard applies (no high-energy reading implies Λ /vacuum-energy cancellation; TOE_FINAL v12/v14). Unitarity violation in the graviton sector at $\Lambda_\star < M_{P1}$ drops UQF-5 one tier (§3.4.2).

(vi) EVIDENCE. Quantum.md §17, §3.3 UQF-14 (AUDIT; "graviton sector's unitarity above the cutoff is conditional on UQF-9"; corpus Λ guard); §3.4.2 coupling.

GATE UQF-4 — BRST/BV nilpotency & anomaly descent

(i) REQUIREMENT. Prove $s^2 = 0$ on the BV-extended phase space and that all chiral/gauge/mixed anomalies cancel on H_{phys} , with the inherited Paper-1 anomaly ledger surviving the 4D descent and the regulator choice.

(ii) STATUS ALONE (a): PARTIAL. Banked tier AUDIT. The Paper-1 anomaly ledger is closed; lifting it under the 4D-descent + BRST quantization here "requires explicit verification, deferred to Phase 4."

(iii) STATUS GIVEN TOE (b): PARTIAL — boundary-anomaly + coset-twist rows OPEN. The cost-floor does NOT dissolve this gate: anomaly descent is a finite, structural quantization question, not a continuum idealization. The bulk nilpotency + inherited anomaly cancellation is the closed part; the boundary-anomaly and coset-twist descent rows remain OPEN with their named pathway, at both levels.

(iv) ARGUMENT. $s^2 = 0$ is verifiable order-by-order on the BV action, and the inherited one-generation anomaly ledger cancels in the bulk. What is NOT discharged is that the cancellation SURVIVES the descent to 4D through the S^1_{Y/Z_2} boundary and the K_6 coset twist — a finite but unperformed verification. Because it is a finite structural object (not a continuum limit), the cost-floor offers no dissolution; the gate stays PARTIAL at level (b), with the boundary+coset rows named OPEN.

(v) EXACT CAVEAT. Bulk nilpotency + inherited cancellation only; boundary-anomaly + coset-twist descent NOT verified. An uncanceled anomaly drops UQF-7 and UQF-6 one tier and strips UQF-3 of CERTIFICATE; the paper as a whole cannot exceed AUDIT until resolved (§3.4.2).

(vi) EVIDENCE. Quantum.md §7, §3.3 UQF-4 (AUDIT), §11.3 "UQF-4 (BRST/anomaly closure, boundary rows) — correctly AUDIT ... boundary-anomaly + coset-twist rows remain open with their named pathway"; §3.4.2 coupling table.

GATE UQF-7 — Fermion chirality / quantization

(i) REQUIREMENT. Quantize one full generation of left-handed Weyl fermions on the active branch in the inherited reps, with NO mirror partners, spin-statistics satisfied, anomaly closure surviving the quantization.

(ii) STATUS ALONE (a): PARTIAL. Banked tier AUDIT. The classical no-mirror inventory is inherited; demonstrating the 4D-descent preserves chirality at the QUANTUM level (no light mirror from KK/quotient subtleties) requires explicit verification.

(iii) STATUS GIVEN TOE (b): classical inventory DERIVED-GIVEN-E (APS index $(+3, 0)$); quantum descent OPEN. The classical chiral inventory is DERIVED-GIVEN-E — closed and twice-derived from the frozen geometry data E (the APS one-sided index $(+3, 0)$, "the three families are the spin- structure witness," cross-checked against the BWB scan with $|index| = 3$). The QUANTUM-descent no-light-mirror question is a finite structural object the cost-floor does not dissolve, so it stays OPEN at both levels.

(iv) ARGUMENT. The classical zero-mode count is load-bearing-closed in the corpus: index $D_{\{K_6\}} = 3$, APS $(+3, 0)$, no mirrors at the zero-mode level — twice-derived (APS + BWB). This is DERIVED-GIVEN-E (it is read off the frozen branch + index data, not the cost-floor). The index count is therefore NOT the open item. The RESIDUAL — that the 4D BV-BRST quantization of the descent introduces no light mirror from KK/quotient/loop subtleties beyond the classical count — is genuinely open. It is finite/structural, so the cost-floor gives no dissolution; OPEN at (b), with a named verification path.

(v) EXACT CAVEAT. Only the CLASSICAL inventory is closed (DERIVED-GIVEN-E); the QUANTUM-descent no-light-mirror verification is open. Tier stays AUDIT (open-item NARROWED to quantum descent, NOT promoted). A surviving mirror drops the row to INTERFACE and downgrades the unified-completion claim to "non-chiral candidate."

(vi) EVIDENCE. Quantum.md §11 (UQFC-11) / §3.3 UQF-7 (AUDIT, with the 2026-06-12 open-item narrowing: classical inventory inherits APS $(+3, 0)$ EXTERNAL; residual = quantum descent); §11.2 UQF-7 row.

GATE Gap-14 — Born rule

(i) REQUIREMENT. Derive the Born-rule probability weights (the $|\psi|^2$ measure on outcomes) from the framework — the CH-2 KK-tower decoherence channel that fixes the probability assignment.

(ii) STATUS ALONE (a): OPEN. The corpus honest-halts (NotImplementedError) on the CH-2 channel; "cascades via Gap 01's a6."

(iii) STATUS GIVEN TOE (b): OPEN. The cost-floor is the WRONG SHAPE for a probability weight: a finite operational cell / cost functional does not, by itself, produce the $|\psi|^2$ measure. So the TOE does NOT dissolve and does NOT close this gate — OPEN at both levels. **Never fabricated.**

(iv) ARGUMENT (why OPEN at both, no fabrication). The Born rule is a statement about the WEIGHTS on the physical Hilbert space, not about the existence/finiteness of an operator spectrum. The cost-floor axiom constrains operational cost (finiteness of refinement), which is a different mathematical object from a normalized probability measure on outcomes; one cannot manufacture the quadratic measure from a cost floor without a separate posit. The decoherence-channel route (CH-2) additionally cascades on Gap 01's a_6 (the UV-defined Hilbert space). So even given the full TOE axiom set the Born weights are not derived; they remain an OPEN object with a named (decoherence/ system-bath) path. No probability rule is invented.

(v) EXACT CAVEAT. The cost-floor cannot be used to manufacture the Born weights (wrong shape). The decoherence route is an honest halt cascading on Gap 01. No $|\psi|^2$ derivation is fabricated.

(vi) EVIDENCE. Quantum.md Gap-14 references (CH-2 KK-tower decoherence honest halt); rendered/TOE/gap_01_uv_quantum_gravity/00_decomposition.md (S5.2 Gap-14 consumer contract; "Gap 14 honest-halts (NotImplementedError) and cascades via Gap 01's a_6 "); gap_13.../S3_page_curve_mechanism.md (system-bath split $\equiv$ Gap 14 first action).

GATE UQF-11 — Yang-Mills mass gap (nonperturbative QCD)

(i) REQUIREMENT. A nonperturbative QCD route compatible with $\kappa_6 = \text{SU}(3)/T^2$: confinement (Wilson-loop area law), a mass gap $\Delta > 0$, hadronic spectrum, lattice–continuum bridge, chiral condensate. The continuum mass-gap existence problem: a non-trivial OS/Wightman continuum $\text{SU}(3)$ Yang-Mills with unique vacuum, $H \geq 0$, and a gap $\Delta > 0$ SURVIVING the continuum limit.

(ii) STATUS ALONE (a): OPEN. Banked tier AUDIT + ROADMAP; this long-standing open problem of mathematical physics is explicitly NOT claimed solved. The corpus banks only a CANDIDATE compatibility (structurally compatible with a gapped nonperturbative phase, explicitly NOT a proof).

(iii) STATUS GIVEN TOE (b): continuum half AXIOM-CLOSED:dissolved; finite uniform-gap-bridge OPEN. The cost-floor dissolves the CONTINUUM-LIMIT demand (the $a \rightarrow 0$ uniform gap that survives the continuum limit — MO-2/MO-5/6/7). But the FINITE uniform-gap-bridge — that a finite-lattice gap is uniform across the operationally-relevant cells — is a genuinely-different, finite object the cost-floor does not supply. So OPEN at level (b).

(iv) ARGUMENT (dissolution + residual). The hard core of the continuum mass-gap existence problem is the conjunction of a nonperturbative continuum CONSTRUCTION + a gap that survives $a \rightarrow 0$ and $\text{volume} \rightarrow \infty$ (reflection positivity of the continuum measure, OS $\rightarrow$ Wightman reconstruction, uniform $\Delta > 0$). The cost-floor (GRANULARITY) declines the $a \rightarrow 0$ half: with a finite operational cell there is no continuum limit to control, so "does the gap survive $a \rightarrow 0$?" is dissolved (NOT solved — no proof is produced; the demand is removed). What the cost-floor does NOT give is the FINITE uniform-gap-bridge: the statement that the gap is uniform (bounded below by a single $\Delta > 0$) across the finite family of operational cells. That is exactly the UQF-11 open object. The geometry contributes only the INPUT

specification (which group $SU(3)_c$, which $(+3,0)$ field content, no architectural obstruction — grade CANDIDATE); it does NOT supply the IR dynamics. The seed-case (ii) is the SAME recognized open continuum problem, if anything HARDER (it inherits all 4D difficulty plus the compact-boundary/parity sector). No measure, bound, or positivity estimate is fabricated.

(v) EXACT CAVEAT. dissolved $\neq$ solved: no continuum construction, no uniform gap, no reflection positivity is proven; the cost-floor only removes the $a \rightarrow 0$ DEMAND. The finite uniform-gap-bridge is OPEN and is never fabricated. Closure owner EXTERNAL (constructive QFT). Geometry supplies an input specification, not a method; (ii) is no easier than (i).

(vi) EVIDENCE. Quantum.md §12, §3.3 UQF-11 (AUDIT + ROADMAP), §11.3 "UQF-11 correctly AUDIT + ROADMAP ... long-standing open problem of mathematical physics; closes nothing here";

rendered/TOE/gap_02_yang_mills_ mass_gap/04_step0_theorem_statement.md (continuum mass-gap existence problem (i) + seed (ii); MO-1...MO-7; "(ii) is no easier than (i)"; fabrication guard).

GATE UQF-12 — Strong CP (θ)

(i) REQUIREMENT. Explain or eliminate θ^- — a named structural mechanism with a named falsifier (corpus default: S^1_Y/Z_2 boundary-parity; fallback: PQ axion, which needs geometry not in the active branch).

(ii) STATUS ALONE (a): OPEN. Banked tier AUDIT (LOW confidence). θ^- -smallness is honestly UNDERIVED; the paper provides "a candidate and a falsifier, not a solution." The geometric route is PROVEN BLOCKED by a mutual-exclusivity theorem.

(iii) STATUS GIVEN TOE (b): OPEN. The cost-floor does NOT dissolve and does NOT close this gate: θ^- -smallness is a finite structural CP question with a banked NO-GO, not a continuum idealization. OPEN at both levels. **Never fabricated.**

(iv) ARGUMENT (why OPEN at both, no fabrication). The geometric route is REFUTED by a representation-theory mutual-exclusivity theorem (owner-ratified 2026-06-14): a Realization-B Z_2 sign-lever on $\arg \det(M_u M_d)$ exists ONLY IF Q_L and u_R/d_R sit on K_6 bundles with OPPOSITE determinant-character; but every dim-3 $su(3)$ irrep is 3 or 3^* , each carrying the SAME sign det-character — so chiral asymmetry (opposite det-character) and the three-family witness $|\text{index}| = 3$ are MUTUALLY EXCLUSIVE. The committed $[-6, 6]$ weight scan finds zero escapes, consistent with the proof. Any escape would require structure OUTSIDE the homogeneous-line-bundle setting (DECLINED, fail-closed). The cost-floor (a finiteness/cost axiom) has no bearing on this determinant-character obstruction; it cannot manufacture the small θ^- . OPEN at both levels, with nEDM as the experimental adjudicator.

(v) EXACT CAVEAT. A CANDIDATE + a falsifier, NOT a solution; θ^- -smallness honestly underived. The geometric route is PROVEN BLOCKED (mutual-exclusivity theorem) — this is a banked NEGATIVE, not progress toward closure. nEDM is the falsifier on the 1.64-rad spin-c-holonomy surface. No θ^- value or mechanism is invented.

(vi) EVIDENCE. Quantum.md §13, §3.3 UQF-12 (AUDIT LOW), §11.3 "UQF-12 correctly AUDIT (LOW) ... most tempting row to complete was verified and left open"; rendered/TOE/gap_03_strong_cp/

subsystems/G03.A.1.c_realization_B_mutual_exclusivity_refuted.md (the mutual-exclusivity theorem, REFUTED, owner-ratified).

SUMMARY LEDGER

Gate	alone (a)	given TOE (b) — HEADLINE
UQF-5 graviton	CERTIFICATE-CONDITIONAL on UQF-9	CERTIFICATE-CONDITIONAL on UQF-9 (2 pols + Newtonian hold; interacting → UQF-9)
UQF-9 UV completion	OPEN	AXIOM-CLOSED:dissolved (continuum UV-fixed-point demand) + OPEN (finite a_6 residual)
UQF-3 positivity	PARTIAL	perturbative CERTIFICATE-CONDITIONAL; interacting half OPEN
Gap-01 $\text{tr}[a_6]$	OPEN	OPEN (continuum question dissolved; finite a_6 VALUE uncomputed → OPEN at both)
Gap-13 BH-entropy/Page	PARTIAL	UV leg AXIOM-CLOSED:dissolved; microstate-count + Page-mechanism OPEN
UQF-10 compactification	PARTIAL	DERIVED-CLOSED (decision-grade existence) (banked tier AUDIT; existence-only, not a promotion); certificate gated by UQF-9 finite residual
UQF-14 unitarity	PARTIAL	perturbative CERTIFICATE-CONDITIONAL; high-energy half OPEN
UQF-4 BRST/anomaly descent	PARTIAL	PARTIAL — boundary + coset-twist OPEN
UQF-7 fermion chirality	PARTIAL	classical DERIVED-GIVEN-E (APS +3); quantum descent OPEN
Gap-14 Born rule	OPEN	OPEN (cost-floor is wrong shape for a probability weight)
UQF-11 mass gap	OPEN	continuum half AXIOM-CLOSED:dissolved; finite uniform-gap-bridge OPEN
UQF-12 strong CP	OPEN	OPEN (mutual-exclusivity theorem; cost-floor cannot manufacture θ)

Genuinely-irreducible residual (gates OPEN given the full TOE)

These survive as OPEN at level (b) — the cost-floor neither dissolves nor manufactures them:

1. **Finite a_6 VALUE** (Gap-01) — uncomputed; never invented.
2. **Finite uniform-gap-bridge** (UQF-11) — the finite residual after the continuum half is dissolved.
3. **Born-rule weights** (Gap-14) — cost-floor is the wrong shape for a probability measure.
4. **Strong-CP θ** (UQF-12) — mutual-exclusivity theorem blocks the geometric route.

Additionally, the INTERACTING/NONPERTURBATIVE HALVES of UQF-3 (positivity) and UQF-14 (unitarity) stay OPEN given the TOE; their perturbative halves are CERTIFICATE-CONDITIONAL. UQF-

4's boundary+coset-twist descent and UQF-7's quantum descent are finite structural OPEN items the cost-floor does not touch.

Σ remains AUDIT. Zero promotions. Every closure above carries its exact caveat; dissolved $\neq$ solved throughout; no a_ϵ , gap value, Born weight, or θ^- is fabricated.