

Fable GUT — Paper I, full three-layer rework (Appendix CR + Layer-1 claim spine + Layer-3 authority). Rendered from Quantum_Q1_main_manuscript.md .

Quantum Paper 3 (Q1 Main Manuscript) — 13D Unified Quantum Force Completion

Assembled Q1 claim-spine manuscript. UV, Physical-State, Nonperturbative, and Precision Certificates — Paper 3 of 4 in the Fable series.

Headline. $\Sigma = \text{AUDIT}$ — the minimum tier over the seventeen UQF gates (UQF-0..UQF-16), with eight named rows {UQF-4, UQF-7, UQF-9, UQF-10, UQF-11, UQF-12, UQF-14, UQF-15} at AUDIT holding the aggregate down by the weakest-link min-rule $\Sigma = \min_{k \in \{0, \dots, 16\}} \sigma_k$.

Q1 Table of Contents

Front matter - Title · One-line thesis · The Big Idea · Preserved invariants · Reader on-ramp pointer - **UQFC-o — Reviewer First Read** (what this paper is / is not · the result $\Sigma = \text{AUDIT}$ · how to read AUDIT · Quantum Authority Stack · reader route · fast checks)

Body 1. Claim Boundary: Force-Sector Quantum Completion, Not TOE 2. UQF Stack and Status Vocabulary 3. Σ Scoreboard and Min-Rule 4. Quantum Object Ledger 5. Core Quantization Machinery 6. Force-Carrier Certificates 7. Matter, Fermion, and Higgs Certificates 8. The AUDIT Rows (UQF-11, UQF-12, UQF-9, UQF-10, UQF-14, UQF-15 + UQF-13 aside + AUDIT→CANDIDATE work plan) 9. External Corpus Reconciliation Summary 10. Falsification and Downgrade Map 11. Conclusion 12. External Engineering Bridge Pointer

Companions (externalized, verbatim — not concatenated here; the teaching, formal-authority, and provenance layers reproduce this manuscript verbatim and carry no independent certificate authority, so their content is fully represented by Paper III,
<https://physics.magflowmeters.com/articles/Quantum.html>) - Reader on-ramp · reviewer test prompts · provenance ledger — Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> - QC engineering bridge (EXTERNAL / SIMULATED; no feedback into UQF status) — Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> - Q2 teaching · Q3 formal authority — Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> - The §11 external-corpus reconciliation ledger (§11.1–§11.5) — Paper III, <https://physics.magflowmeters.com/articles/Quantum.html>

13D Unified Quantum Force Completion

Paper 3 of the Fable series — restructured build UV, Physical-State, Nonperturbative, and Precision Certificates — Paper 3 of 4

One-line thesis. Writing down the forces is the easy half. The hard half — where most unification programmes quietly die — is making them survive quantization: ghosts that fail to cancel, anomalies that survive, mirror fermions the world does not contain. So this paper runs all four forces through a seventeen-gate stress-test, publishes its own weakest link as the headline ($\Sigma = \text{AUDIT}$), and shows the geometry it quantizes is the same one that builds a simulated quantum computer.

The Big Idea (in ~180 words)

A grand-unified geometry can reproduce the Standard Model's entire particle content and still be a corpse. Classical field content is cheap; turning it into a consistent **quantum** field theory is where most unification programmes quietly die — ghosts that fail to cancel, anomalies that survive, mirror fermions the world does not contain, a Higgs with no positive-norm state. None of these shows up until you actually quantize. So this paper takes the four force interfaces a sister paper already closed and asks the only question that matters next: *do they admit honest quantum completion as force theories?*

It answers with a discipline most theories avoid. Seventeen gates (UQF-o..UQF-16, §3) grade gravity, the strong, weak, and electromagnetic sectors; the headline number is the **minimum** over all of them, so the weakest link sets the claim and no strong result can hide a weak one. The paper ships **at AUDIT, on purpose** — because the Yang-Mills mass gap, asymptotic safety, and strong CP genuinely sit open inside its scope, and a min-rule forbids it from claiming more. Then the part that makes the geometry hard to dismiss: the same K_6 coset these certificates quantize also defines the admissibility chamber of an error-correcting quantum computer, designed and simulated on open tools (§19B, EXTERNAL, SIMULATED).

The pitch in one breath: *a theory that publishes its own weakest link as its front-page number — and whose geometry earns its keep in a machine you can run.*

Companion paper above the Four-Force Interface paper (Paper 2) and below the future TOE paper (Paper 4). Paper 2 closes the four-force *interface* compatibility question via the C-FFo..C-FF14 backbone. Paper 3 (this paper) asks whether those four interfaces admit honest quantum-field-theoretic completion as force theories, under the UQF-o..UQF-16 gate stack. Aggregate tier: $\Sigma(\text{UQFC}) = \text{AUDIT}$ at the close of the 2026-06-08 draft. *Read that label correctly: Σ is the minimum tier over all seventeen gates (§3.4.3). AUDIT is the honest floor the weakest-link rule forces — the deliberate consequence of refusing to let any strong row hide a weak one, not a verdict that the work is unfinished. A theory that printed its average instead of its minimum would be the one to distrust.*

Scope, stated once and hard: this is a force-sector paper — gravity, strong, weak, electromagnetic, asked only whether they admit honest quantum completion. Cosmology, dark matter, dark energy, baryogenesis, and initial conditions are not in scope; they are walled off to Paper 4 by name (§1.0, §5). "Theory of everything" is the sibling above this one, not this paper's claim.

Preserved invariants (paper-wide). SoT hash

88e5903fe1c3d17655acef7e4fb45078e3168add25362040e21598b3b161ff17 ; hard-gate vector **D, D-local, D, D, D**; BG-10 = *Open / Diagnostic* (deferred to Paper 4); C-FFo..C-FF14 in Paper 2 not modified; no edits to filed-patent material, NRC packet, SoT manuscript, baryogenesis_build, Article C §8.2.

Supporting Documentation (exact corpus register)

This paper does not stand alone; it imports frozen authority from the constraint-first-geometry corpus and is audited against published data. Every "Paper 1 / Paper 2 / Paper 4 / Article / Appendix / main GUT manuscript / PDG" reference in the body resolves to one of the **exact locators** below. Where a body sentence names a GUT-side appendix or article informally, the exact GUT.html anchor is given here; that anchor is authoritative.

Paper I — GUT (geometry / Standard-Model authority; owns the active branch, the hard-gate vector, the SoT hash, the SM routing, flavor, proton safety, the appendix certificates). -

<https://physics.magflowmeters.com/articles/GUT.html> - GUT anchors used by this paper: App A1/A2/A3/A (geometry + active branch), C2/C4/C7/C8/C9 (constraint modules), D, E/E-prime, GP, CR (gate-review modules); **Appendix H** = GUT.html Appendix H (the UQF-8B Higgs Wilson-line authority); **Appendix K** = GUT.html Appendix K (the UQF-7G neutrino-mechanism authority); Appendix I/J the chamber + quark/lepton certificates; **Gate 11** = the GUT claim-boundary discipline gate (the "Strong CP excluded from scope" authority cited by UQF-12). The Q1 names "Article A / Article B / Article C" and "main GUT manuscript §7/§12/§13/§14" denote the corresponding sections/appendices of this same GUT.html source-of-truth manuscript. - GUT teaching / authority-index / reproducibility / provenance companions reproduce GUT.html verbatim and carry no independent certificate authority — Paper I, <https://physics.magflowmeters.com/articles/GUT.html>.

Paper II — Forces (the four-force C-FFo..C-FF14 interface backbone; owns the projection maps

π_{grav} , π_{strong} , π_{weak} , π_{QED} and the §6/§7/§8/§9 interface sections cited throughout). -

<https://physics.magflowmeters.com/articles/Forces.html> - The C-FF Rosetta, formal-authority package, and provenance companions reproduce Forces.html verbatim and carry no independent certificate authority — Paper II, <https://physics.magflowmeters.com/articles/Forces.html>.

Paper III — Quantum (this paper) and its companions (the teaching, formal-authority, reconciliation, provenance, on-ramp, reviewer-prompt, and QC-bridge companions reproduce this manuscript verbatim and carry no independent certificate authority; their content is fully represented by the public article): - This manuscript:

<https://physics.magflowmeters.com/articles/Quantum.html> - Q2 — UQF Rosetta (teaching) — Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> - Q3 — Appendix U formal authority — Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> - Q3 external-corpus reconciliation ledger (the §11 ledger) — Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> - Provenance ledger — Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> - Reader on-ramp (longform) — Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> - Reviewer test prompts (§19B.5) — Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> - QC engineering bridge (§12 / §19B; EXTERNAL / SIMULATED, no feedback into any UQF status) — Paper III, <https://physics.magflowmeters.com/articles/Quantum.html>

Paper IV — Scoped TOE (owns everything walled off from this paper: cosmology, dark sector, baryogenesis/BG-10, initial conditions, the Λ /cosmological-constant line). -

<https://physics.magflowmeters.com/articles/TOE.html> - The TOE Truth-Table Rosetta, formal-authority package, and provenance companions reproduce TOE.html verbatim and carry no independent certificate authority — Paper IV, <https://physics.magflowmeters.com/articles/TOE.html>.

Companion — Particles (Observed Particle Spectrum Closure; the PDG-anchored spectrum companion). -

<https://physics.magflowmeters.com/articles/Particles.html> - Executable regression suite + frozen CSVs and scripts hosted at https://physics.magflowmeters.com/scripts/particles_regression/.

Downstream engineering audit (cross-reference only — not physics authority for this paper). A downstream metric-interface engineering audit consumes this geometry (out of scope here; available on request).

Experimental data — PDG. All measured comparison quantities are cited to the **Particle Data Group, Review of Particle Physics (PDG 2024)**, by the specific listing/quantity per number (e.g. the $\alpha_3(M_Z)$ strong-coupling listing for the $1/8.47 \pm 0.05$ comparison in §8.3; the m_u up-quark-mass listing for the $m_u \approx 2.16 \pm 0.07$ MeV value in §8.5; the electroweak/ m_W world-average listing for the $\sim 1.5\sigma$ tension in §8.8). Computational artifacts and reproducibility scripts: <https://physics.magflowmeters.com/scripts/>.

Locator rule. A reference of the form "Paper n", "Article X", "Appendix Y", "main GUT manuscript §z", or "the PDG value" anywhere in this paper is shorthand for the exact full path / anchor / PDG-2024 listing registered

above. If a body shorthand and this register ever disagree, **this register is authoritative for the locator** (it does not change any status, tier, number, or Σ).

How to read this paper — the one character to follow

Premise. Writing forces down on paper is the cheap half of physics. The expensive half — where most unification programmes quietly die — is forcing the same construction to survive quantization: ghosts that must cancel, anomalies that must close, mirror fermions the world refuses to contain, a Higgs that must keep a positive-norm state. None of those failures show up classically. This paper takes one frozen geometry — the active-branch $M_{13} = M_{3,1} \times K_6 \times S^2 \times S^1$ with $K_6 = SU(3)/T^2$, inherited unchanged from Papers 1–2 — and asks the only thing left to ask: when you quantize it, what survives?

The character. The protagonist of this paper is not a person and not a promise. It is the frozen, un-tunable construction on trial — the geometry that you are not allowed to adjust to make a gate pass. You can recognize it by one habit: it hands you the knife. For every one of the seventeen gates it states, up front, the exact measurement or calculation that would dissolve it if it were wrong (the nEDM bound on strong CP, a surviving mirror fermion, a missing fixed point, a negative-norm physical state). It does not flinch from its own weakest link — it prints that link on the cover. That is the bond: you can trust it precisely because it tells you where to cut.

The journey. We imprint on the character at §1–§4, where it draws its own boundary (force sectors only — not a Theory of Everything) and lays out its seventeen gates and nine quantum objects with nothing hidden. We start to trust it in §5–§7, watching the same geometry survive quantization where it can — the linearized graviton's two helicities, the gauge carriers, the Higgs separating from its Goldstones — each claimed only at the tier it earns. Then comes the part that earns the reader's excitement: in §8 the construction walks us straight to the eight rows it cannot yet close — nonperturbative QCD, strong CP, the UV fixed point, and the rest — and refuses to bluff past them. §10 turns every claim into a falsifier; §11 lands the only honest number the min-rule permits. Read the headline correctly: $\Sigma = \text{AUDIT}$ is the construction's minimum gate, published deliberately — the honest floor, not an apology, and not a claim that the constraint "B-UQFC" has been adopted (it has not). The thrill here is not a triumphant result; it is watching a construction that would rather tell you exactly how to kill it than oversell what it can do.

Reader on-ramp (externalized). The non-technical reader's preface ("Before the equations: what you are about to watch happen"), the WHY-THIS-MATTERS narrative, the six-rung concept ladder ("The concepts, in the order you need them"), and the "What you'll know after..." time-to-understanding ladder are reader-facing framing, not part of the claim spine. They are preserved **verbatim** within Paper III, <https://physics.magflowmeters.com/articles/Quantum.html>. Nothing in that framing changes a result. The deeper teaching layer (the §10 intuition pump, the strongest-objections steelman) lives in **Q2** (Paper III); pull it from there.

UQFC-0 — Reviewer First Read

This opening chapter is the reviewer's orientation: what this paper is and is not, the result $\Sigma = \text{AUDIT}$ and how to read it, the Quantum Authority Stack (who owns what), the reader route, and the fast checks. It advances no status;

it tells a skeptical reader exactly where to push. Reading order and load-bearing-piece locations live in the §3.7 master table (Q3 / Appendix U); the per-row formal templates and certificate registry are Q3's authority.

What this paper is

This paper is **Paper 3** in a four-paper hierarchy on the constraint-selected 13D framework:

Paper 1 – Main GUT Manuscript (active branch, SM routing, flavor, proton safety, freeze records)

Paper 2 – Four-Force Interface (the four-force C-FF0..C-FF14 backbone)

Paper 3 – Unified Quantum Force Completion <-- THIS PAPER

Paper 4 – Theory of Everything (cosmology, dark sector, baryogenesis, initial conditions)

Paper 2 established that gravity, the strong force, the weak force, and QED can be written as four mutually compatible *interface-level* projections of one 13D parent geometry. Paper 2 is an **interface** paper: it does not claim those four projections constitute complete quantum theories of their respective forces; it claims only that the projection maps mesh. Paper 3 — this paper — asks the next question: **do those four interfaces admit honest quantum-field-theoretic completion?** The question is sharply force-sector-only. It is not the TOE question; it is the narrower question "are the four force interfaces themselves quantum-complete force theories?"

What this paper is not

The claim boundary is hard, and it is the single most-attacked surface of the document (full treatment in Q1 §1):

This paper attempts unified quantum completion of the force sectors only. It does NOT yet claim a full theory of everything. Cosmology, the dark sector, baryogenesis, initial conditions, the measurement problem, the emergence of classicality, and "why this universe" all defer to Paper 4.

The paper claims, under declared assumptions, a force-sector unified quantum-completion candidate at the tier the weakest UQF certificate admits. It does not claim TOE-tier closure of anything. It does not edit Paper 1's hard-gate vector, does not edit Paper 2's C-FF0..C-FF14 backbone, and does not litigate BG-10.

Four claim-control phrases a reviewer should be able to find easily — "interface claim", "main-manuscript certificate", "positivity / UV-completion certificate", "diagnostic / illustrative" — are defined in Q2 (the UQF Rosetta). The rule they enforce: any sentence asserting a CERTIFICATE-tier conclusion without naming the gate ID, the frozen inputs, the pass/fail criterion, and the downgrade rule is a bug, and downgrades per §3's ladder.

The result: $\Sigma = \text{AUDIT}$

Here is this paper's front-page result, stated the way the min-rule demands it be stated. The unified quantum-force-completion claim is exactly as strong as its weakest gate:

$$\Sigma = \min_{k \in \{0, \dots, 16\}} \sigma_k.$$

The scoreboard below is the authoritative per-row tier ledger (auto-derived from §3.3 with the §3.8 phase-close reconciliations applied; any aggregate-tier sentence anywhere in this paper that disagrees with this table is a drafting bug per §3.4.4):

Namespace key (read before chasing any "11"). Three numbering systems share the digits in this paper, and a reader following a row ID from this scoreboard can collide them. (i) **UQF-*n*** are the *seventeen audit gates* — the rows of the scoreboard below and of §3.3 (so UQF-11 = *nonperturbative QCD*, AUDIT). (ii) **UQFC-*n*** are the *numbered chapters* of THIS paper (so UQFC-11 is a chapter, e.g. a fermion chapter — not a gate). (iii) **UQC-**

n is the *retired* prior backbone; its rows, and the old "UQF-11 (dark matter)" of that earlier hybrid numbering, are **moved to Paper 4 reserve** and are not gates here. When in doubt, the full prior-row-to-gate crosswalk is the §3.5 mapping table. Throughout this scoreboard and §3.3, "UQF-11" always means the nonperturbative-QCD audit gate.

Gate	Name	Tier	Discharged in	If AUDIT: what raises it
UQF-0	Active-branch inheritance	CERTIFICATE	§2	—
UQF-1	Quantum object ledger	CANDIDATE	§4	—
UQF-2	Canonical / path-integral equivalence	CANDIDATE	§5	—
UQF-3	Physical Hilbert space	CANDIDATE	§6	—
UQF-4	BRST/BV nilpotency and anomaly closure	AUDIT	§7	Phase-4 anomaly lift under 4D descent
UQF-5	Graviton certificate	CANDIDATE	§8	—
UQF-6	Gauge-boson certificate	CANDIDATE	§9	—
UQF-7	Fermion quantization	AUDIT	§11	Phase-3 no-light-mirror verification
UQF-8	Higgs / Goldstone quantum certificate	CANDIDATE	§10	—
UQF-9	UV-completion certificate	AUDIT	§14	non-Gaussian fixed point at declared truncation (global open problem)
UQF-10	Quantum compactification stability	AUDIT	§15	blocked by UQF-9 (loop control of moduli potential)
UQF-11	Nonperturbative QCD	AUDIT	§12	named lattice / partner-community program
UQF-12	Strong CP	AUDIT	§13	nEDM falsifier on boundary-parity candidate (LOW conf.)
UQF-13	Precision-force phenomenology	CANDIDATE	§16	—
UQF-14	Unitarity / causality / locality audit	AUDIT	§17	graviton-sector unitarity above cutoff (UQF-9)
UQF-15	No-hidden-sector force leakage	AUDIT	§18	§4 ledger exhaustiveness + Phase-4 audit
UQF-16	Final downgrade map	CANDIDATE	§19	—

Aggregate: Σ = min over rows = AUDIT (per §3.4.3).

The number: Σ = AUDIT. The paper claims precisely that and no more — a unified quantum-completion *audit* of the four force interfaces, with frozen gate-by-gate accounting of what is closed (the linearized force carriers, the framework equivalence, the object ledger, the downgrade map), what is candidate (positivity, Higgs at tree level, Tier-1 precision specification), and what holds the aggregate at AUDIT (the eight AUDIT rows in the table above). Raising Σ to CANDIDATE is the declared Phase-7 target and requires exactly those eight rows; raising it to CERTIFICATE requires the named partner-community executions. No sentence in this paper outranks this table.

The secondary count. Every quantum object in all four forces traces to **nine ledger rows** (§4) — three metric blocks, the descended connections, one generation of chiral matter, one Higgs doublet, the KK tower, ghosts, antifields — with zero objects introduced outside the ledger and zero rows left unconsumed. Seventeen gates, nine objects, one number.

How to read AUDIT

$\Sigma = \text{AUDIT}$ is not a flattering average and not a failure label. It is the minimum tier across all seventeen UQF gates. The paper ships at AUDIT because **eight named rows remain at AUDIT** — {UQF-4, UQF-7, UQF-9, UQF-10, UQF-11, UQF-12, UQF-14, UQF-15} — and the min-rule forbids strong rows from hiding weak ones.

AUDIT is also strictly *more* than OPEN: an AUDIT row carries a draft argument, a named falsifier, and at least one open dependency. The eight that hold the aggregate down are exactly the genuinely-hard problems inside this paper's scope — anomaly lift under 4D descent (UQF-4), no-light-mirror fermion descent (UQF-7), the UV non-Gaussian fixed point (UQF-9, a global open problem), compactification stability blocked on it (UQF-10), nonperturbative QCD (UQF-11, a long-standing open problem of mathematical physics), strong CP (UQF-12, a candidate-and-falsifier not a solution, LOW confidence), graviton-sector unitarity above the cutoff (UQF-14), and hidden-sector closure (UQF-15). The AUDIT rows are *routed to the top* (§19, §3.3) so a hostile reviewer finds the weak links first, exactly where the paper put them. The deeper "weakest-link-on-the-cover" intuition pump is in Q2.

Quantum Authority Stack

This paper does not own everything it uses. The table fixes, for each load-bearing object, whether Paper 3 owns it, where its authority lives, and its status. $\Sigma = \text{AUDIT}$.

Claim / object	Owned by Paper 3?	Authority	Status
UQF gate stack (UQF-0..UQF-16)	Yes	Q1 §2 / Q3 Appendix U	governing quantum-completion stack
Σ min-rule ($\Sigma = \min_k \sigma_k$)	Yes	Q1 §3 / Q3 Appendix U	aggregate status rule
UQF row statuses (incl. the 8 AUDIT rows)	Yes	Q1 §3 + Q3 registry	status ledger
Active-branch inheritance (UQF-0)	No	Paper 1	imported frozen object
Four-force interface C-FF0..C-FF14 rows	No	Paper 2	imported interface backbone
Quantum object ledger (nine rows)	Yes	Q1 §4 + Q3 Appendix U	object-control layer
TOE_FINAL v6–v15 reconciliation	External	Q1 §9 / Q3 reconciliation ledger	no-promotion external context
QC engineering bridge (§19B)	No physics authority	external — Paper III, https://physics.magflowmeters.com/articles/Quantum.html	EXTERNAL / SIMULATED
Retired UQC rows	Historical only	provenance / namespace key	not current gates

Authority rule. If Q1 narrative conflicts with Q3 Appendix U / the formal registry, **Q3 controls**. If Q2 explanation conflicts with Q1 status or Q3 authority, **Q1/Q3 control**. External-corpus results (TOE_FINAL v6–v15; the QC bridge) may be cited but **may not promote a UQF row without countersign** (the Return-YAML / Chris instrument). The QC bridge is EXTERNAL / SIMULATED and **feeds no result back into any UQF status** (no-target-loading firewall); strong CP (UQF-12), UV completion (UQF-9), and nonperturbative QCD (UQF-11) stay AUDIT/open; BG-10 stays Open / Diagnostic.

Reader route

Reader	Start at	Then read	What you will be able to judge
Deciding whether it's worth your hour (the skeptic)	WHY THIS MATTERS (on-ramp companion), then THE STRONGEST OBJECTIONS, ANSWERED (Q2)	§1 (claim boundary), then §19B (the geometry builds a machine, EXTERNAL) and the five test-it-yourself prompts, then §19 (falsification map)	Whether the scope discipline, the min-rule honesty, and the engineering bridge clear your bar for a serious read
New to the framework (smart non-specialist)	The <i>plain</i> passes of §1.0–§1.2 (Q1 §1)	§3 (the seventeen gates), the §3.7 master table (Q3), then §19B	What is claimed, what is deferred to Paper 4, what would kill it, and that the geometry is buildable
Physicist auditing the completions	§1 <i>precise</i> , then §3.3	§§5–8 (quantization + positivity + graviton), §§9–13 (the per-force certificates), §11 (corpus reconciliation)	Whether each certificate earns its stated tier — no more no less
Reviewer auditing honesty	§3 (the status vocabulary + min-rule), then THE STRONGEST OBJECTIONS, ANSWERED (Q2)	the checked-and-correctly-open register (§11.3) and the completeness-exceptions register (§11.5), both in the Q3 reconciliation ledger (Paper III, https://physics.magflowmeters.com/articles/Quantum.html); then §10 (downgrade map)	That every row sits at a labeled tier with a falsifier, and that nothing was promoted
The countersign owner	the completeness-exceptions register (§11.5) + the §11.4 promotion note , in the Q3 reconciliation ledger (Paper III, https://physics.magflowmeters.com/articles/Quantum.html)	The AUDIT rows in §8 and the Σ ladder in §3.4 / §11.4	Which decision-grade corpus discharges are queued for a binding ruling — and that none was self-

Reader	Start at	Then read	What you will be able to judge
			enacted here

Fast checks

A fast check, before you commit the hour

If you want one concrete thing to verify by hand before trusting the rest: pick a sector where the answer is already known, and check that this paper's geometry returns the same number the textbook returns. Two such checks are worked in-doc, at the free-field level (not a curved-space GR match — that lives in the sister papers):

- **The linearized graviton (§8.4.3–§8.5).** In 4D de Donder gauge the construction reproduces the standard helicity-mode expansion, and the polarization count is the textbook reduction $10 - 4 \text{ (gauge)} - 4 \text{ (residual)} = 2$ transverse-traceless modes. This is flagged CERTIFICATE-tier at the linearized level (§8.6) — and the section states plainly what it does not cover (the interacting, nonperturbative graviton, routed to UQF-9).
- **Canonical ↔ path-integral equivalence (§5.5).** On the free / perturbative-overlap sector, the canonical brackets, the physical spectrum, the gauge-invariant correlators, and the tree-level S-matrix agree between the canonical and the BV/path-integral formulations — by the standard 4D theorems (Peskin–Schroeder, Henneaux–Teitelboim, Weinberg Vol. II), with the 13D generalization adding no new ingredient on the overlap.

Both are deliberately the easy, checkable end of the claim: where a reviewer can confirm in an afternoon that the new machinery has not quietly changed the physics. The hard ends — the interacting UV, nonperturbative QCD, strong CP — are the AUDIT rows the §10 scoreboard prints on the cover.

Five more checks — copy-paste prompts you can run against a calculator or any AI, spanning Papers 1–3 — are externalized verbatim within Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> (the §19B.5 block: 3 Type-A equivalence checks + 2 Type-B non-falsification checks, each with a confirms / does-not-show reading). They raise no gate tier; Σ = AUDIT is unchanged.

External pointers (this front matter only carries pointers; the companion content reproduces this manuscript verbatim and carries no independent certificate authority — all of it is represented by Paper III, <https://physics.magflowmeters.com/articles/Quantum.html>). - **Reader on-ramp (longform):** Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> — reader's preface, WHY THIS MATTERS, concept ladder, time ladder. Framing only; changes no result. - **Reviewer test prompts (§19B.5):** Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> — five copy-paste consistency / non-falsification checks across Papers 1–3. - **Provenance ledger:** Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> — the full append-only build / merge / pass-log / countersign record (verbatim). No status moves there. - **QC engineering bridge (§19B):** Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> — EXTERNAL / SIMULATED; the K_6 admissibility chamber as a simulated error-correcting quantum computer. No feedback into any UQF status. - **Teaching layer:** Q2 (UQF Rosetta) — the §10 intuition pump, the four claim-control phrases, the strongest-

objections steelman. - **Formal authority:** Q3 / Appendix U — the §3.7 master table, the per-row certificate templates, and the formal object ledger. If Q1 and Q3 disagree, Q3 controls. - **External-corpus reconciliation (the §11 ledger):** Paper III, <https://physics.magflowmeters.com/articles/Quantum.html> — the §11.1 cross-paper convention, the §11.2 stale-row reconciliation table, the §11.3 checked-and-correctly-open register, the §11.4 corpus events noted for completeness, and the §11.5 completeness-exceptions register (the MR-1 disposition). Verbatim; no UQF tier is advanced there. $\Sigma = \text{AUDIT}$.

1. Claim Boundary: Force-Sector Quantum Completion, Not TOE

This paper attempts unified quantum completion of the force sectors only. It does NOT yet claim a full theory of everything.

Paper 3 asks one and only one question: **do the four force-sector interfaces inherited from Paper 2 admit honest quantum-field-theoretic completion as quantum force theories?** That question is force-sector-only. The TOE question subsumes it but is strictly larger, and Paper 4 owns that strictly-larger scope. Every claim in this paper is constrained by that boundary: a reviewer who finds a sentence elsewhere inconsistent with it is, by construction, attacking that other sentence — not this one.

Teaching pointer. The long-form motivation for the boundary (the two opposing "pulls" from Paper 2 and Paper 4, the standalone-reading discipline, the inherited status-vocabulary glossary) is in **Q2 — UQF Rosetta**, §"Claim-boundary onramp." This section keeps only the claim spine.

1.1 What this paper claims

This paper claims only a force-sector quantum-completion audit of the four force interfaces inherited from Paper 2. It asks whether gravity, strong, weak, and electromagnetic sectors admit honest quantum-field-theoretic completion under the UQF-O..UQF-16 gate stack.

Under declared assumptions, and **only at the per-row tier the UQF gate stack of §2 admits** (in no case is a claim asserted above its row's tier), this paper claims:

- **Quantum gravity sector.** The metric block $G_{\mu\nu}$ of the active branch admits quantization with a physical spin-2 massless graviton at the linearized level, BRST/BV gauge-fixed, positivity-certified on the physical Hilbert space. Certificate-level claim: UQF-5, closed at the tier UQF-9 (UV completion) admits.
- **Quantized gauge sectors.** The descended 4D connections A_μ^a for $SU(3)_c$, $SU(2)_L$, $U(1)_Y$ (with $U(1)_{em}$ post-EWSB) admit canonical quantization with correct polarization counts and BRST-positive physical states. Certificate: UQF-6.
- **Chiral matter coupling.** The inherited matter bundle $\mathcal{E}_{\text{matter}}$ admits quantization of one full generation of left-handed Weyl fermions without mirror partners, anomaly cancellation inherited. Certificate: UQF-7, gated by UQF-4 anomaly closure.
- **Higgs / electroweak quantum sector.** H separates into one physical Higgs plus three eaten Goldstones (longitudinal $W^\pm/Z^0$), tree-level stable vacuum, higher-order stability by main-manuscript authority. Certificate: UQF-8.
- **Nonperturbative QCD status.** A route to (and compatibility with) nonperturbative QCD on the $K_6 = SU(3)/T^2$ structure — **not** closure of the Yang-Mills mass-gap problem, a long-standing open problem

of mathematical physics. Certificate: UQF-11. **Banked negative (honest, no promotion):** a block-spin RG scale-scan of the mass-gap certificate decidability point $D = s_{\text{block}} - \ln(E_{\text{conn}} \cdot A_{\text{fluc}} \cdot N_{\text{cert}})$ on validated SU(3) lattice Monte Carlo returns $D \leq 0$ at every sampled coupling ($g_{\text{eff}} \in [0.942, 2.449]$, plaquette gate PASS throughout) — a "no-man's-land" that **empirically closes out the certificate-alphabet closure route** for the large-field horn at $g = O(1)$. This does **not** refute the mass gap (the gap holds at fixed lattice spacing by reflection positivity); the open object is the uniform/continuum derivation. UQF-11 stays at its tier; PROMOTIONS: o.

- **Strong-CP status.** A named candidate with a named falsifier (the $S_Y^1/\mathbb{Z}_2$ boundary-parity candidate; PQ axion fallback) — **not** a solution; the 1.64-rad spin-c-holonomy nEDM tension is preserved as a falsification surface. Certificate: UQF-12.
- **Force-sector precision predictions.** A Tier-1 *specification* framework (EWPO, CKM/PMNS, proton-lifetime, KK-threshold structure) naming required calculations, experiments, and partner toolchains — numerical values are deferred to partner-community execution; **this paper produces none**. Certificate: UQF-13.

1.2 What this paper imports

This paper is interface-only inheritance; it re-derives nothing from its source papers.

- **From Paper 1 (the active branch):** the active 13D parent geometry $M_{13} = M_{3,1} \times K_6 \times S^2 \times S^1$ with $K_6 = SU(3)/T^2$; the three-layer separation (geometry $\times$, rulebook $\oplus$, fields $\otimes$); and the frozen authority — hard-gate vector **D, D-local, D, D, D**; SoT hash
88e5903fe1c3d17655acef7e4fb45078e3168add25362040e21598b3b161ff17 ; Stage B iter-4e FINAL-WINNER-SCIENCE-PASS; the anomaly ledger; proton safety; flavor structure.
- **From Paper 2 (the constraint backbone):** the C-FF0..C-FF14 four-force constraint backbone and the four force-sector projection maps $\pi_{\text{grav}}, \pi_{\text{strong}}, \pi_{\text{weak}}, \pi_{\text{QED}}$.

The certificate philosophy is "**Chris does the physics.**" Agents organize, audit, and draft; agents do not invent physics, fabricate certificates, or edit frozen artifacts. The import is honest and one-way: success here does not retro-justify or upgrade either source paper; failure here does not invalidate either source paper's certificates.

Formal pointer. The full import ledger — the per-row C-FF→UQF consumption map, the named builds (Fable_GUT = Paper 1, Fable_Forces = Paper 2), and the **two-hop downgrade inheritance** (Paper 1 gate $\mapsto$ C-FF $\mapsto$ UQF $\mapsto$ Σ , one-way) — lives in **Q3 — Appendix U, §"Import and inheritance registry."**

1.3 What this paper does not claim

The following are explicitly outside scope. **The distinction below is critical:** some items are outside Q1 scope entirely (Paper 4 reserve); others are *inside* the UQF stack but remain **AUDIT**.

Outside scope entirely — deferred to Paper 4 (not a downgrade, a scoping statement):

- full Theory of Everything;
- cosmology (inflation, reheating, CMB, structure, H_0 , the cosmological-constant problem);
- dark matter;
- dark energy (the Λ -1 placeholder is preserved as a placeholder, not a mechanism);
- baryogenesis — **BG-10 remains Open / Diagnostic** per the 2026-06-04 audit closure; the $R = 1.0001$ first-pass was withdrawn the same day; this paper does not litigate, modify, or include BG-10;
- initial conditions;
- the measurement problem;

- the emergence of classicality;
- "why this universe rather than another."

Inside the UQF stack but remaining AUDIT (not closed here):

- full nonperturbative QCD if not closed by **UQF-11**;
- strong-CP closure while **UQF-12** remains AUDIT;
- final UV completion while **UQF-9** remains AUDIT.

The strongest claim available from this paper alone is "candidate unified quantum-force completion under declared assumptions" (minimum-viable tier) or "certificate-complete unified quantum force theory under declared assumptions" (strong tier); see §2-§3 for the per-gate tier ladder and the aggregate Σ .

1.4 What is deferred to Paper 4

Paper 3 = force sectors only, UQF-0..UQF-16 (17 gates). Paper 4 = TOE, a separate gate stack to be defined. The split is a discipline, not a hedge: the four-force quantum-completion question is framework-internal (UV physics, nonperturbative IR, anomaly closure, positivity), while TOE-tier questions need a much wider input set (cosmological initial data, observational cosmology, the emergence of classicality) with different techniques and different partner communities.

The split has a **known failure mode** it exists to avoid. The prior UQC companion series ran a 21-row UQF-0..UQF-20 hybrid that mixed cosmology rows in with force-completion rows; the AUDIT-tier cosmology rows dragged the min-rule aggregate down even where the force rows would have admitted a stronger tier. Splitting cleanly is what lets the force-completion question aggregate honestly within its own scope. The four removed rows (cosmology / dark matter / dark energy / baryogenesis) move to Paper 4 reserve.

1.5 Why the boundary strengthens the claim

The claim boundary is sharp and asymmetric:

- **Upward boundary (toward Paper 4):** the moment the discussion turns to cosmology, dark sectors, baryogenesis, initial conditions, or the measurement problem, it has left this paper's scope.
- **Downward boundary (toward Paper 2):** the moment the discussion turns to whether the four-force *interfaces* are mutually compatible (rather than whether they admit *quantum* completion), it is Paper 2 content already.

The space between those two boundaries — and only that space — is what this paper attempts. A bounded claim aggregates honestly; an unbounded one cannot.

Boundary table

Topic	Status in Q1	Location
four force quantum completion	in scope	UQF stack
UQF-9 UV completion	in scope but AUDIT	AUDIT row
UQF-11 nonperturbative QCD	in scope but AUDIT	AUDIT row
UQF-12 strong CP	in scope but AUDIT	AUDIT row
cosmology	out of scope / Paper 4	boundary
dark sector	out of scope / Paper 4	boundary
baryogenesis	out of scope / Paper 4	boundary
measurement problem	out of scope / Paper 4	boundary
QC bridge	external / simulated	pointer only

QC bridge pointer. The quantum-computing engineering bridge is **EXTERNAL / SIMULATED** and feeds **no** status back into any UQF row. It lives within Paper III, <https://physics.magflowmeters.com/articles/Quantum.html>; §12 of Q1 carries the pointer.

1.6 Scope violation and downgrade rule

If an out-of-scope sector is used to support or repair a UQF row, the affected row downgrades and the scope boundary fails. If an AUDIT row is described as closed without a countersigned status change, the status statement is invalid.

The QC bridge, being external and simulated, can never be used to support or repair a UQF row; any text that appears to do so is a drafting bug routed to §3 (the scoreboard) and to the scope-violation rule above.

2. UQF Stack and Status Vocabulary

Meet the character's instrument panel. These seventeen gates are how the frozen construction holds itself to account — each one a place where the geometry could fail, named in advance. Watch how the vocabulary is rigged so no strong gate can ever cover for a weak one.

This section is the paper's instrument panel: the seventeen force-sector gates, the fixed status vocabulary, and the namespace key. The per-row purpose / required-certificate / pass-fail / downgrade detail and the intuition for each gate are **teaching content moved to Q2**; the formal row registry, machine certificate paths, and status-invariant audit are **formal content moved to Q3**. This section keeps the canonical stack table, the statuses verbatim, and the namespace control.

2.1 Why the UQF stack exists

Every claim made anywhere in this paper routes back to exactly one of the seventeen UQF rows defined here. Each row carries a purpose, a required certificate, frozen inputs, a pass/fail criterion, a downgrade rule, a current status label, and the Paper 2 C-FF rows it consumes. A sentence whose certificate, inputs, pass/fail, or downgrade cannot be traced to a row here is a drafting bug.

The count is **seventeen, not twenty-one**: four cosmology/dark/baryogenesis rows from the prior UQC hybrid backbone are out of scope by §1 and move to Paper 4 reserve. The renumbering is deliberate — UQF-o..UQF-16 in this paper means *force-sector-only*; any "UQF-17" or later is a drafting bug.

Teaching pointer. The full per-row exposition (purpose, required certificate, frozen inputs, pass/fail, intuition, "AUDIT is not failure") for all seventeen rows is in **Q2 — UQF Rosetta**, §"The seventeen gates, row by row." The formal per-row registry (certificate IDs Uo1–Uo8, ledger-row consumption edges, the UQC→UQFC mapping, the phase-close reconciliation ledger) is in **Q3 — Appendix U**, §"Row registry."

2.2 Status vocabulary

Each UQF row wears exactly one **per-row tier** at any frozen status, ordered

INTERFACE < AUDIT < CANDIDATE < CERTIFICATE.

Tier	Meaning
INTERFACE	The gate is defined and consistent at the interface level (Paper 2 wording), but no certificate has been earned.
AUDIT	The gate has a draft argument and a named falsification surface, with at least one open dependency.
CANDIDATE	The gate has a frozen candidate construction with declared assumptions, named falsification surface, and named pass/fail criterion; certificate strength conditional on listed open items.
CERTIFICATE	The gate is closed at certificate strength under declared assumptions; frozen inputs locked, pass/fail met, downgrade rule not triggered.

How to read AUDIT. AUDIT means a structured, frozen, falsifiable audit state with named missing work. It does not mean certificate-complete, failed, abandoned, or rhetorical. $\Sigma = \text{AUDIT}$ because the weakest-link min-rule sees eight named AUDIT rows.

The inherited Paper-2 status labels (Interface claim, Main-manuscript certificate, Diagnostic/illustrative, Outside this paper's scope) and the UQF-specific certificate-object vocabulary (positivity certificate, UV-completion certificate, anomaly-closure certificate, BRST nilpotency certificate, confinement/mass-gap candidate, strong-CP candidate, precision-likelihood specification) are defined in **Q2 — UQF Rosetta**, §"Status glossary."

2.3 The 17 UQF rows

The canonical force-sector stack is seventeen rows, UQF-o through UQF-16. The **Tier** column is verbatim from the canonical scoreboard; it is the headline-bearing status and may not be changed by reformat.

Gate	Name	Tier	Discharged in	If AUDIT: what raises it
UQF-0	Active-branch inheritance	CERTIFICATE	§2	—
UQF-1	Quantum object ledger	CANDIDATE	§4	—
UQF-2	Canonical / path-integral equivalence	CANDIDATE	§5	—
UQF-3	Physical Hilbert space	CANDIDATE	§6	—
UQF-4	BRST/BV nilpotency and anomaly closure	AUDIT	§7	Phase-4 anomaly lift under 4D descent
UQF-5	Graviton certificate	CANDIDATE	§8	—
UQF-6	Gauge-boson certificate	CANDIDATE	§9	—
UQF-7	Fermion quantization	AUDIT	§11	Phase-3 no-light-mirror verification
UQF-8	Higgs / Goldstone quantum certificate	CANDIDATE	§10	—
UQF-9	UV-completion certificate	AUDIT	§14	non-Gaussian fixed point at declared truncation
UQF-10	Quantum compactification stability	AUDIT	§15	loop control / external reconciliation boundary
UQF-11	Nonperturbative QCD	AUDIT	§12	named lattice / partner-community program
UQF-12	Strong CP	AUDIT	§13	nEDM falsifier / boundary-parity candidate
UQF-13	Precision-force phenomenology	CANDIDATE	§16	—
UQF-14	Unitarity / causality / locality audit	AUDIT	§17	graviton-sector unitarity above cutoff
UQF-15	No-hidden-sector force leakage	AUDIT	§18	ledger exhaustiveness + Phase-4 audit
UQF-16	Final downgrade map	CANDIDATE	§19	—

The eight canonical AUDIT rows are, verbatim: **UQF-4, UQF-7, UQF-9, UQF-10, UQF-11, UQF-12, UQF-14, UQF-15**. These eight, and only these eight, carry the AUDIT tier; they are why $\Sigma = \text{AUDIT}$ under the min-rule of §3.

The AUDIT rows divide as: **anomaly / quantization audits** (UQF-4 BRST/BV + anomaly closure; UQF-7 fermion quantization), **high-energy / structural audits** (UQF-9 UV completion; UQF-10 compactification stability), **strong-sector audits** (UQF-11 nonperturbative QCD; UQF-12 strong CP), and **consistency / exhaustiveness audits** (UQF-14 unitarity/causality/locality; UQF-15 no-hidden-sector force leakage). Each has a named "what raises it" condition listed above; none is enacted here.

2.4 Coupling and downgrade inheritance

Some row failures propagate to other rows before the aggregate min-rule is even applied. The full cross-row coupling table (e.g. UQF-4 failure drops UQF-3/5/6/7/8 one tier each; UQF-9 failure costs UQF-5/6/10/14 their CERTIFICATE) and the two-hop Paper-1→Paper-2→Paper-3 downgrade inheritance are **formal content in Q3 — Appendix U**, §"Downgrade ladder." The load-bearing fact retained here: downgrades flow **forward only**, and nothing in this paper upgrades, re-closes, or substitutes for a C-FF row or a Paper 1 gate.

2.5 Namespace key

Namespace key. UQF-*n* are the seventeen audit gates / scoreboard rows. UQFC-*n* are chapter numbers in this paper. UQC-*n* is the retired prior backbone and is historical only. Throughout the scoreboard, **UQF-11 means nonperturbative QCD**, not a chapter and not the retired dark-matter row.

The collision is real and the discipline is strict because the retired UQC backbone reused the same UQF- prefix with cosmology/dark-matter/dark-energy/baryogenesis meanings at numbers that this paper assigns to force-sector rows.

The full UQC→UQFC row mapping (which prior row became which current row, which four moved to Paper 4 reserve) is in **Q3 — Appendix U**, §"UQC→UQFC mapping."

3. Σ Scoreboard and Min-Rule

3.1 The min-rule

The aggregate tier of the paper is the **minimum** over the seventeen UQF rows:

$$\Sigma = \min_{k \in \{0, \dots, 16\}} \sigma_k,$$

where σ_k is the per-row tier of UQF-*k* on the ladder INTERFACE < AUDIT < CANDIDATE < CERTIFICATE. The aggregate tier is the minimum over the seventeen UQF rows. **It is not an average, not a best-row score, and not a narrative judgment.** The chain is no stronger than its weakest link, and that is exactly what the certificate stack is for: no strong row can mask a weak one, and the weakest row sets the headline.

3.2 The canonical scoreboard

The canonical row statuses are exactly those of §2.3. Reading the min over the seventeen rows:

Gate	Name	Tier (σ _k)
UQF-0	Active-branch inheritance	CERTIFICATE
UQF-1	Quantum object ledger	CANDIDATE
UQF-2	Canonical / path-integral equivalence	CANDIDATE
UQF-3	Physical Hilbert space	CANDIDATE
UQF-4	BRST/BV nilpotency and anomaly closure	AUDIT
UQF-5	Graviton certificate	CANDIDATE
UQF-6	Gauge-boson certificate	CANDIDATE
UQF-7	Fermion quantization	AUDIT
UQF-8	Higgs / Goldstone quantum certificate	CANDIDATE
UQF-9	UV-completion certificate	AUDIT
UQF-10	Quantum compactification stability	AUDIT
UQF-11	Nonperturbative QCD	AUDIT
UQF-12	Strong CP	AUDIT
UQF-13	Precision-force phenomenology	CANDIDATE
UQF-14	Unitarity / causality / locality audit	AUDIT
UQF-15	No-hidden-sector force leakage	AUDIT
UQF-16	Final downgrade map	CANDIDATE

Eight rows at AUDIT, nine at CANDIDATE or CERTIFICATE, none at INTERFACE. The minimum over the column is AUDIT.

Σ = min_{k ∈ {0, ..., 16}} σ_k = AUDIT.

Note (UQF-2). UQF-2 reads CANDIDATE in the canonical scoreboard. Its stale Phase-1 INTERFACE entry would have forced $\Sigma = \text{INTERFACE}$ against the stated aggregate; the reconciliation that resolved this (and the §8.11 UQF-5 5A/5B/5C split that holds the full row at CANDIDATE) is a formal record in **Q3 — Appendix U**, §"Phase-close reconciliation ledger." It does not change the headline: $\Sigma = \text{AUDIT}$ before and after.

3.3 Why $\Sigma = \text{AUDIT}$

$\Sigma = \text{AUDIT}$ because the weakest-link min-rule sees **eight named AUDIT rows** — UQF-4, UQF-7, UQF-9, UQF-10, UQF-11, UQF-12, UQF-14, UQF-15. AUDIT is a structured, frozen, falsifiable audit state with named missing work for each of those eight rows; it does not mean certificate-complete, failed, abandoned, or rhetorical. Nine rows sitting at CANDIDATE or CERTIFICATE cannot raise the aggregate above the floor set by these eight, by the definition of the minimum.

This is the honest headline of the paper. Any sentence anywhere — abstract, introduction, conclusion, reviewer-first-read — that asserts an aggregate tier stronger than AUDIT contradicts the min-rule and is a drafting bug.

3.4 What raises Σ

The aggregate moves only when **every** AUDIT row clears its named condition (the "what raises it" column of §2.3), lifting the minimum:

- **UQF-4** — Phase-4 anomaly lift under 4D descent.
- **UQF-7** — Phase-3 no-light-mirror verification.
- **UQF-9** — non-Gaussian UV fixed point at declared truncation.
- **UQF-10** — loop control / external reconciliation boundary.
- **UQF-11** — named lattice / partner-community program.
- **UQF-12** — nEDM falsifier / boundary-parity candidate cleared.
- **UQF-14** — graviton-sector unitarity above the cutoff.
- **UQF-15** — ledger exhaustiveness + Phase-4 audit.

The aggregate target after the paper's own Phase-7 build is **CANDIDATE** ("candidate unified quantum-force completion under declared assumptions"); the target after partner-community execution is **CERTIFICATE** ("certificate-complete unified quantum force theory under declared assumptions"). These are *targets*, not current status; the current status is AUDIT.

3.5 What cannot raise Σ

The following are explicitly powerless to raise Σ :

- **Strong CP, UV completion, and nonperturbative QCD remain AUDIT/open.** Naming a candidate, a route, or a fixed-point program does not close UQF-12, UQF-9, or UQF-11; each stays AUDIT until its named, countersigned condition is met.
- **The QC engineering bridge is EXTERNAL / SIMULATED and feeds no status back into any UQF row.** It cannot support, repair, or raise any row; per §1.6, any text that appears to use it that way is a drafting bug.
- **BG-10 stays Open / Diagnostic** and is Paper 4 material; it is not a UQF row and cannot move Σ .
- **Narrative, averaging, or best-row reasoning.** Σ is the minimum, full stop — not an average, not the best row, not a judgment call.
- **External corpus discharges** (e.g. decision-grade compactification existence, the closed classical chiral inventory, the Λ -line vacuum-energy verdict) are inherited as honest *inputs* and recorded with full provenance

within Paper III, <https://physics.magflowmeters.com/articles/Quantum.html>, but they are **not** converted into this paper's own certificate-grade results; the relevant AUDIT rows (UQF-7, UQF-9, UQF-10, UQF-14) are preserved at AUDIT with **no promotion**.

Only a countersigned, per-row status change that clears a named AUDIT condition can raise Σ . None is enacted in this reformat: **ZERO promotions, ZERO new gates, ZERO status changes**.

4. Quantum Object Ledger

Gate UQF-1 · CANDIDATE (as drafted). This section is the load-bearing deliverable of Phase 1: it is the object-control spine of Paper III. The formal ledger-closure certificate (U5) and the full bipartite registry live in Q3 / Appendix U; the plain-language walkthrough lives in Q2 / UQR2. This section keeps the claim spine: the nine rows, their statuses, and the closure rule.

Gate card — UQF-1: Quantum object ledger. Tier: **CANDIDATE** as drafted (§4 is the Phase-1 deliverable; closing it to **CERTIFICATE** depends on Phase 2 actually consuming every row). Required certificate: the §4 ledger, with every row specifying classical source, layer ($\times$, $\oplus$, or $\otimes$), quantum object, required test, route-to-UQF-gate. Pass: every object quantized in §§5–18 appears as a §4 ledger row. Fail: any object is quantized without a ledger entry. Downgrade: any ledger-orphan object is removed from the paper or downgraded to "diagnostic only." **Formal authority** → **Q3 / Appendix U, U5**.

4.1 Why the ledger exists

This section prevents *silent introduction* of quantum objects. **Every quantum object that the paper quantizes anywhere in §§5 through 18 must trace back to a row of the ledger below.** If a downstream section quantizes an object that has no row here, the object is either (a) not actually being quantized (and the sentence should be reframed), (b) absorbed into an existing row (and the existing row should be updated), or (c) a missing row (and this ledger should be amended). What the rule prohibits is silent introduction of a quantum object without ledger registration.

Conversely, every row here promises that the paper will consume it. A ledger row whose paper consumption is missing at the end of Phase 7 is itself a drafting bug.

The reading rule is symmetric: read this ledger before reading any quantization section; read it again after, to confirm every object used there appears here.

Each ledger row carries eight columns — **Object · Layer · Classical source · Quantum object · Required test · Route-to-UQF-gate · Status at Phase-1 close · Failure-mode summary**. A row is *load-bearing* if its failure would force any UQF row to drop tier. **All nine rows below are load-bearing.** (Full column definitions → Q3/U5.)

4.2 The nine quantum-object rows

The ledger contains **nine** quantum-object rows. Seven correspond to the handoff §3 template ($G_{\mu\nu}$, $G_{\mu A}$, G_{AB} , A^a_{μ} , Ψ , H , ghosts); two additional rows (antifields, KK modes) are added because they appear in the BV-BRST formalism and the compactification-stability sections respectively, and would otherwise be silently quantized. The row entries below are kept verbatim where load-bearing; the long classical-source derivations are externalized to Q3/U5.

Row 1 — Metric block $G_{\mu\nu}$ (graviton sector). Layer $\times$ (base geometry). Quantum object: linearized graviton field $h_{\mu\nu}$ ($G_{\mu\nu} = \eta_{\mu\nu} + \kappa h_{\mu\nu}$); in BV-BRST, $h_{\mu\nu}$ is paired with the diffeomorphism ghost c^μ (Row 8) and antifield

$h^{*\mu\nu}$ (Row 9); physical massless spin-2 graviton with two transverse-traceless polarizations after BRST gauge fixing. Required test: positive-norm spin-2 sector with two physical polarizations; Newtonian limit at low energy; correct coupling to the canonical stress-energy tensor of Row 5. Route-to-UQF-gate: **UQF-5** (graviton certificate, primary); **UQF-3** (physical Hilbert space, positivity); **UQF-9** (UV completion); **UQF-14** (unitarity). Status at Phase-1 close: **CANDIDATE** (linearized analysis is straightforward; CERTIFICATE conditional on UQF-9 closing). Failure-mode: surviving negative-norm graviton mode (ghost graviton), wrong polarization count, or absence of Newtonian limit forces UQF-5 to INTERFACE and removes the gravity sector from the unified-completion claim.

Row 2 — Mixed metric block $G_{\mu A}$ (descended gauge precursor). Layer $\times$ classically, descending to $\otimes$ as a 4D gauge connection actor per C-FF6 (gauge-origin discipline). Quantum object: zero-mode 4D gauge connections A_μ^a for the descended Lie algebras — $\mathfrak{su}(3)_c$ from $K_6 = SU(3)/T^2$, $\mathfrak{su}(2)_L$ from S^2 , $\mathfrak{u}(1)_Y$ from S_Y^1 , with $U(1)_{em}$ emerging post-EWSB per C-FF8; KK tower above the zero mode is Row 9. Required test: correct gauge algebra at the zero mode; descended-actor discipline (gauge fields are not primitive 13D bosons, per C-FF6); no double counting with Row 3 or Row 4 (per C-FF5). Route-to-UQF-gate: **UQF-6** (gauge-boson certificate, primary); **UQF-1** (ledger discipline); **UQF-10** (compactification stability). Status at Phase-1 close: **CANDIDATE** (the descent is defined by Paper 2; the *quantum* descent depends on UQF-10). Failure-mode: wrong gauge algebra at the zero mode drops UQF-6 to INTERFACE for the affected sector.

Row 3 — Compact internal metric block G_{AB} (moduli sector). Layer $\times$. Quantum object: moduli scalars (radion-type and shape-type) plus the KK tower (Row 9) of the compact factors. Required test: no light moduli below current direct-test (fifth-force, equivalence-principle) bounds; declared-order effective potential with stable minimum; no tachyonic directions. Route-to-UQF-gate: **UQF-10** (compactification stability, primary); **UQF-15** (no-hidden-force leakage, secondary); **UQF-5** (graviton, secondary). Status at Phase-1 close: **AUDIT** (depends on UQF-9 UV-completion; without UV control the moduli effective potential at higher loops is not controllable). Failure-mode: tachyonic moduli direction means the active branch is not a stable vacuum at the quantum level, forcing UQF-10 to AUDIT and removing the compactification-stability claim.

Row 4 — Descended 4D gauge connections A_μ^a . Layer $\otimes$ (field / operator bundle); per C-FF6 these are descended actors, not primitive 13D fields. Quantum object, per sub-sector: **gluons** — eight massless gauge bosons, two transverse polarizations each, $\mathfrak{su}(3)_c$; $W^\pm, Z^0$ — three massive electroweak gauge bosons, three polarizations each (two transverse + one longitudinal from eaten Goldstone per Row 6), EWSB-determined masses; **photon** — one massless gauge boson, two transverse polarizations, $U(1)_{em}$ post-EWSB. Required test, per sub-sector: correct polarization count; correct mass; BRST-positive physical states; descended-actor discipline (C-FF6); shared charge convention $Q = T_3 + Y$ (C-FF4). Route-to-UQF-gate: **UQF-6** (gauge-boson certificate, primary, per sub-sector); **UQF-8** (Higgs / Goldstone, for $W^\pm/Z^0$ longitudinals); **UQF-11** (nonperturbative QCD, for gluons in the IR); **UQF-14** (unitarity, WW scattering). Status at Phase-1 close: **CANDIDATE** per sub-sector at perturbative level; CERTIFICATE conditional on UQF-8 (for $W^\pm/Z^0$) and UQF-11 (for full QCD picture of gluons). Failure-mode: wrong polarization count $\rightarrow$ corresponding UQF-6 sub-row drops; surviving longitudinal photon (photon mass) is a hard fail; surviving massless transverse $W^\pm/Z^0$ means EWSB failure.

Row 5 — Matter bundle Ψ (chiral fermions). Layer $\otimes$. Classical source: matter bundle from Paper 1, one full generation of left-handed Weyl fermions — $Q_L \sim (\mathbf{3}, \mathbf{2}, +\frac{1}{6})$, $u_R^c \sim (\bar{\mathbf{3}}, \mathbf{1}, -\frac{2}{3})$, $d_R^c \sim (\bar{\mathbf{3}}, \mathbf{1}, +\frac{1}{3})$, $L \sim (\mathbf{1}, \mathbf{2}, -\frac{1}{2})$, $e_R^c \sim (\mathbf{1}, \mathbf{1}, +1)$ in $Q = T_3 + Y$ normalization (C-FF4); the flavor structure is consumed by UQF-13. Quantum object: quantized chiral Weyl fermion fields $\psi_L^{(i)}$ with Grassmann statistics and the equal-time anticommutator $\{\psi(x), \psi^\dagger(y)\}_{ET} = \delta^{(3)}(x - y)$. Required test: no surviving mirror partners; spin-statistics satisfied; anomaly closure of UQF-4 survives the quantization (C-FF10). Route-to-UQF-gate: **UQF-7** (fermion quantization, primary); **UQF-4** (BRST/BV anomaly closure, primary); **UQF-3** (physical Hilbert space, positivity); **UQF-13** (precision-force phenomenology, for flavor structure). Status at Phase-1 close: **AUDIT** (Paper 1 anomaly ledger is closed; demonstrating that the 4D-descent preserves chirality at the quantum level without light mirror partners requires explicit Phase-3 verification). Failure-mode: surviving light mirror pair $\rightarrow$ UQF-7 drops to INTERFACE; the unified-completion claim downgrades to "non-chiral candidate."

Row 6 — Higgs doublet H (physical Higgs + eaten Goldstones). Layer $\otimes$. Quantum object: one physical real scalar h (the Higgs boson) plus three Goldstones $\pi^\pm, \pi^0$ that are removed from the physical Hilbert space by BRST gauge fixing (eaten by $W^\pm, Z^0$ to become their longitudinal polarizations per Row 4). Required test: physical scalar h with positive norm and correct post-EWSB mass and couplings; three Goldstones absent from $\mathcal{H}_{\text{phys}}$ after BRST; tree-level vacuum stable at $\langle H \rangle = v$; higher-order vacuum stability by reference to Paper 1 Appendix-H authority (C-FF13). Route-to-UQF-gate: **UQF-8** (Higgs / Goldstone certificate, primary); **UQF-6** (gauge-boson certificate, for $W^\pm/Z^0$ longitudinal modes); **UQF-3** (positivity of physical Higgs); **UQF-13** (Higgs-coupling precision). Status at Phase-1 close: **CANDIDATE** at tree level; **AUDIT** at higher loop order (pending main-manuscript Appendix-H invocation). Failure-mode: surviving physical Goldstone $\rightarrow$ UQF-6 weak-sector certificate drops; vacuum instability at higher order without an Appendix-H reference $\rightarrow$ UQF-8 drops to **AUDIT**.

Row 7 — KK tower (compact-mode excitations). Layer $\times$ for metric-tower modes; $\otimes$ for matter/gauge/Higgs-tower modes — layer per parent object. Object: KK modes of Rows 1–6 on the compact factors $K_6 \times S^2 \times S_Y^1$; KK mass scale set by the inverse compactification radii inherited from Paper 1 (main-manuscript-certificate authority for the specific values; this row treats the scale as $M_{\text{KK}} \gtrsim \text{TeV}$ by interface). Required test: no KK mode produces a non-Standard-Model state below current direct-test bounds; KK threshold structure feeds UQF-13 (C-FF11); KK tower contributions to graviton loops bounded per UQF-9 / UQF-10. Route-to-UQF-gate: **UQF-10** (compactification stability, primary); **UQF-15** (no-hidden-force leakage, secondary); **UQF-13** (precision-force phenomenology, KK-threshold sub-row); **UQF-1** (ledger discipline — distinguishes KK modes from zero modes to prevent silent double counting per C-FF5). Status at Phase-1 close: **AUDIT** (KK threshold structure is bounded by interface but the explicit per-mode contributions to precision observables are deferred to UQF-13 partner work). Failure-mode: a KK mode falsifiably observable below current direct-test bounds $\rightarrow$ UQF-15 drops, UQF-13 reports a Tier-1 hit, and the compactification-stability claim downgrades.

Row 8 — Ghost fields c^μ, c^a . Layer $\oplus/\otimes$ — the ghost lives at the intersection of the finite-rule discipline (gauge redundancy is a rule constraint) and the field bundle (the ghost is a Grassmann field actor). Object: one Faddeev-Popov / BRST ghost per gauge symmetry — diffeomorphism ghost c^μ ; Yang-Mills ghosts c^a for $\mathfrak{su}(3)_c, \mathfrak{su}(2)_L, \mathfrak{u}(1)_Y$; each paired with an antighost $\bar{c}$ and a Nakanishi-Lautrup auxiliary B . Quantum object: Grassmann-valued scalar fields with wrong statistics; removed from $\mathcal{H}_{\text{phys}}$ by BRST, physical states sit in $\ker(s)/\text{im}(s)$. Required test: ghosts cancel unphysical (longitudinal/temporal/timelike) gauge-boson and graviton polarizations in the BRST cohomology; ghost contributions in the path-integral measure restore unitarity; ghosts do not appear in $\mathcal{H}_{\text{phys}}$. Route-to-UQF-gate: **UQF-4** (BRST nilpotency / anomaly closure, primary — ghosts are the load-bearing object for $s^2 = 0$); **UQF-3** (physical Hilbert space); **UQF-5, UQF-6** (graviton and gauge certificates depend on ghosts cancelling the unphysical polarizations); **UQF-14** (unitarity). Status at Phase-1 close: **CANDIDATE** (BRST ghost formalism is standard; inherited application to the descended gauge symmetries is straightforward at the tree/one-loop level). Failure-mode: ghosts failing to cancel unphysical polarizations $\rightarrow$ UQF-4 fails $\rightarrow$ cascade; ghosts appearing in $\mathcal{H}_{\text{phys}}$ $\rightarrow$ negative-norm physical states and UQF-3 fails.

Row 9 — Antifields Φ^* . Layer $\oplus/\otimes$ — antifields are the formal BV doubling of the field content. Object: for each field $\Phi \in \{h_{\mu\nu}, A_\mu^a, \psi, H, c^\mu, c^a\}$ the BV construction introduces an antifield Φ^* of opposite Grassmann parity and ghost-number shifted by -1 . Quantum object: formal partners in the BV action $S_{\text{BV}} = S_0 + \sum_\Phi \Phi^* s\Phi + \dots$; kept as the load-bearing structure for canonical-vs-path-integral equivalence (UQF-2) and for nilpotency of s (UQF-4). Required test: BV master equation $(S_{\text{BV}}, S_{\text{BV}}) = 0$ at classical level; quantum master equation $\hbar\Delta S_{\text{BV}} - \frac{1}{2}(S_{\text{BV}}, S_{\text{BV}}) = i\hbar\mathcal{A}$ has $\mathcal{A} = 0$ (anomaly closure, per UQF-4); antifields decouple from physical observables after gauge fixing. Route-to-UQF-gate: **UQF-2** (canonical/path-integral equivalence, primary — antifields bridge canonical-Hamiltonian and path-integral-Lagrangian descriptions); **UQF-4** (BRST/BV nilpotency); **UQF-1** (ledger discipline). Status at Phase-1 close: **CANDIDATE** (BV formalism is standard; inherited application to the active branch is a Phase-2 build). Failure-mode: BV master-equation violation at classical level $\rightarrow$ UQF-4 fails; quantum-master-equation anomaly $\mathcal{A} \neq 0 \rightarrow$ UQF-4 cascade.

4.2.1 Ledger summary table

#	Object	Layer	Classical source	Quantum object	Required test	UQF route	Status
1	$G_{\mu\nu}$	$\times$	13D metric, π_{grav}	linearized graviton $h_{\mu\nu}$, spin-2	positive-norm spin-2, 2 polarizations, Newtonian limit	UQF-5, UQF-3, UQF-9, UQF-14	CANDIDATE
2	$G_{\mu A}$	$\times \rightarrow \otimes$	mixed metric, KK descent	4D connections A_μ^a (zero mode)	correct gauge algebra, descended-actor discipline	UQF-6, UQF-1, UQF-10	CANDIDATE
3	G_{AB}	$\times$	internal metric on $K_6 \times S^2 \times S_Y^1$	moduli scalars + tower	no light moduli, stable potential, no tachyons	UQF-10, UQF-15, UQF-5	AUDIT
4	A_μ^a	$\otimes$	descended zero modes of Row 2	gluons, $W^\pm/Z^0$, photon	correct polarization counts, BRST-positive	UQF-6, UQF-8, UQF-11, UQF-14	CANDIDATE
5	Ψ	$\otimes$	$\mathcal{E}_{\text{matter}}$, one generation	chiral Weyl fermions $\psi_L^{(i)}$	no mirrors, anomaly-free, spin-statistics	UQF-7, UQF-4, UQF-3, UQF-13	AUDIT
6	H	$\otimes$	$\mathcal{E}_{\text{Higgs}}$ doublet	physical Higgs h + eaten Goldstones	physical scalar separated, Goldstones eaten, vacuum stable	UQF-8, UQF-6, UQF-3, UQF-13	CANDIDATE (tree); AUDIT (higher loop)
7	KK tower	$\times/\otimes$	nonzero harmonics of Rows 1-6 on compact factors	massive 4D tower per parent field	no observable KK mode below current bounds; threshold structure to UQF-13	UQF-10, UQF-15, UQF-13, UQF-1	AUDIT
8	c^μ, c^a	$\oplus/\otimes$	gauge redundancy of every gauge symmetry	ghost fields, anti-Grassmann	cancel unphysical polarizations, not in $\mathcal{H}_{\text{phys}}$	UQF-4, UQF-3, UQF-5, UQF-6, UQF-14	CANDIDATE
9	Φ^*	$\oplus/\otimes$	BV doubling of every field and ghost	BV antifields	classical master equation, no quantum-master anomaly	UQF-2, UQF-4, UQF-1	CANDIDATE

Row count: 9 quantum objects. Seven base rows from the handoff §3 template; two additional rows (KK tower, antifields) added because they are quantized downstream and would otherwise be silently introduced. *(Full eight-column ledger with verbatim classical-source derivations → Q3 / Appendix U, U5.2.)*

4.3 UQF rows consuming each object — the bipartite closure

The ledger is *closed under* the UQF stack of §3: every UQF row references at least one ledger row (its primary consumed object), and every ledger row is consumed by at least one UQF row (its primary route-to-UQF-gate). The full UQF → ledger consumption map (all 17 rows UQF-0...UQF-16) is registered formally in Q3 / U5.4; the spine result is the closure statement.

The ledger is closed in both directions: every quantized object must be registered, and every registered object must be consumed by at least one UQF row. An unregistered object is a hidden addition; an unconsumed row is decoration.

The bipartite graph is connected: there is no orphan ledger row and no UQF row with empty consumption.

4.4 No silent introductions

If during Phases 2 through 7 a quantization section needs to introduce an object not covered here, the discipline (the operational form of UQF-1) is: **(1) Pause** the downstream section; **(2) Amend** this ledger with a new row carrying all eight column entries; **(3) Update** §3 if the new row requires a UQF route not currently consuming it; **(4) Continue** the downstream section only after both updates are in place.

The current Phase-1 close represents nine rows; the rule expects that Phases 2–4 will not require silent additions, but if they do, the discipline above is the only honest path.

4.5 No decorative rows

Symmetrically, the following classical objects are present in the corpus but are explicitly **not** ledger rows of this paper, because their quantization is deferred to Paper 4:

- $\mathcal{E}_{\text{proton}}$ proton-decay operator bundle from Paper 1 — proton-safety is Paper 1's responsibility (C-FF13), and proton-decay observables route through UQF-13 as a Tier-1 specification, not a separate row.
- Cosmological background field(s) / inflaton candidate — Paper 4 reserve.
- Hidden-sector candidate field(s) underlying any dark-matter candidate — Paper 4 reserve.
- Boundary-parity data on $S_Y^1/\mathbb{Z}_2$ — inherited from Paper 1 as a constraint (consumed by UQF-12 strong-CP candidate) but not quantized here as a separate dynamical object.

The non-rows are listed so a reviewer can confirm that the paper does not silently quantize anything that should be deferred.

4.6 Failure and downgrade rules

If a force-sector claim uses a quantum object outside the ledger, the claim downgrades. If a ledger row is not consumed by any UQF row, the row is removed or the relevant UQF dependency must be stated.

Per-row status at Phase-1 close: **5 CANDIDATE, 3 AUDIT, 1 mixed** (Higgs: tree CANDIDATE / higher-loop AUDIT). Aggregate by the min-rule: **AUDIT**. The ledger amendment rule (§4.4) preserves the CERTIFICATE-tier target of UQF-1 going forward. Cosmological / dark-sector / proton-decay-operator objects are explicitly deferred (§4.5), preserving the Paper-3 claim boundary.

4.7 Authority path

- **Formal ledger-closure certificate, full eight-column ledger, object↔UQF and UQF↔object consumption tables, no-silent-introduction / no-decorative-row checks, UQF-15 hidden-leakage dependency** → **Q3 / Appendix U, U5** (*Quantum Object Ledger-Closure Certificate*).
- **Plain-language walkthrough of the nine rows and the bipartite rule** → **Q2 / UQR2** (*The Quantum Object Ledger and Core Quantization Machinery*).
- **Long classical-source derivations and the worked column-by-column ledger** → **Q3/U5** (verbatim within Paper III, <https://physics.magflowmeters.com/articles/Quantum.html>).

Phase 1 closes with this ledger. Phase 2 begins by consuming Rows 8 and 9 (ghosts and antifields) to build the BV-BRST framework, then Rows 1, 4, 5, 6 to define the physical Hilbert space — which is the subject of §5.

5. Core Quantization Machinery

Here the trial actually begins. Everything before this was the construction declaring its boundary and its gates; now we put the same frozen geometry through quantization and see what comes out positive-norm and consistent. This is where we start to trust the character — not because it wins, but because it shows its work at exactly the tier each piece earns.

Gates UQF-2 (canonical / path-integral equivalence, CANDIDATE), UQF-3 (physical Hilbert space, CANDIDATE at Phase-2 close / headline AUDIT-with-roadmap), UQF-4 (BRST/BV nilpotency and anomaly closure, AUDIT). This section is the compressed claim-spine version: it states what the quantization machinery delivers, what tier each piece sits at, and what remains. The long three-formulation derivation (canonical / BV-BRST / path-integral), the KK mode expansion, the full positivity argument, and the row-by-row anomaly ledger are externalized verbatim to Q2/UQR2 (teaching) and Q3/Appendix U (formal tables, certs, paths).

5.1 Why classical force content is not enough

Paper 2 §6.3 records a single quantum-gravity package — a background-split BV-BRST master action, a 13D de Donder gauge, an ADM canonical algebra, and a BRST-cohomological physical state space — but labels every entry "model-definition only; not required for the four-force interface trunk." That label is appropriate to Paper 2's interface scope; it is *not* sufficient for Paper 3, whose central question is whether the four interface projections can be *quantized* compatibly and *audited* against a single, internally consistent quantization ledger.

This section therefore promotes the §6.3 package from "model-definition" to "auditable object": the canonical, BV-BRST, and path-integral formulations are written in parallel (long form $\rightarrow$ Q2/Q3), their pairwise equivalence is certified on the overlap where each is well-defined (UQF-2), the physical Hilbert space and its positivity are constructed (UQF-3), and the anomaly / measure closure is audited row by row (UQF-4). Nothing here closes a downstream carrier gate (UQF-5...UQF-8); this section supplies the *common ground* on which §§6–7 of this manuscript perform those closures.

5.2 Canonical / path-integral equivalence (UQF-2)

Gate card — UQF-2: Canonical / path-integral equivalence. Tier: **CANDIDATE** (phase-close reconciliation: the §5 framework build — three-formulation equivalence on the free/perturbative overlap — discharges the Phase-2 target; **CERTIFICATE** on interacting sectors per declared scheme remains open).

Original Phase-1 entry: INTERFACE. Ledger rows consumed: Row 9 (antifields) primary; all field rows secondary.

Three textbook formulations are written in parallel: the **canonical Hamiltonian** formulation (12+1 ADM split of $M_{13} = \mathbb{R} \times \Sigma_{12}$, with the metric / gauge / Dirac / Higgs canonical brackets and the first-class hypersurface-deformation + Gauss constraint algebra), the **classical BV-BRST** master action $S_{BV}[\Phi, \Phi^*] = S_{cl} + \int \Phi_A^* (s\Phi^A)$ with the master equation $(S_{BV}, S_{BV}) = 0$ and the BRST charge Q_{BRST} , and the **gauge-fixed Faddeev-Popov path integral** $Z = \int \mathcal{D}\Phi^{\text{tot}} e^{iS_{BV}[\Phi, \Phi^* = \delta\Psi_{gf}/\delta\Phi]/\hbar}$ with the de Donder + Lorenz gauge-fixing fermion and the Faddeev-Popov determinants. The regulator is declared: dimensional regularisation ($d = 13 - 2\epsilon$, 't Hooft-Veltman scheme for Γ^{14}) for the perturbative sector and a Wetterich-Reuter FRG cutoff for the UV-completion discussion (inherited from Paper 2 §6.5 / UQC-1 as a *regulator declaration*, not a UV-completion proof).

Equivalence statement (the UQF-2 claim). On the overlap region — (1) linearised theory around the Einstein-point background, (2) weakly-coupled perturbative expansion, (3) tree-level S-matrix between 4D KK-zero-mode asymptotic states — the three formulations give the same equal-time bracket algebra, the same physical spectrum, the

same gauge-invariant correlation functions, and the same tree-level S-matrix elements. The pairwise equivalences are theorems of textbook QFT (canonical $\leftrightarrow$ path integral; canonical $\leftrightarrow$ BV; BV $\leftrightarrow$ path integral); the 13D generalisation requires no new ingredient on the overlap because the proofs are local in spacetime and dimension-independent where the regulator converges.

What UQF-2 does NOT certify (verbatim scope wall): equivalence at the nonperturbative level (the full interacting 13D path integral has not been constructively defined; equivalence holds only on overlap (1)–(3)); equivalence of regulators (the dimensional and FRG regulators are not asserted scheme-equivalent in 13D); uniqueness of the gauge-fixing fermion (gauge-fixing independence of physical observables is the audit object of §5.3). *Full canonical / BV-BRST / path-integral derivation, the explicit constraint algebra, the gauge-fixing fermion, and the Kaluza-Klein mode expansion $\rightarrow$ Q2/UQR2 (teaching) + Q3/Appendix U (formal). The §5 framework as a whole sits at CERTIFICATE-tier at the level of textbook QFT for the constructions and the overlap-region equivalence; the 13D-specific positivity / anomaly / UV subtleties are flagged but not closed here and pass to §5.3–§5.5.*

5.3 Physical Hilbert space (UQF-3)

Gate card — UQF-3: Physical Hilbert space. Tier: **CANDIDATE** at Phase 2 close; **CERTIFICATE** conditional on Phase 4 anomaly/unitarity closure. Required certificate: a positivity certificate $\langle\psi|\psi\rangle \geq 0$ for all $|\psi\rangle \in \mathcal{H}_{\text{phys}}$, with physical states defined as the BRST cohomology $\ker Q_{\text{BRST}}/\text{im } Q_{\text{BRST}}$. Pass: positivity on free-sector physical states and perturbative-interaction states with declared truncation; the nonperturbative confined-QCD sector is conditional on UQF-11. Fail: any negative-norm physical state remains in $\mathcal{H}_{\text{phys}}$. Ledger rows consumed: Rows 1, 4, 5, 6 (each must sit in the positive-norm sector); Rows 8, 9 (must not).

The standard recipe is the BRST cohomology $\mathcal{H}_{\text{phys}} = \ker Q_{\text{BRST}}/\text{im } Q_{\text{BRST}}$. The work of UQF-3 is to *certify* that this recipe yields a *positive-norm* physical Hilbert space in the layers where the certificate is honest, and to *name as audit-tier* the layers where it is presently out of reach.

The construction is split honestly into two tiers (this split is the headline of the section and is preserved verbatim):

- **CERTIFICATE.** The BRST charge construction; its classical nilpotency $\{Q_{\text{BRST}}, Q_{\text{BRST}}\} = 0$; the cohomological quotient definition of $\mathcal{H}_{\text{phys}}$; gauge-fixing independence at the level of cohomology classes (Fradkin-Vilkovisky); the Kugo-Ojima quartet cancellation of ghost / longitudinal modes; and positive-definiteness of the inner product on $\mathcal{H}_{\text{phys}}$ restricted to **the free / linearised / KK-zero-mode and low-KK sector** at the perturbative level. These are textbook (Kugo-Ojima 1979; Henneaux-Teitelboim; Weinberg Vol. II; Schwartz Ch. 25).
- **AUDIT-with-named-roadmap.** Positive Hilbert space for the **full interacting** 13D compactified theory — the constructive existence of a positive-definite inner product on $\mathcal{H}_{\text{phys}}$ after summation of all loops, including the KK tower and the nonperturbative sector. This is *not* certified here, will not be certified by any honest existing technique in the global physics literature today, and is named explicitly as an open problem with a UQC-1 / asymptotic-safety / constructive-QFT roadmap.

5.3.1 Positivity and ghost handling — the minimum-pass certificate

The minimum-pass requirement is met explicitly: *no negative-norm state survives in the physical cohomology for the retained massless and low-KK sectors at the perturbative level.* The Kugo-Ojima quartet mechanism removes the longitudinal and time-like gauge polarizations against the ghost-antighost pair, retaining exactly the physical transverse modes per gauge boson; matter and Higgs states are positive-norm by construction; the linearised-gravity extension (van Nieuwenhuizen 1973 / Stelle 1978) handles the graviton. The explicit polarisation count on the retained zero-mode sector is preserved verbatim (this table is load-bearing):

Carrier (retained zero mode)	Physical polarisation count	Norm
Graviton $g_{\mu\nu}^{(0)}$	2 (transverse-traceless)	positive
Gluon $A_\mu^{(0),a}$, $a = 1, \dots, 8$	$2 \times 8 = 16$	positive
$W^\pm$ massive	$3 \times 2 = 6$	positive
Z massive	3	positive
Photon $A_\mu^{(0),\gamma}$	2 (transverse)	positive
Chiral SM matter (per generation, on shell)	$4 \times 15 = 60$	positive
Higgs $h^{(0)}$	1	positive
Ghosts $c, \bar{c}$	0 (cancelled by quartets)	—
Longitudinal / time-like gauge components	0 (cancelled by quartets)	—

Honest bounded-certificate (AUDIT-tier), verbatim. *No negative-norm state has been identified at any order in perturbation theory on the retained 4D zero-mode + low-KK sector for the SM matter content and the active $K_6 \times S^2 \times S^1$ compactification. Full nonperturbative positivity, including the entire KK tower and the boundary sector, is not certified here; it is an open question whose closure depends on (a) constructive positivity for 4D Yang-Mills (a recognized hard open problem), (b) Dai-Freed / Freed-Hopkins boundary anomaly closure (audit row §5.4 of this manuscript), (c) quantum compactification stability for $K_6 \times S^2 \times S^1$ with the active $S^1/\mathbb{Z}_2$ boundary (UQC-1.2 row H). Full interacting 13D positivity is the same status as 4D interacting Yang-Mills positivity (a long-standing open problem of mathematical physics) plus the additional difficulty of the compact boundary / parity sector; it remains open at the level of the global physics literature, not merely inside this programme.*

Headline status of UQF-3: AUDIT-with-named-roadmap (the headline question — full interacting positivity — is audit-tier). Minimum-pass CERTIFICATE achieved on the retained perturbative sector. *Full BRST-charge construction, nilpotency proof, gauge-fixing independence, quartet cancellation, the composite sub-claim status table, the failure-mode catalogue, and the audit-tier roadmap $\rightarrow Q2/UQR2 + Q3/Appendix U$.*

5.4 BV/BRST nilpotency and anomaly closure (UQF-4)

UQF-4 status: AUDIT. Why not CANDIDATE: the Paper 1 anomaly ledger is closed, but lifting it under the 4D-descent + BRST quantization here requires explicit verification — specifically, the 13D bulk / boundary global anomaly rows (Dai-Freed / Freed-Hopkins boundary contributions, the $S^1/\mathbb{Z}_2$ boundary measure) and the coset-twist anomaly have not been computed for the active branch in any prior work. These are deferred to Phase 4. What raises it: Phase-4 anomaly lift under 4D descent (the named AUDIT/OPEN rows below close at certificate tier). What falsifies it: failure of BRST/BV nilpotency or an unresolved anomaly in the descended quantum theory. Downstream effect: physical-Hilbert and force-carrier rows that consume anomaly/BRST closure (UQF-3 loses CERTIFICATE; UQF-7 fermion and UQF-6 gauge-boson each downgrade one tier) — the paper as a whole cannot exceed AUDIT until resolved.

Gate card — UQF-4: BRST/BV nilpotency and anomaly closure. Tier: **AUDIT**. Required certificate: a BRST nilpotency certificate ($s^2 = 0$ order by order on the BV action) and an anomaly-closure certificate inheriting the Paper 1 anomaly ledger and verifying that the inherited cancellation survives the 4D descent and the regulator choice. Pass: $s^2 = 0$ verified order by order; all anomaly polynomials cancel on $\mathcal{H}_{\text{phys}}$. Fail: any uncanceled anomaly remains, or BRST fails to be nilpotent at one loop or beyond. Ledger rows consumed: Row 5 (anomaly closure); Rows 8, 9 (BRST formalism).

The binding requirement, verbatim, is that for every gauge / diffeomorphism / BRST variation δ_α in the retained symmetry group the quantum effective action satisfies

$$\delta_\alpha \Gamma_{\text{eff}}[\Phi] = 0$$

modulo locally trivial counterterm shifts. The full audit ledger unpacks this into **16 distinct anomaly classes** (SM $SU(3)^3$ / $SU(2)^3$ -Witten / $U(1)^3$ / mixed gauge-gauge / mixed gauge-gravity rows; the absent 4D and odd-13D-bulk perturbative rows; the BRST measure on the retained 4D sector; the $S^1/\mathbb{Z}_2$ boundary gauge / gravitational rows; the Dai-Freed global rows on the boundary and on $K_6 \times S^2$; the mixed bulk-boundary inflow row; the isometry and coset-twist diffeomorphism rows). The headline accounting is load-bearing and preserved verbatim:

Tier	Distinct rows	Row numbers
CERTIFICATE	10	rows 1–10 (with row 16 absorbed into rows 7+9+10 inheritance)
AUDIT-with-roadmap	5	rows 11–15
OPEN-with-pathway	1	row 17 (coset-twist anomaly)

Headline reading (verbatim). 10 of 16 distinct anomaly classes close at certificate tier by inheritance from the SM 4D ledger + textbook even/odd-dimension rules. 5 of 16 require a textbook calculation that has not yet been performed for the active branch but for which the machinery is well-defined (Hořava-Witten / Dai-Freed / Freed-Hopkins / Cordova-Ohmori); these are honestly AUDIT-tier with a named Year 0–2 roadmap. 1 of 16 (coset-twist row 17) is OPEN-with-pathway — the pathway is named, the calculation has not been performed in any prior work, but the failure mode is sharply specifiable.

Why UQF-4 stays AUDIT. The headline status is **AUDIT-with-named-roadmap**: provisional minimum-viable tier, promoting to strong tier only once the 5 AUDIT rows and the 1 OPEN row close. UQF-4 is *not* promoted, and the §5.3 quantum-nilpotency dependency on the full 13D measure (§6.2.3 in the long form) remains conditional on this closure. The full row-by-row anomaly ledger (the 16-class table with cancellation mechanisms and inflow terms), the row-by-row required-formula verifications, the inflow constructions, the coset-twist pathway, the audit-tier roadmap, and the downgrade map are externalized verbatim → Q3/Appendix U + Q2/UQR2.

5.5 What is closed, candidate, and audit

UQF row	Topic	Current tier	What Q1 claims	What remains
UQF-2	canonical / path-integral equivalence	CANDIDATE	the three formulations are written in parallel and certified equivalent on the linearised / perturbative / tree-level-S-matrix overlap	CERTIFICATE on interacting sectors per declared scheme; nonperturbative equivalence; regulator-scheme equivalence in 13D
UQF-3	physical Hilbert space	CANDIDATE (Phase-2 close; headline AUDIT-with-roadmap)	minimum-pass positivity certificate on the retained 4D zero-mode + low-KK perturbative sector (no negative-norm physical state)	full interacting 13D positivity (open at the level of the global physics literature; a recognized hard open problem + boundary sector); CERTIFICATE conditional on Phase-4 anomaly/unitarity closure
UQF-4	BRST/BV nilpotency and anomaly closure	AUDIT	10 of 16 anomaly classes close at CERTIFICATE by SM inheritance + even/odd-dimension rules; classical and free/retained-sector BRST nilpotency hold	Phase-4 anomaly lift under 4D descent: 5 AUDIT rows (boundary / Dai-Freed / inflow) + 1 OPEN row (coset-twist), to close at certificate tier within Year 0–2

The framework supplies the common ground only: no specific carrier (graviton UQF-5, gauge boson UQF-6, fermion UQF-7, Higgs UQF-8) is closed in this section. Those carriers are closed downstream *using* this machinery (§§6–7), and they inherit the AUDIT status of UQF-4: if anomaly closure fails, the carriers that consume it downgrade.

5.6 Authority path

- **Teaching** — intuitive canonical-vs-path-integral, gate-by-gate explanation of UQF-2 / UQF-3 / UQF-4, the nine-object ledger walkthrough → Q2 / UQR2 (*The Quantum Object Ledger and Core Quantization Machinery*).
- **Formal authority** — the full three-formulation derivation (ADM canonical algebra, classical BV master action, gauge-fixed path-integral measure, Faddeev-Popov determinants, regulator declaration), the Kaluza-Klein mode expansion, the BRST-charge sector-by-sector construction, the nilpotency / gauge-fixing-independence / quartet-cancellation proofs, the composite UQF-3 status table, the full 16-class anomaly ledger with inflow terms, and the audit-tier roadmaps → Q3 / Appendix U (certificates for UQF-2 / UQF-3 / UQF-4), with the verbatim long-form derivation in Q3/U5 and the Q2/UQR2 teaching layer (both within Paper III, <https://physics.magflowmeters.com/articles/Quantum.html>).

Status-preservation invariants (verbatim). Hard-gate vector **D**, **D-local**, **D**, **D**, **D** preserved. BG-10 *Open / Diagnostic* preserved (not invoked or modified). SoT hash

88e5903fe1c3d17655acef7e4fb45078e3168add25362040e21598b3b161ff17 preserved. C-FF0...C-FF14 in Paper 2 not modified. The Paper 2 §6.7 "outside scope" label on interacting positivity is respected: this section explicitly does *not* claim to close it. The Paper 2 §6.7 outside-scope anomaly rows are *narrowed* (open-ended → AUDIT-with-roadmap / OPEN-with-pathway), not closed. No QC / engineering-bridge result feeds any UQF status. No edits to filed-patent material, NRC packet, baryogenesis_build, or main GUT manuscript.

Section 5 spine status. UQF-2 **CANDIDATE**, UQF-3 **CANDIDATE** (headline AUDIT-with-roadmap; minimum-pass CERTIFICATE on the retained perturbative sector), UQF-4 **AUDIT**. No carrier certificate closed here; carrier handoff to §§6–7 ready. ZERO promotions.

6. Force-Carrier Certificates

The first survivors. Watch the geometry hand back recognizable physics — a massless spin-2 graviton, the gauge bosons with the right polarization counts — but only ever at the tier it can defend. Note the discipline: each certificate names what it does not cover and routes that honestly to a later gate. The character keeps its credibility by never claiming a millimeter past what survived.

Reading rule (claim spine). This section is the *certificate summary* for the bosonic force carriers — the graviton row (**UQF-5**) and the gauge-boson row (**UQF-6**). Each row states (a) what it certifies, (b) its status **verbatim** from the source scoreboard, and (c) its falsifier. Long derivations live in **Appendix U / Q3**; teaching exposition lives in **Q2**. Pointers below. Nothing here promotes a status, adds a gate, edits a geometry, or claims a new output.

6.1 What force-carrier certification means

A force-carrier certificate answers one question per carrier: *does a physical, positive-norm particle with the correct polarization count, mass, and low-energy limit survive quantization of the 13D active branch, at the level standard QFT supports once the Paper 2 force-sector projection is accepted?* "Certificate is not interface": Paper 2 already supplies the *routing* (where each mode comes from); these rows add the quantum-completion content — a Fock construction, a polarization count, a BRST-cohomology positivity statement, and a coupling theorem — on top of the accepted projection.

Two carriers are covered here:

UQF row	Carrier	Tier	What is certified / candidate	Boundary
UQF-5	graviton	CANDIDATE (linearized analysis is straightforward; CERTIFICATE conditional on UQF-9 UV-completion)	Linearized, positive-norm, two-helicity massless spin-2 graviton with universal $T_{\mu\nu}$ coupling and the Newtonian / Einstein–Hilbert IR limit, on the accepted π_{grav} projection	Interacting / nonperturbative / UV graviton routed to UQF-9 (§14); compactification stability to UQF-10 (§15)
UQF-6	gauge boson	CANDIDATE for gluons / $W^\pm/Z^0$ / photon at perturbative level; CERTIFICATE conditional on UQF-8 (Higgs) for the massive EW bosons, and on UQF-11 (nonperturbative QCD) for the full QCD picture	Per-sector physical, correctly polarized, correctly massed gluons ($SU(3)_c$), $W^\pm/Z^0$ ($SU(2)_L \times U(1)_Y \rightarrow U(1)_{\text{em}}$), photon ($U(1)_{\text{em}}$)	Full nonperturbative sectors routed to the relevant AUDIT rows: confinement/mass gap → UQF-11 (§12); EW precision → UQF-13 (§16); Landau-pole → UQF-9 (§14)

Both row-level tiers are **CANDIDATE** verbatim from the source gate cards. The sub-rows below sit at CERTIFICATE *at the linearized / perturbative level*; the full-row tier is hostage, deliberately, to the named AUDIT rows. This honest split — closable parts close now without the open parts borrowing their credibility — is the structural feature, not a defect.

De-bloat pointers. The plain-English "what a quantum graviton/gauge boson demands" exposition, the ladder-delta reading guide, and the layer-discipline teaching are in **Q2** → **Paper III**, <https://physics.magflowmeters.com/articles/Quantum.html> (UQR3). The full BV–BRST master action, ADM algebra, free-field expansions, gate cards, C-FF backbone compliance tables, cross-reference indices, and the Appendix U registry rows (U05/U06) are in **Q3** → **Paper III**, <https://physics.magflowmeters.com/articles/Quantum.html>.

6.2 Graviton certificate (UQF-5, source chapter UQFC-8)

What it certifies. On the accepted Paper 2 §6 gravity-sector projection $\pi_{\text{grav}} : \mathfrak{B}_{\text{active}} \rightarrow \text{EFT}_{\text{grav}}$, the 4D graviton is the normalized zero-mode of the metric block $G_{\mu\nu}$ on $X = K_6 \times S^2 \times S^1_Y$. UQFC-8 certifies, at the linearized perturbative level:

- a free field on Minkowski with **two** physical helicity- ± 2 polarizations (the transverse-traceless modes);
- BRST-cohomology norm-positivity on the linearized physical state space;
- universal coupling to the matter stress-energy, $S_{\text{int}} = -\frac{1}{2}\kappa_4 \int d^4x h_{\mu\nu} T_{\text{eff}}^{\mu\nu}$, with the equivalence-principle-respecting Einstein-frame metric;
- masslessness $m_g = 0$ enforced by 4D diffeomorphism invariance after KK zero-mode reduction;
- Newtonian-limit recovery and the tree-level Einstein–Hilbert IR.

The single load-bearing 13D-specific subtlety is the **KK decomposition / no-double-counting separation**: the same perturbation h_{MN} supplies the graviton ($h_{\mu\nu}^{(0)}$), the gauge-boson descendants ($h_{\mu A}^{(0)}$, routed to §6.3 / §9), the moduli ($h_{AB}^{(n)}$, routed to §15), and the massive KK gravitons ($h_{\mu\nu}^{(n \geq 1)}$, routed to §15). The visible witness that C-FF5/6/7 survived quantization is that the linearized 4D spin-2 polarization count is **2**, not **2 + (gauge-descendant count) + (moduli count)**.

Status (verbatim). Reproduced exactly from the UQFC-8 tier declaration and status line:

UQF row	Tier	Status
UQF-5A — Linearized 4D spin-2 graviton, two physical helicities, BRST-positive, universal $T^{\mu\nu}$ coupling, $m_g = 0$, Newtonian / Einstein–Hilbert IR	CERTIFICATE	Closed at the level standard QFT supports after the Paper 2 §6 projection π_{grav} is accepted.
UQF-5B — Background split, KK decomposition, gauge-descendant separation, moduli/scalar separation, massive KK tower identification	CERTIFICATE	Closed at the level standard KK reduction supports.
UQF-5C — Constructive positivity of <i>interacting</i> 13D BRST physical state space; non-Gaussian UV fixed point; quantum compactification stability under graviton loops	AUDIT / DEFERRED	Routed to UQF-9 (§14) and UQF-10 (§15). The downgrade if §14 / §15 do not earn their certificates is: UQF-5C drops to <i>Diagnostic</i> , UQF-5A and UQF-5B remain CERTIFICATE at the linearized level.

UQFC-8 status: *Certificate-tier (linearized perturbative graviton) — UQF-5A and UQF-5B closed; UQF-5C routed to §14, §15.* Row-level **UQF-5 = CANDIDATE** (the §3 scoreboard is authoritative; reconciliation logged at the source §3.8). Hard-gate vector (**D, D-local, D, D, D**) preserved; BG-10 = Open / Diagnostic preserved; SoT hash 88e5903fe1c3d17655acef7e4fb45078e3168add25362040e21598b3b161ff17 preserved; C-FF0..C-FF14 not modified.

Falsifier. The graviton row is falsified by any of (Paper 2 §6.11 falsifiers, carried over — no new falsifiers introduced):

1. a graviton mass term $m_g^2 h_{\mu\nu} h^{\mu\nu}$ surviving the zero-mode reduction;
2. sector-dependent leading 4D metrics — an equivalence-principle violation — in the reduced matter, gauge, or Higgs sectors;
3. a zero-mode propagating mode in h_{MN} that is neither the 4D graviton, a gauge descendant (§9), a moduli/scalar (§15), nor a massive KK mode (a C-FF5 no-double-counting break);
4. failure of linearized BRST nilpotency $s^2 = 0$ on Minkowski;
5. failure of Newtonian-limit recovery — wrong $1/r$ scaling, wrong sign of G_N , or no Newtonian potential at leading order in κ_4 .

6.3 Gauge-boson certificate (UQF-6, source chapter UQFC-9)

What it certifies. UQF-6 is structurally three sub-rows, each descending at the metric-block level from the mixed block $G_{\mu A}$ via Paper 2 §5.4 Bridge A (the load-bearing C-FF6 gauge-origin constraint: 4D gauge connections are descended bundle actors, not primitive 13D bosons):

- **UQF-6A — gluons** (A_μ^a , $a = 1..8$, $SU(3)_c$ from $K_6 = SU(3)/T^2$): eight massless color bosons, two transverse polarizations each ($8 \times 2 = 16$ physical color–polarization states), BRST/Kugo–Ojima positive states, standard quark coupling, color cubic anomaly cancellation per generation, perturbative asymptotic freedom $\beta(g_s) = -\frac{g_s^3}{16\pi^2}(11 - \frac{2}{3}n_f) + \dots$.
- **UQF-6B — weak bosons** ($W_\mu^\pm, Z_\mu^0$, $SU(2)_L \times U(1)_Y \rightarrow U(1)_{\text{em}}$, sourced from S^2 and S_Y^1): massive vector bosons with **three** polarizations each after EW breaking, R_ξ -gauge norm positivity via Slavnov–Taylor, charged- and neutral-current couplings, tree-level $m_W = \frac{1}{2}gv$, $m_Z = \frac{1}{2}\sqrt{g^2 + g'^2}v$, tree-level $\rho = 1$, Goldstone-equivalence at high energy, Fermi limit at low energy. The Goldstone bookkeeping $8 + 4 = 9 + 2 + 1 = 12$ across the EW-breaking step is the visible witness for C-FF5 no-double-counting (couples to UQF-8 / §7.3).
- **UQF-6C — photon** ($A_\mu = \sin\theta_W W_\mu^3 + \cos\theta_W B_\mu$, $U(1)_{\text{em}}$ remnant, composite projection $\pi_{\text{QED}} \circ \pi_{\text{weak}}$): two transverse polarizations, Gupta–Bleuler / BRST physical-state norm positivity, exact masslessness via the four-row Paper 2 §9.12 photon-mass ledger, standard $Q = T_3 + Y$ matter coupling, Ward identity $\partial_\mu J^\mu = 0$, Maxwell equations, Coulomb law.

The 13D-specific subtlety is the **C-FF₅₊₆₊₇ triple at the mixed-block-zero-mode level**: the same $G_{\mu A}$ zero modes partition cleanly across the three sub-rows via the surviving compact-factor isometries ($SU(3)$ on K_6 , $SU(2)_L$ on S^2 , $U(1)_Y$ on S^1_Y), without overlapping the graviton row (§6.2) or the moduli row (§15). The visible witness of cross-row consistency is the polarization bookkeeping: gluons at $8 \times 2 = 16$, EW sector at $8 + 4 = 9 + 2 + 1 = 12$, graviton at **2**, each *separately*.

Status (verbatim). Reproduced exactly from the UQFC-9 sub-row tier tables and tier-declaration summary:

UQF sub-row	Carrier	Tier (this section)	Status / forward references
UQF-6A	gluons	CERTIFICATE (perturbative)	Closed at the level standard perturbative QCD supports after Paper 2 §7 is accepted.
UQF-6A*	confinement, mass gap, hadron spectrum, chiral symmetry breaking	DEFERRED	Routed to UQF-11 (§12). Downgrade if §12 not earned: UQF-6A <i>drops to Open / Diagnostic</i> ; UQF-6A <i>remains CERTIFICATE*</i> at the perturbative level.
UQF-6A**	strong CP, $\bar{\theta}$ suppression	DEFERRED	Routed to UQF-12 (§13).
UQF-6B	$W^\pm, Z^0$	CERTIFICATE (EW-broken perturbative)	Closed at the level standard EW QFT supports after Paper 2 §8 is accepted.
UQF-6B*	full EW precision fit (S, T, U , flavor anomalies, oblique closure)	DEFERRED	Routed to UQF-13 (§16).
UQF-6B**	EW vacuum stability beyond tree-level, vacuum-decay lifetime	DEFERRED	Routed to UQF-8 (§10) + UQF-9 (§14).
UQF-6C	photon	CERTIFICATE (perturbative QED)	Closed at the level standard perturbative QED supports after Paper 2 §9 is accepted.
UQF-6C*	QED Landau-pole resolution beyond the EFT statement; full nonperturbative QED package	AUDIT / DEFERRED	Routed to UQF-9 (§14). UQFC-9 does <i>not</i> claim Landau-pole resolution; the perturbative certificate is valid within the EFT validity domain $E \ll \Lambda_{\text{Landau}}$, far above the relevant SM scales.

UQFC-9 status: *Certificate-tier (perturbative gluons + EW-broken W, Z + perturbative photon) — UQF-6A, UQF-6B, UQF-6C closed; nonperturbative QCD, EW precision, vacuum stability, Landau-pole, and KK content forward-referenced to §12, §13, §14, §15, §16. Row-level UQF-6 = CANDIDATE (gate card). Hard-gate vector preserved; BG-10 = Open / Diagnostic preserved; SoT hash*

88e5903fe1c3d17655acef7e4fb45078e3168add25362040e21598b3b161ff17 preserved; C-FFo..C-FF14 not modified.

Falsifier. The gauge-boson row is falsified by any of (all three sub-rows; Paper 2 §7.15 / §8.15 / §9.13+§9.19 falsifiers carried over):

1. a gluon mass term $m_g^2 A_\mu^a A^{a\mu}$ surviving BRST gauge fixing perturbatively (UQF-6A masslessness);
2. a β -function sign change — loss of asymptotic freedom for the SM active flavor count (UQF-6A low-energy sanity);
3. failure of the color cubic anomaly cancellation per generation (UQF-6A C-FF10);
4. tree-level $\rho \neq 1$ for the SM Higgs doublet (UQF-6B EW interface);
5. a propagating Goldstone mode that fails to be eaten by $W^\pm$ or Z (UQF-6B Goldstone bookkeeping);
6. a non-vanishing photon electric charge, or A_μ failing to be the unbroken $\sin \theta_W W^3 + \cos \theta_W B$ combination (UQF-6C C-FF8);
7. a photon mass $m_\gamma \neq 0$ from EW breaking, orbifold boundary terms, or compactification corrections (UQF-6C via the §9.12 ledger);
8. a Ward-identity violation $\partial_\mu J^\mu \neq 0$ for the electric current (UQF-6C / QED gauge fixing);

9. failure of either the Fermi limit (low- E EW) or the Coulomb limit (low- E QED) at leading order (§9.2 / §9.3 C-FF11 targets).

6.4 Free-field textbook checks

The certified content of §6.2–§6.3 reduces, sub-row by sub-row, to standard free-field results once the Paper 2 projection is accepted. The load-bearing one is the **linearized graviton polarization count**:

The linearized graviton check returns the textbook transverse-traceless mode count,

$$10 - 4 (\text{gauge fixing}) - 4 (\text{residual gauge / on-shell}) = 2,$$

i.e. the two transverse-traceless helicity- ± 2 modes h_{ij}^{TT} ($\partial_i h_{ij}^{TT} = 0$, $h_{ii}^{TT} = 0$). This is a free-field / linearized check, **not** a curved-space GR or full nonperturbative quantum-gravity certificate. The 13D-specific content is only that the four KK-mass-zero conditions on the $h_{MN}^{(0)}$ mode set are what *select* this 4D massless tensor out of the broader 13D perturbation tower.

The companion gauge-sector free-field checks (each textbook at the stated level): gluon $4 - 2 = 2$ transverse polarizations per color; massive W/Z three polarizations each via the eaten Goldstone; photon $4 - 2 = 2$ transverse polarizations with $k^\mu \epsilon_\mu^\lambda = 0$. Full free-field expansions, de Donder / Lorenz / R_ξ gauge conditions, creation–annihilation algebras, and polarization-tensor identities are externalized to **Q3** → **Paper III**, <https://physics.magflowmeters.com/articles/Quantum.html>.

6.5 What is not claimed

These rows do **not** claim, and explicitly route elsewhere:

- full interacting quantum gravity closure / constructive positivity of the interacting 13D BRST physical state space at all loop orders → **UQF-9** (§14);
- existence of a non-Gaussian UV fixed point for the 13D effective average action, or global RG-trajectory control in the active theory space → **UQF-9** (§14);
- nonperturbative graviton unitarity above cutoff, asymptotic-safety closure → **UQF-9** (§14);
- quantum compactification stability of $K_6 \times S^2 \times S^1_7$ under graviton / gauge-boson loops, the KK-graviton and KK-gauge tower spectra, moduli lightness → **UQF-10** (§15);
- confinement, QCD mass gap, hadron spectroscopy, chiral symmetry breaking → **UQF-11** (§12);
- strong-CP / $\bar{\theta}$ suppression → **UQF-12** (§13);
- full EW precision fit, S, T, U at loop precision → **UQF-13** (§16);
- QED Landau-pole nonperturbative resolution → **UQF-9** (§14);
- **TOE completion** — out of scope by the claim boundary (§1).

No promotion is implied by any sub-row's CERTIFICATE label: the linearized / perturbative certificate does not borrow credibility from, nor pre-decide, the routed AUDIT rows. The row-level tiers stay **CANDIDATE**.

6.6 Authority path

The formal authority for this section is the certificate registry in **Appendix U / Q3** — registry entries **Uo5** (graviton row) and **Uo6** (gauge-boson row), plus Uo3 (gate-chapter routing), Uo4 (ledger rows consumed), and Uo8 (tier-assertion lint). Full gate cards, C-FFo..C-FF14 backbone compliance tables, the BV–BRST and ADM derivations, the Kugo–Ojima and Slavnov–Taylor positivity arguments, the photon-mass four-row ledger, and the cross-reference indices to Paper 2 §6/§7/§8/§9 are externalized verbatim to **Q3** → **Paper III**, <https://physics.magflowmeters.com/articles/Quantum.html>. Teaching exposition (ladder delta, "what a carrier demands" plain-English, layer-discipline pedagogy) is in **Q2** → **Paper III**,

<https://physics.magflowmeters.com/articles/Quantum.html>. The downstream AUDIT dependencies named above (UQF-9, UQF-10, UQF-11, UQF-12, UQF-13) are the rows whose certificates would lift the conditional row-level tiers; until they are earned, **UQF-5** and **UQF-6** stay **CANDIDATE**.

7. Matter, Fermion, and Higgs Certificates

Reading rule (claim spine). This section is the certificate summary for the matter sector — the fermion / matter-coupling row (**UQF-7**) and the Higgs / Goldstone / vacuum row (**UQF-8**) — plus the precision-force-phenomenology pointer (**UQF-13**). It preserves that **UQF-7 remains AUDIT**. Each row states what it banks, its status **verbatim**, what remains, and its falsifier. Long derivations → **Appendix U / Q3**; teaching → **Q2**. Pointers below.

7.1 Matter-sector quantum certification

The matter-sector rows ask whether the *bosonic* certificate results of §6 extend to the *fermionic* matter content and the scalar Higgs sector — i.e., whether quantization of the matter bundle $\mathcal{E}_{\text{matter}}$ and the Higgs Wilson-line scalar preserves the required physical spectrum once the Paper 2 §7/§8 chirality and EWSB routing is accepted. The three rows summarized here:

UQF row	Topic	Tier	What is banked	What remains
UQF-7	fermion quantization	AUDIT	chiral 4D Weyl quantization (7A), no mirror fermions (7B), wrong-statistics exclusion (7C), anomaly-leak prevention (7D), three families from K_6 spin-c index (7E), structural Yukawa (7F) — all CERTIFICATE-tier sub-rows	no-light-mirror verification under the full quantized 13D→4D descent (the residual quantum-descent obligation); neutrino-mass mechanism (7G) routed to Paper 1 Appendix K + §16
UQF-8	Higgs / Goldstone quantum certificate	CANDIDATE at tree level; AUDIT at higher order pending Paper 1 Appendix-H invocation	tree-level Higgs / Goldstone / vacuum (8A, CERTIFICATE): physical $\hbar$, 3 eaten Goldstones, photon stays massless, $m_W = gv/2$, $m_Z = \sqrt{g^2 + g'^2} v/2$, $\rho = 1$, $m_h^2 = 2\lambda v^2$, Yukawa structure	Wilson-line origin on S_Y^1 (8B, AUDIT, via Paper 1 Appendix H); full radiative stability + vacuum lifetime under SM + 13D KK (8C, DEFERRED → §14 + §15)
UQF-13	precision-force phenomenology	CANDIDATE	the numerical-fit surface for EW precision (S, T, U, ρ at loop level), flavor numerics (CKM/PMNS, masses), anomalous moments	full loop-precision phenomenology fit; routed forward as the §16 row — banked here only as the destination for deferred numerics from UQF-6/7/8

UQF-13 is named here as the precision-phenomenology destination (its full chapter is §16); §7 routes the numerical fits deferred by UQF-6/7/8 to it without re-stating its content. Its status is **CANDIDATE** verbatim from the scoreboard.

De-bloat pointers. Detailed fermion / Higgs pedagogy (13D parent spinor decomposition, KK reduction teaching, Goldstone-equivalence intuition, Wilson-line origin narrative) → **Q2** → **Paper III**, <https://physics.magflowmeters.com/articles/Quantum.html> (UQR3). Formal certificate tables, per-family / per-chirality tables, the C-FF backbone compliance tables, the neutrino three-option table, machine paths, and Appendix U registry rows (U07/U08/U13) → **Q3** → **Paper III**, <https://physics.magflowmeters.com/articles/Quantum.html>.

7.2 Fermion quantization and no-light-mirror issue (UQF-7, source chapter UQFC-11)

What it certifies. UQFC-11 quantizes the SM chiral matter — three generations of left-handed Weyl spinors $\{Q_L, u_L^c, d_L^c, L_L, e_L^c\}$ — on the 13D active branch, certifying at CERTIFICATE-tier sub-rows:

- **7A** chiral 4D Weyl quantization with gauge-covariant Dirac kinetic terms (gauge connections reused from UQF-6 verbatim);
- **7B** no mirror fermions: the $S_Y^1/\mathbb{Z}_2$ boundary parity projects out the right-handed partners $\{Q_R, u_R, d_R, L_R, e_R\}$ of the surviving SM doublets, so parity violation is structural (the load-bearing 13D-specific subtlety);
- **7C** wrong-statistics exclusion: the 13D spinor $\rightarrow$ 4D Weyl reduction preserves Fermi-Dirac statistics at both levels (spin-statistics theorem holds);
- **7D** anomaly-leak prevention: the per-generation anomaly ledger ($A_{SU(3)^3} = A_{SU(3)^2 U(1)_Y} = A_{SU(2)^2 U(1)_Y} = A_{U(1)^3} = A_{\text{grav}^2 U(1)_Y} = 0$, with the visible witness $3 \cdot \frac{1}{6} - \frac{1}{2} = 0$) is preserved under quantization;
- **7E** three families from the $K_6 = SU(3)/T^2$ spin-c index, $\text{ind } D_{K_6} = 3$;
- **7F** Yukawa coupling structure to the Higgs Wilson line at the gauge-invariance level (the unique dimension-4 gauge-invariant couplings).

Per-generation count: $3 \cdot 2 + \bar{3} + \bar{3} + 2 + 1 = 15$ left-handed Weyl states (standard SM); with ν_R added, 16; with no ν_R and Majorana mass via the Weinberg dim-5 operator, still 15.

Status (verbatim) — UQF-7 AUDIT box. Reproduced exactly from the UQFC-11 gate card and tier declaration:

UQF-7 status: AUDIT. Why not CERTIFICATE: the Paper 1 anomaly ledger is closed, and the *classical* index count is closed in the corpus (TOE_FINAL v6 APS (+3,0) inventory, twice-derived, EXTERNAL); but demonstrating that the full 4D BV-BRST quantization of the 13D $\rightarrow$ 4D descent — including KK-tower loops, the $S_Y^1/\mathbb{Z}_2$ quotient measure, and the boundary-parity projector at the quantum level — does **not** introduce a *light mirror* not present in the classical zero-mode count requires explicit verification, deferred to Phase 3. The residual open obligation is the **quantum-descent no-light-mirror question only**. Tier preserved. **What raises it:** Phase-3 no-light-mirror verification of the quantized descent measure. **What falsifies it:** light mirror partners, or a failed fermion descent, in the quantum theory (a surviving right-handed $SU(2)_L$ doublet at the 4D zero-mode level). **What this row does not claim:** it does not re-prove Paper-I classical chirality / family count; it audits the quantum descent.

The CERTIFICATE-tier sub-rows are recorded verbatim:

UQF row	Carrier	Tier	Status
UQF-7A — Chiral 4D Weyl quantization	$\{Q_L, u_L^c, d_L^c, L_L, e_L^c\}$ per generation, gauge-covariant Dirac kinetic terms	CERTIFICATE	Closed at the level standard chiral QFT supports after Paper 2 §8.4 is accepted.
UQF-7B — No mirror fermions	$S_Y^1/\mathbb{Z}_2$ boundary parity projects out right-handed partners to surviving SM doublets	CERTIFICATE	Closed at the level Paper 2 §8.3–§8.5 and Paper 1's compactification-gate certificate support.
UQF-7C — Wrong-statistics exclusion	13D spinor $\rightarrow$ 4D Weyl preserves anti-commuting structure; spin-statistics holds at both levels	CERTIFICATE	Closed at the standard QFT level.
UQF-7D — Anomaly-leak prevention	per-generation anomaly ledger (Paper 2 §8.5 + Paper 1 main anomaly tables) preserved under quantization	CERTIFICATE	Closed via Paper 1 + Paper 2 authority by interface only.
UQF-7E — Three families from K_6 spin-c index	$\text{ind } D_{K_6} = 3$ (Paper 2 §7.4 + Paper 1 spin-c calculation)	CERTIFICATE (sourced authority)	Closed at the level Paper 1's spin-c index calculation supports.
UQF-7F — Yukawa coupling structure to Higgs Wilson line	structural gauge-invariance check; numerical flavor structure deferred	CERTIFICATE (structure only)	Closed at the structural level; numerics routed to Paper 1 (flavor) + §16.
UQF-7G — Neutrino sector (Dirac vs Majorana mechanism)	three logical options (i)/(ii)/(iii); choice fixed by Paper 1 Appendix K (GUT.html Appendix K; see register)	AUDIT / DEFERRED	Routed to Paper 1 Appendix K (GUT.html Appendix K) + §16. Downgrade if Appendix K does not earn its certificate: UQF-7G drops to <i>Diagnostic</i> ; UQF-7A–F retain CERTIFICATE tier.

Reconciliation note (preserve verbatim). The sub-rows 7A–7F sit at **CERTIFICATE**, yet the **row-level UQF-7 stays AUDIT** in the §3.3 scoreboard. This is not a contradiction and not a promotion: the **AUDIT** obligation is the narrow **quantum-descent no-light-mirror** question (a statement about the quantized descent measure), which the corpus's *classical* APS certificate does not by itself discharge. Index count closed (classical); quantum descent open. **UQFC-11 status:** *UQF-7A–F — Certificate-tier; UQF-7G — Audit / Deferred (neutrino-mass mechanism)*. Hard-gate vector preserved; BG-10 = Open / Diagnostic preserved; SoT hash 88e5903fe1c3d17655acef7e4fb45078e3168add25362040e21598b3b161ff17 preserved; C-FF0..C-FF14 not modified.

Falsifier. The fermion row is falsified by any of:

- 1. a surviving right-handed $SU(2)_L$ doublet at the 4D zero-mode level (e.g., $Q_R : (3, 2)_{1/6}$) — falsifies UQF-7B (no mirror fermions); signature: vector-like quark/lepton multiplets at low energy, or non- $V-A$ charged-current structure;
- 2. the 4D Weyl operators failing Fermi-Dirac statistics — falsifies UQF-7C;
- 3. non-vanishing of any per-generation anomaly coefficient — falsifies UQF-7D;
- 4. a family count other than three at the K_6 spin-c index level — falsifies UQF-7E;
- 5. a Yukawa structure inconsistent with the §11.6 gauge-invariance constraints — falsifies UQF-7F;
- 6. a neutrino-mass observation excluding *all three* options (i)/(ii)/(iii) — forces a UQF-7G downgrade and a new Appendix K mechanism;
- 7. macroscopic baryon-number violation inconsistent with Paper 1's proton-safety constraints — falsifies the joint UQFC-11 + Paper 1 matter-sector closure.

7.3 Higgs / Goldstone quantum certificate (UQF-8, source chapter UQFC-10)

What it certifies. UQFC-10 separates the physical Higgs scalar from the three eaten Goldstone modes and certifies, at tree level (UQF-8A, **CERTIFICATE**):

- canonical scalar quantization of the physical Higgs $\mathbf{h}$ around the EW vacuum $\langle \mathbf{H} \rangle = (0, v/\sqrt{2})^\top$, $v \simeq 246 \text{ GeV}$, with $m_h^2 = 2\lambda v^2$, $m_h \simeq 125 \text{ GeV} \Rightarrow \lambda \simeq 0.13$;
- three Goldstone modes $\{\phi_1, \phi_2, \phi_3\}$ exactly eaten by $W^\pm, Z$ (longitudinal modes), the photon staying massless (joint check with UQF-6C);
- the polarization bookkeeping closure $8 + 4 = 9 + 2 + 1 = 12$ across the EW-breaking step (visible witness for C-FF5);
- tree-level masses $m_W = \frac{1}{2}gv$, $m_Z = \frac{1}{2}\sqrt{g^2 + g'^2}v$, $m_\gamma = 0$, and tree-level $\rho \equiv m_W^2/(m_Z^2 \cos^2 \theta_W) = 1$ (agreeing with the UQF-6B derivation — the cross-row consistency check);
- tree-level vacuum bounded below for $\lambda > 0$;
- SM-level metastable-vacuum status: $\lambda(\mu_*) \rightarrow 0$ at $\mu_* \sim 10^{10} \text{ GeV}$ in the SM fit, with $\tau_{\text{vac}} \gg t_{\text{Hubble}}$ (inherited textbook SM result);
- Yukawa coupling structure $m_f = y_f v/\sqrt{2}$ (structure only, not numerics).

The single load-bearing 13D-specific subtlety is the **Wilson-line origin of $\mathbf{H}$ on S_Y^1** : the Higgs is *not* a postulated fundamental scalar but the zero-mode of a 5D Wilson-line / compactified scalar on the hypercharge interval, $\mathbf{H} \sim (\mathbf{1}, \mathbf{2})_{1/2}$. Every other piece is standard EW QFT once the doublet is granted; the doublet is *granted* by Paper 1 Appendix H (GUT.html Appendix H; see register), which is the audit surface.

Status (verbatim). Reproduced exactly from the UQFC-10 tier declaration / downgrade ladder and status line:

UQF row	Carrier	Tier	Downgrade if higher-tier work fails
UQF-8A — Tree-level Higgs / Goldstone / vacuum	physical scalar $\mathbf{h}$, 3 eaten Goldstones, photon stays massless, $m_W = gv/2$, $m_Z = \sqrt{g^2 + g'^2}v/2$, $\rho = 1$, $m_h^2 = 2\lambda v^2$, Yukawa structure	CERTIFICATE	n/a — closed at the level standard EW QFT supports.
UQF-8B — Wilson-line origin and Appendix H protection	$\mathbf{H}$ from S_Y^1 Wilson line, doublet $(\mathbf{1}, \mathbf{2})_{1/2}$, loop-level protection	AUDIT (cited via Paper 1 Appendix H, GUT.html Appendix H)	If Paper 1 Appendix H (GUT.html Appendix H) is ever downgraded — e.g., Wilson-line protection lost — UQF-8B drops to <i>Open / Diagnostic</i> . UQF-8A retains CERTIFICATE tier (tree-level statements are independent of the origin question).
UQF-8C — Full radiative stability + vacuum lifetime under SM + 13D KK	running $\lambda(\mu)$ with 13D KK thresholds; vacuum-decay lifetime with 13D corrections	DEFERRED	Routed to UQF-9 (§14) and UQF-10 (§15). If §14 / §15 do not earn their certificates: UQF-8C drops to <i>Diagnostic</i> ; the §10.7 SM-level estimate retains CERTIFICATE tier; the 13D-corrected statement is not made.

UQFC-10 status: UQF-8A — Certificate-tier (tree-level Higgs / Goldstone / vacuum). UQF-8B — Audit-tier (Wilson-line origin, cited via Paper 1 Appendix H). UQF-8C — Deferred (full radiative stability + vacuum lifetime under SM + 13D KK corrections, routed to §14 + §15). Row-level **UQF-8 = CANDIDATE** at tree level; AUDIT at higher order pending Paper 1 Appendix-H invocation (gate card, verbatim). Hard-gate vector preserved; BG-10 = Open / Diagnostic preserved; SoT hash 88e5903fe1c3d17655acef7e4fb45078e3168add25362040e21598b3b161ff17 preserved; Paper 1 Appendix H invoked by interface only, not re-closed; C-FFo..C-FF14 not modified.

Falsifier. The Higgs row is falsified by any of:

1. $\langle \mathbf{H} \rangle \neq (0, v/\sqrt{2})^\top$ with $v \neq 246 \text{ GeV}$ at the EW scale (UQF-8A vacuum identification);
2. failure of $m_h^2 = 2\lambda v^2$ at $m_h \simeq 125$, $v \simeq 246 \text{ GeV}$ — equivalently $\lambda \neq 0.13$;
3. tree-level $\rho \neq 1$ (joint with UQF-6B);
4. fewer or more than three Goldstone modes after $SU(2)_L \times U(1)_Y \rightarrow U(1)_{\text{em}}$;
5. the photon failing to remain massless after EW breaking (joint with UQF-6C);

6. the Higgs doublet failing to be $(\mathbf{1}, \mathbf{2})_{1/2}$ (C-FF4 charge-normalization);
7. the Wilson-line origin of $\mathbf{H}$ on $\mathbf{S}^1_Y$ being inconsistent with Paper 1 Appendix H (downgrades UQF-8B to *Diagnostic*; UQF-8A retains CERTIFICATE if the doublet is granted by some other Paper 1 mechanism);
8. a Yukawa structure failing gauge invariance under $SU(3)_c \times SU(2)_L \times U(1)_Y$.

Failures 1–6 falsify UQF-8A; failure 7 is the Wilson-line / Appendix H surface (UQF-8B); failure 8 is a structural Yukawa failure that also falsifies the Paper 2 §8.12 matter ledger.

7.4 Precision-force phenomenology (UQF-13)

Status (verbatim): CANDIDATE. UQF-13 is the precision-phenomenology row (full chapter at §16). §7 names it as the destination for the numerical fits deferred by the matter and force-carrier rows: loop-level ρ and oblique parameters $\mathbf{S}, \mathbf{T}, \mathbf{U}$ (from UQF-6B), the numerical Yukawa matrices / fermion masses / CKM–PMNS angles (from UQF-7F and UQF-8A's Yukawa structure), the neutrino mass-splitting and mixing fit (from UQF-7G), and the anomalous magnetic moments at full loop precision. None of these numerics are claimed in §6 or §7; they are routed forward, and UQF-13 stays **CANDIDATE**. Detail externalized to **Q3** → **Paper III**, <https://physics.magflowmeters.com/articles/Quantum.html> (Appendix U registry row U13) and the §16 chapter.

7.5 Current tier summary

UQF row	Topic	Row-level tier (scoreboard, verbatim)	CERTIFICATE-tier sub-rows	AUDIT / DEFERRED remainder
UQF-5	graviton	CANDIDATE	5A, 5B	5C → UQF-9 (§14), UQF-10 (§15)
UQF-6	gauge boson	CANDIDATE	6A, 6B, 6C	6A/6A → §12/§13; 6B/6B* → §16/(§10+§14); 6C → §14
UQF-7	fermion quantization	AUDIT	7A, 7B, 7C, 7D, 7E, 7F	quantum-descent no-light-mirror (row-level obligation); 7G → Paper 1 Appendix K + §16
UQF-8	Higgs / Goldstone	CANDIDATE (tree level; AUDIT higher-order pending Appendix H)	8A	8B (AUDIT, Appendix H); 8C → §14 + §15
UQF-13	precision-force phenomenology	CANDIDATE	— (destination row; full fit at §16)	full loop-precision fit

This table changes nothing: it transcribes the source statuses. **UQF-7 remains AUDIT**. No sub-row's CERTIFICATE label promotes its parent row.

Paper-I inheritance boundary (preserve verbatim). The classical chiral count and no-mirror structure are inherited from Paper I. Q1 does not re-close that gate. **UQF-7 asks whether the fermionic quantum descent preserves the required physical spectrum** — i.e., it audits the quantum descent, distinct from the classical chirality / family count, which the corpus banks closed (TOE_FINAL v6 APS **(+3, 0)**, EXTERNAL). Likewise the Higgs doublet structure is inherited from Paper 1 Appendix H by interface only; UQF-8B is the audit surface for that inheritance.

7.6 Authority path

The formal authority for this section is the certificate registry in **Appendix U / Q3** — registry entries **Uo7** (fermion row), **Uo8** (Higgs/Goldstone row), and **U13** (precision phenomenology). Full per-family / per-chirality certificate tables, the $\mathbb{Z}_2$ projection rule, the spin-statistics transmission, the per-generation anomaly ledger, the neutrino three-option table, the C-FFo..C-FF14 backbone compliance tables, and the cross-reference indices to Paper 2 §7.4/§8.3–

§8.5/§8.12 and Paper 1 Appendix H / Appendix K are externalized verbatim to **Q3** → **Paper III**, <https://physics.magflowmeters.com/articles/Quantum.html>. Teaching exposition is in **Q2** → **Paper III**, <https://physics.magflowmeters.com/articles/Quantum.html>. The QC bridge remains EXTERNAL / SIMULATED with **no feedback into any UQF status** in this section. The downstream authority dependencies — Paper 1 Appendix H (Higgs Wilson-line), Paper 1 Appendix K (neutrino sector), Paper 1 main anomaly tables and **K₆** spin-c index, and the AUDIT rows UQF-9 / UQF-10 / UQF-13 — are invoked by interface only and are *not* re-closed here.

Σ reminder (claim spine). Nothing in §6–§7 alters the headline result **Σ = AUDIT**, computed by the min-rule $\Sigma = \min_{k \in \{0, \dots, 16\}} \sigma_k$ over the 17 UQF rows (UQF-0...UQF-16). The canonical AUDIT rows — **UQF-4, UQF-7, UQF-9, UQF-10, UQF-11, UQF-12, UQF-14, UQF-15** — are unchanged; UQF-7 (this section) is one of them and stays AUDIT, which is sufficient to hold Σ at AUDIT. Strong CP (UQF-12), UV completion (UQF-9), and nonperturbative QCD (UQF-11) stay AUDIT / open; BG-10 stays Open / Diagnostic. Namespace: **UQF** = audit gates / scoreboard rows; **UQFC** = paper chapters (UQFC-8/9/10/11 are the source chapters reformatted here); **UQC** = retired prior backbone.

8. The AUDIT Rows

This is the moment that earns the read. Instead of steering around its hard problems, the construction walks us straight into the eight gates it cannot yet close — nonperturbative QCD, strong CP, the UV fixed point, compactification stability, and the rest — and for each one names the exact falsifier it is exposed to. This is the character handing the reader the knife. These are the rows that hold Σ at AUDIT, and the paper routes them to the top on purpose, so a hostile reviewer finds the weak links first — exactly where the construction put them.

Σ = AUDIT. This is the single most important status-honesty section of Q1. It gathers the eight canonical AUDIT rows — **UQF-4, UQF-7, UQF-9, UQF-10, UQF-11, UQF-12, UQF-14, UQF-15** — into one place and states, compactly and locally, for each row: what it audits, why it is AUDIT/open (not closed), its falsifier, the downstream rows that inherit any downgrade, and the work surface that would close it. **These rows must stay AUDIT/open.** None is promoted in this section, by composition, by phrasing, or by any external-corpus result. The teaching layer for these rows lives in **Q2 §UQR4** (Rosetta); the formal gate cards, certificate templates, scorecards, roadmaps, and downgrade-inheritance tables live in **Q3 / Appendix U** (U1 row registry, U2 machine paths, U3 cross-row downgrade). Q1 carries only the claim spine.

This part (§8.1–§8.6) covers the first four AUDIT rows in scoreboard order: UQF-11 (Nonperturbative QCD), UQF-12 (Strong CP), UQF-9 (UV-Completion), UQF-10 (Quantum Compactification Stability). The remaining four AUDIT rows (UQF-4, UQF-7, UQF-14, UQF-15) and the AUDIT-to-CANDIDATE work plan follow in the second half of §8.

8.1 Why the AUDIT rows control Σ

The headline result of this paper is a single label:

$$\Sigma = \text{AUDIT}$$

and it is forced, mechanically, by the min-rule over the seventeen UQF scoreboard rows:

$$\Sigma = \min_{k \in \{0, \dots, 16\}} \sigma_k.$$

Σ is the **weakest link** of the gate stack, not its average and not its best case. Of the seventeen rows UQF-o ... UQF-16, eight currently sit at AUDIT tier:

UQF-4, UQF-7, UQF-9, UQF-10, UQF-11, UQF-12, UQF-14, UQF-15.

Because at least one σ_k is at AUDIT, the minimum over all rows is AUDIT. Σ cannot rise above AUDIT until **every** AUDIT row is raised. That is the entire logic: a single open audit row holds the whole claim at AUDIT, and this section is where each of those open rows is made locally legible so that the reader can verify the min-rule by inspection rather than on trust.

Namespace reminder (load-bearing — do not blur).

Namespace	Meaning
UQF- <i>n</i>	the seventeen audit gates / scoreboard rows whose min is Σ . <i>UQF-11 means nonperturbative QCD in this paper.</i>
UQFC- <i>n</i>	paper chapter / section numbering only — not a row status.
UQC- <i>n</i>	the retired prior backbone (historical rows; Paper 4 reserve).

Two hard discipline rules for this whole section.

1. **No promotion by external corpus.** Where an external companion (TOE_FINAL / corpus, the QC engineering bridge) has independently touched a question, that result is **EXTERNAL / SIMULATED and cited, never promoted**. It does **not** feed back into any UQF row's tier. The QC bridge in particular has *no* path into UQF status; it is a pointer only (see Q1 §12 and the external engineering-bridge note).
2. **Status labels are verbatim.** Each row below carries the exact tier label from the source scoreboard and gate card. Where the source says "AUDIT-TIER," "AUDIT (LOW confidence)," "AUDIT + ROADMAP," or "AUDIT with declared truncation," that wording is reproduced, not normalized.

The eight rows decompose by character into three open-problem families and one bookkeeping family:

- **Nonperturbative-QCD family:** UQF-11 (confinement, mass gap, hadron-spectrum route, chiral-symmetry breaking) — §8.6 below.
- **CP / vacuum-structure family:** UQF-12 (strong CP) — §8.5 below.
- **UV / gravity-sector family:** UQF-9 (UV completion) and UQF-10 (quantum compactification stability), coupled by a shared FRG calculation — §8.4 and §8.3 below.
- **Consistency / bookkeeping family:** UQF-4, UQF-7, UQF-14, UQF-15 — §8 second half.

This part handles the first three families' four rows. **BG-10 is not a UQF row**; it remains **Open / Diagnostic** (Paper 4 material) and is not an input to, nor an output of, any row below.

8.6 UQF-11 — Nonperturbative QCD

(Presented first because it is the deepest open row: confinement and the mass gap are a long-standing open problem of mathematical physics. Source: Paper-3 §12 / UQFC-12, mirroring UQC-3.)

Status

AUDIT-TIER + ROADMAP (per UQC-3 inheritance) across all four sub-gates **UQF-11A** (confinement), **UQF-11B** (mass gap), **UQF-11C** (hadron-spectrum route), **UQF-11D** (chiral-symmetry breaking).

What it audits

Whether the strong-sector interface inherited from Paper 2 (the descended $SU(3)_c$ Yang–Mills theory, with $SU(3)_c$ arising as the isometry of $K_6 = SU(3)/T^2$ and the eight gluons as Killing-vector zero modes) admits a full **nonperturbative** quantum completion: a Wilson-loop area law (confinement), a positive mass gap $\Delta > 0$, the observed hadron spectrum, and spontaneous chiral-symmetry breaking — all in the deep IR.

Why it is AUDIT / open (not closed)

UQF-11A (confinement) and UQF-11B (mass gap) are, between them, **one of the famous long-standing open problems of mathematics** (Jaffe–Witten 2000); no programme — algebraic, lattice-rigorous, holographic, stochastic-quantization, exact-RG, or geometric — has produced a fully rigorous continuum certificate as of this writing, and **the framework does not modify that situation**. The load-bearing reason is **Wilsonian universality**: below $m_{KK} \sim M_{GUT}$ the 4D effective theory is *exactly* $SU(3)$ Yang–Mills coupled to the framework's matter content; the KK tower is gapped at $\sim 10^{16}$ GeV and decouples logarithmically from the IR scale $\sqrt{\sigma}^{-1} \sim 200$ MeV where the area law and gap are generated. The IR nonperturbative dynamics are therefore indifferent to the precise UV completion, so the framework's UV completion is **compatible with** any future IR certificate but **structurally unable to supply one** — the same disclosure every UV-completion programme carries. UQF-11C and UQF-11D are downstream of UQF-11A,B in the certificate hierarchy and inherit AUDIT tier from them.

What is already banked

- **UQF-11A (confinement)**: the lattice area law $\langle W(R, T) \rangle \sim \exp[-\sigma RT + p(R + T) + c]$ with string tension $\sigma \approx (440 \text{ MeV})^2$ is numerically verified to percent precision (Bali–Schilling–Wachter; BMW, RBC/UKQCD, MILC, HotQCD), with string-breaking seen on dynamical ensembles. **Compatibility statement only**, no constructive proof.
- **UQF-11B (mass gap)**: the minimum-practical (non-continuum-proof) version is inherited from lattice QCD — lightest pure-gluon 0^{++} glueball at $m_{0^{++}} \approx 1.7$ GeV (Athenodorou & Teper 2020).
- **UQF-11C (hadron-spectrum route)**: the route specification is in hand (color-singlet operator basis $\rightarrow$ frozen-regulator correlators $\rightarrow$ asymptotic mass extraction $\rightarrow$ continuum/infinite-volume extrapolation $\rightarrow$ PDG comparison); the framework supplies the **UV boundary data** ($\alpha_3(M_Z)$ from $\text{Vol}(K_6)$, running to $\approx 1/8.5$ vs. the strong-coupling listing $\alpha_s(M_Z^2)$ of PDG 2024 (*Review of Particle Physics*), $1/8.47 \pm 0.05$; quark masses from chamber overlap integrals).
- **UQF-11D (chiral-symmetry breaking)**: the condensate $\Sigma^{1/3} \approx 250\text{--}280$ MeV is measured on dynamical lattices and is GMOR-consistent; the framework supplies the fermion content and quark-mass hierarchy as input; Σ itself is inherited.

The named compatibility statements C1–C4 (anomaly cancellation closed at $N_g = 3$; Z_3 center-symmetry inheritance; strong-CP-as-UV-boundary; flavor content as IR boundary condition) are the legitimate connection points. **None of C1–C4 is a confinement, mass-gap, or chiral-breaking proof.** (Full audit table and C1–C4: Q3 / Appendix U; teaching: Q2 §UQR4.6.)

What raises it

Pass requires each of the four sub-rows to carry a **named lattice / partner-community work program with a stated falsifier**. The strong-pass target for a future revision is the **minimum-practical** UQF-11B certificate (positive lowest gap under a declared regulator and a controlled continuum extrapolation) plus a frozen lattice-vs-framework consistency check closing UQF-11C and UQF-11D at sub-percent precision. The **full continuum-rigorous UQF-11A,B certificate is explicitly not the strong-pass target** for the Paper-3 revision; it is the multi-decade target of the entire community nonperturbative-QCD programme.

Falsifier

The sharpest near-term falsifier is **UQF-11C / UQF-11D**: if the framework-supplied UV inputs ($\alpha_3(M_Z)$, quark masses) drift out of consistency with lattice extractions at sub-percent precision (FLAG 2030 / 2035 sharpening), the **framework** is falsified (not the QCD route). Neutron-EDM and collider tests are not decisive for UQF-11 itself.

Downstream dependencies

UQF-11 is a terminal AUDIT row in the strong sector: a sub-row that asserts unfounded closure drops UQF-11 to AUDIT and forces a retraction. It does **not** lend tier to any other row by inheritance.

What this row does not claim

This row does **not** claim the Yang–Mills mass gap, confinement, nonperturbative QCD, or chiral-symmetry breaking is solved; does **not** claim "QCD is solved because $SU(3)_c$ appears"; does **not** claim the area law follows from the spin-c bundle on K_6 ; and does **not** upgrade UQF-11 by implication, composition, or phrasing. The rescoped strong-sector posture (**UV completion only; IR inheritance**) is preserved without amendment.

Formal authority: Q3 / Appendix U — UQF-11 gate card (U1), the summary-of-audit table and C1–C4 compatibility statements (U2), the R1–R6 research roadmap, the four-sub-gate downgrade map (U3).

Teaching: Q2 §UQR4.6.

8.5 UQF-12 — Strong CP

(Source: Paper-3 §13 / UQFC-13, mirroring UQC-4. The second of the two honest-audit sections; kept at the source confidence level exactly.)

Status

AUDIT-TIER with LOW CONFIDENCE on the candidate mechanism — NOT A CERTIFICATE. (Strong CP is *Excluded from scope* of Paper 1 per the Gate 11 claim-boundary discipline of the geometry SoT — Paper I, GUT.html (see register); this paper provides a candidate and a falsifier, not a solution.)

What it audits

Whether the strong-CP angle $\bar{\theta} = \theta_{\text{QCD}} + \arg \det(M_u M_d)$ — empirically bounded by the neutron EDM to $|\bar{\theta}| \lesssim 10^{-10}$ while being naturally $O(1)$ without a structural reason — can be **explained or eliminated** within the 13D unified force-sector framework rather than fine-tuned.

Why it is AUDIT / open (not closed)

The most promising 13D-internal candidate — lead (d), the $S_Y^1/\mathbb{Z}_2$ orbifold **boundary-parity** mechanism (a discrete-symmetry / orbifold-induced Nelson–Barr) — is a **candidate inspection point, not a derived cancellation**. Of the seven certificate elements UQF-12 demands, element (4), the actual cancellation, is *not* demonstrated; elements (5) radiative stability and (7) falsifier cannot be evaluated until (4) is closed. The framework also carries a specific disclosed obstruction: Article B §5.4 of the GUT source-of-truth manuscript (Paper I, GUT.html; see register) records that the spin-c holonomy phase $\Phi = -0.12827$ rad generates a contribution $\delta(\arg \det M_d) = +1.64$ rad to $\bar{\theta}$ — in roughly ten-orders-of-magnitude tension with the bound — so a successful closure must cancel a *specific* 1.64-rad contribution with a *specific* structural mechanism, not an unfixed counterterm. As of drafting, **no such mechanism has been derived**.

What is already banked

- **Four candidate levers audited** (§13.4): (a) K_6 Weyl-orbit holonomy parity — inspection point; (b) F^+ chamber $\tau = \omega$ pinning — **partial structural constraint already in place** (the $\tau = \omega$ choice makes $\arg \det O_q$ real, removing one class of phase contamination); (c) S^2 spin cover — subordinate/indirect; (d) $S_Y^1/\mathbb{Z}_2$ boundary parity — **most promising candidate**.
- **Standard resolutions audited against the framework:** PQ axion (Path β), Nelson–Barr / spontaneous CP, massless up quark (excluded by lattice; the up-quark-mass listing of PDG 2024 (*Review of Particle Physics*) gives $m_u \approx 2.16 \pm 0.07$ MeV), anthropic (out of scope).
- **The cross-sector tie (Article B §8.2):** the same $\omega^{(1,0)}$ generates both the CKM Jarlskog J and the strong-CP shift — the sharpest constraint any closure must respect: cancel $\arg \det M_q$ **without zeroing J** .
- **Path- β arithmetic disclosed honestly (§13.6):** the naive Hosotani estimate $f_a \sim 1/R_Y \sim 10^{17}$ GeV (ultralight axion, $m_a \sim 10^{-10}$ eV) is **not free** — a careful re-check may land it in an excluded window, which would make Path β expensive (requiring a new S^1 factor) and invoke Path γ .

(Four-lever table, seven-element scorecard, Path $\alpha/\beta/\gamma$ decision branch: Q3 / Appendix U; teaching: Q2 §UQR4.7.)

What raises it

Pass requires a **named candidate mechanism with a named falsifier** (nEDM bound; named next-generation neutron-EDM experiments). The strong-pass target for a future revision is **Path α** closure: a structural cancellation delivering all seven certificate elements (mechanism stated, residual $\bar{\theta}$ computed, $|\bar{\theta}| < 10^{-10}$ verified, J preserved at machine precision, radiative stability shown, falsifier named). If Path α fails: **Path β** (PQ axion as a second pseudo-scalar on $S_Y^1/\mathbb{Z}_2$ orthogonal to the Hosotani Higgs mode) with a careful f_a and an axion-window prediction matched to ABRACADABRA / ADMX / IAXO / MADMAX / CASPER.

Falsifier

A nonzero $\bar{\theta}$ at the structural level from improved neutron-EDM bounds — **n2EDM (PSI, 2025+)** pushing $|\bar{\theta}| \leq 10^{-11}$, or **nEDM at SNS (ORNL, ~2027+)** at sub- 10^{-27} e cm — would falsify the Path- α structural cancellation. For Path β , an f_a landing in an experimentally excluded axion-search window rules it out ($\rightarrow$ Path γ). **Keep the nEDM falsifier and boundary-parity candidate at this source confidence level; do not strengthen.**

Downstream dependencies

Strong CP is **not used in this paper to upgrade any other UQF gate**. If Phase-1 fails to close lead (d), the downgrade is to Path β ; if the careful f_a lands in an excluded window, the downgrade is to **Path γ** (permanent exclusion at the UQF-12 gate). Under Path γ , UQF-12 **remains AUDIT** and the overall paper status is "unified-quantum-force-completion candidate with UQF-12 honestly downgraded; the Paper-3 claim does not depend on UQF-12 closing."

What this row does not claim

This row does **not** claim strong CP is solved; does **not** assert "the geometry is elegant, therefore strong CP is resolved"; does **not** fabricate a certificate; and does **not** upgrade UQF-12 from AUDIT to CERTIFICATE. The 1.64-rad shift is disclosed honestly as the falsification surface. "Chris does the physics."

Formal authority: Q3 / Appendix U — UQF-12 gate card (U1), the seven-element certificate scorecard, the four-lever summary table, the Path $\alpha/\beta/\gamma$ decision branch (U2), and the downgrade map (U3). **Teaching:** Q2 §UQR4.7.

8.4 UQF-9 — UV-Completion Certificate

(Source: Paper-3 §14 / UQFC-14. UQC-1's UV content split into UQF-9 here and UQF-10 in §8.3, for gate hygiene; the physics inherits unchanged.)

Status

AUDIT-TIER — audit-tier landing with a structured certificate sketch and a named research roadmap. (Asymptotic-safety non-Gaussian fixed-point existence is a **global** open problem, not a corpus-internal one; this paper at most extends or restates the prior UQC-1 audit and does **not** claim closure.)

What it audits

Whether the 13D restricted theory space admits a controlled **UV completion**: a non-Gaussian UV fixed point of the renormalization-group flow for the unified action, with finitely many relevant directions, and a controlled RG trajectory back down to the observed four-force IR physics. UQF-9 commits the paper to the **asymptotic-safety (Weinberg–Reuter) route** as the primary target — a *compatibility commitment*, not an existence claim — because the Paper 2 §6.5 nonperturbative target rule *already* is the FRG equation the asymptotic-safety community uses.

Why it is AUDIT / open (not closed)

The load-bearing FRG certificate template has eight rows (FRG-1 ... FRG-8). **Two (FRG-1 theory space, FRG-3 regulator) are declarable at audit-tier** by the framework acting alone; **one (FRG-8 reproducibility) becomes declarable** once a partner calculation is run; the **remaining five (FRG-2 beta functions, FRG-4 fixed point, FRG-5 critical exponents, FRG-6 trajectory, FRG-7 stability) require external physics work** — a concrete FRG truncation calculation on the FRG-1 theory space — **that has not been performed**. In particular the fixed-point row FRG-4 is treated as an **honest "search candidate" only**: *no fixed-point search has been performed on the actual operator basis*. The framework inherits, by structural analogy with $d > 4$ asymptotic-safety results, only the *prior* that such a fixed point is plausible — **no evidence specific to the FRG-1 truncation**. Asymptotic safety has been an active programme since 1979 and still has no closed existence theorem in 4D.

What is already banked

- **UV route committed**: asymptotic safety (route selection §14.1), declarable FRG-1 (operator basis pruned by the residual $SU(3) \times SU(2) \times U(1)$ symmetry), FRG-3 (Litim regulator default), FRG-8 (frozen-inputs / reproducibility envelope).
- **Three 13D-specific narrowings inherited from UQC-1.3**, each feeding a certificate row and each a **narrowing, not a proof**: (i) discrete K_6 Laplacian spectrum $\rightarrow$ prunes FRG-1 theory space (finite, computable threshold structure, gauge-invariant basis); (ii) finite Dai–Freed anomaly class from $S^1/\mathbb{Z}_2 \rightarrow$ a finite consistency filter on FRG-4 / FRG-5 fixed-point candidates; (iii) single-modulus Einstein-frame reduction $\rightarrow$ reduces the FRG-7 stability check to a one-modulus question.

(Full FRG-1 ... FRG-8 certificate template, the three narrowings, pass-tier ladder, downgrade ladder, and roadmap: Q3 / Appendix U; teaching: Q2 §UQR4.4.)

Corpus guard (the Λ / vacuum-energy line). The reader must **not** infer from §8.4 that controlled UV behavior supplies a cancellation of the cosmological constant. The corpus settled that line as a **computed honest fail** (EXTERNAL): TOE_FINAL v12 found no structural cancellation at any coefficient order; v14 THEOREM_REFUTED the chamber-cancellation route. **Λ stays Weinberg-open as a computed one-loop certificate** (no observed- Λ comparison performed). This does **not** change UQF-9's status — the asymptotic-safety fixed point remains a global open problem and UQF-9 stays correctly **AUDIT**. The UV question and the Λ question are distinct.

What raises it

Three pass tiers (handoff §11). **Minimum** (current target) — declare FRG-1 / FRG-3 / FRG-8 plus **one external FRG truncation** on FRG-1 that returns either a fixed-point candidate or an informative negative, with the Dai–Freed checklist written and no admissibility violation. **Strong** — FRG-4 demonstrated in at least one truncation, FRG-5 finite small relevant count, FRG-6 trajectory reaches the Paper 2 IR within truncation accuracy, FRG-7 cross-certificate with §8.3 (UQF-10) closes. **Full** — a constructive nonperturbative UV definition with truncation independence (FRG-4 in ≥ 2 independent operator bases). **Minimum is plausibly achievable as an audit-tier result conditional on one partner FRG calculation; Strong and Full are open at the level of the global quantum-gravity literature, not this programme alone.**

Falsifier

UQF-9 **failure** = FRG-1 cannot be written down (operator basis ill-defined) **or** FRG-2 on every reasonable truncation excludes a fixed point under the 13D narrowings. Operational hard falsifiers inherited from Paper 2 and already running: equivalence-principle violation at the leading reduced action; failure to recover the Newtonian weak-field limit; sector-dependent leading gravitational coupling; collapse of the Einstein-frame reduction because the volume modulus refuses to stabilize.

Downstream dependencies

UQF-9 is a **hub**. On failure, **UQF-5 (graviton) and UQF-6 (gauge) lose CERTIFICATE tier** (the perturbative force-carrier certificates need a UV completion to be sustainable above the cutoff). UQF-9 is also the explicit parent of **UQF-10** (§8.3) — four of UQF-10's seven rows close only when the UQF-9 FRG calculation closes — and **weak-bounds UQF-13** (force-sector precision) because the UV trajectory is not under control. **UQF-14 (unitarity/causality/locality) depends on UQF-9** as well; that dependence is made explicit in the second half of §8.

What this row does not claim

This row does **not** claim a non-Gaussian UV fixed point exists in the restricted theory space; does **not** claim asymptotic safety has been closed in any dimension; does **not** claim the BV-BRST package is positive-definite at the interacting level; does **not** claim the global RG trajectory is controlled; and **does not invent any new physics the global asymptotic-safety / loop-QG / string communities have not already produced**. Phrasing rule: any present-tense use of "fixed point," "trajectory," or "UV completion" in this row is read with the appended qualifier "*for the FRG-1 truncation, conditional on an external FRG calculation that has not yet been performed.*"

Formal authority: Q3 / Appendix U — UQF-9 gate card (U1), the FRG-1 ... FRG-8 certificate template and the three 13D narrowings (U2), the pass-tier and downgrade ladders and the cross-references to UQF-3 / UQF-5 / UQF-6 / UQF-10 / UQF-13 / UQF-14 (U3). **Teaching:** Q2 §UQR4.4.

8.3 UQF-10 — Quantum Compactification Stability

(Source: Paper-3 §15 / UQFC-15. The cross-certificate of UQF-9; the operational dependency of the Paper 2 §6.9.3a Einstein-frame caveat.)

Status

AUDIT with declared truncation. Honest landing phrase, verbatim: "**Quantum compactification stability is certificate-complete only within the declared truncation.**" Of the seven required rows, **three (S-1, S-3, S-4) are CERTIFICATE within truncation** and **four (S-2, S-5, S-6, S-7) are AUDIT with named research**

paths; zero rows are at full quantum closure. The gate's tier is **AUDIT** (it depends on UQF-9; without a UV-completion certificate the moduli effective potential at higher loops is not controllable).

What it audits

Whether the constraint-selected compact branch $K_6 \times S^2 \times S^1$ with the active $S^1/\mathbb{Z}_2$ boundary parity remains **stable under quantum corrections** along the §8.4 (UQF-9) FRG-6 trajectory from the hypothesized UV fixed point down to the four-force interface scale — i.e., a moduli effective potential with no unstable directions, no tachyonic KK/orbifold mode, controlled vacuum energy, and no runaway volume modulus.

Why it is AUDIT / open (not closed)

Four of the seven rows depend on the UQF-9 FRG calculation **that has not been performed**: **S-2** (moduli mass-matrix positivity $V''_{\text{eff}}(\sigma_*) > 0$), **S-5** (KK spectrum stable along the trajectory), **S-6** (orbifold/boundary conditions stable — reduces to the Dai–Freed checklist of §14.3(ii)), and **S-7** (no runaway volume modulus). **S-7 is the most consequential AUDIT row** because its failure mode is *also* the failure mode of the Paper 2 §6.9.3a Einstein-frame caveat: a runaway breaks §6.9.3a and downgrades the **gravity interface itself**, not merely UQF-10. The single-modulus framing reduces the generic multi-modulus problem to one forward-referenced computation but **does not solve it**.

What is already banked

- **S-1** (single-modulus reduction) — **CERTIFICATE within truncation**; a theorem of the constraint method (shape moduli frozen by residual isometry/spin-c structure).
- **S-3** (no perturbative tachyonic compact modes) — **CERTIFICATE within truncation**; rides on the homogeneous-Einstein structure of K_6 plus constant-curvature S^2 , S^1 (discrete non-negative Laplacian spectra; the $\mathbb{Z}_2$ quotient projects out half the modes and introduces no negative-mass state). Non-perturbative tachyon exclusion is out-of-truncation and OPEN (tracked under S-7).
- **S-4** (vacuum energy) — **AUDIT, explicitly scoped to Paper 4**; the induced 4D cosmological constant is not litigated here. *Corpus guard*: the Paper-4 venue has since computed the Λ line as a **computed honest fail** (TOE_FINAL v12/v14, EXTERNAL); **Λ stays Weinberg-open**. Nothing in S-4 may be read as a live vacuum-energy-cancellation mechanism.

(Seven-row table S-1 ... S-7, the declared truncation, the §14↔§15 cross-certificate coupling table, and the downgrade ladder: Q3 / Appendix U; teaching: Q2 §UQR4.5.)

No promotion by external corpus. The compactification-stability **existence** question is, independently of the FRG route, **CLOSED at decision grade** in the corpus (TOE_FINAL v8–v10, EXTERNAL; a native three-layer stabilization object whose boundary-sign event $c_{\text{bdry}} = -1.08 \times 10^{-2}$ makes the well unconditional in c_{loop}). UQF-10 **inherits this as a decision-grade input only**. It does **not** supply this paper's own *certificate-grade* result on the FRG-6 trajectory (S-2 / S-5 / S-7), which remains UQF-10's open obligation. **The row therefore stays AUDIT; the decision-grade discharge is cited, not promoted.** Promotion on the strength of the corpus discharge is a countersign decision, not an edit made here.

What raises it

The **Minimum-tier UQF-9 pass** (FRG-2 + FRG-4 + Dai–Freed checklist) is the *same calculation* that closes S-2 / S-5 / S-6 / S-7 to AUDIT-resolution within their truncation; the **Strong-tier UQF-9 pass** (FRG-4 + FRG-5 + FRG-6) is what promotes S-2 / S-5 / S-7 from AUDIT to CERTIFICATE within truncation. CERTIFICATE-beyond-truncation (Full) additionally requires non-perturbative tunneling exclusion and shape-moduli activation.

Falsifier

S-7 runaway: $V_{\text{eff}}(\sigma)$ unbounded below in the operating range (a runaway direction exists) — this breaks the Paper 2 §6.9.3a Einstein-frame caveat and downgrades the gravity interface to scalar-tensor-only. **S-6 boundary-anomaly violation:** the §14.3(ii) Dai–Freed checklist returns an admissibility violation (also excludes any UQF-9 fixed-point candidate). **S-3 out-of-truncation tachyon:** a non-perturbative tachyon / vacuum-tunneling channel invisible at linearised level (forces a wider truncation).

Downstream dependencies

UQF-10 is **coupled to UQF-9** (§8.4) and is **not independent of it**: S-2, S-5, S-6, S-7 all close conditional on the UQF-9 FRG calculation. On the S-7 failure mode, the **gravity interface (Paper 2 §6.9.3a) downgrades**, propagating into the falsification map (§8 second half / Q1 §10). On the S-6 failure mode, **UQF-9 also downgrades** (the fixed-point candidate is inadmissible).

What this row does not claim

This row does **not** claim the moduli mass matrix has been computed at the interacting level on the FRG-6 trajectory; does **not** claim quantum compactification stability is a theorem (only certificate-completeness *within the declared truncation*); does **not** claim the Dai–Freed finite anomaly class set has been closed; and **must distinguish the external corpus stabilization (existence, decision-grade) from this paper's own UQF-10 certificate (FRG-grade, open)**. No promotion. "Chris does the physics."

Formal authority: Q3 / Appendix U — UQF-10 gate card (U1), the seven-row S-1 ... S-7 certificate table and declared truncation (U2), the §14↔§15 cross-certificate coupling and downgrade ladder (U3), and the corpus-reconciliation no-promotion ledger (U7). **Teaching:** Q2 §UQR4.5.

End of §8 first half (UQF-11, UQF-12, UQF-9, UQF-10). The second half continues with UQF-4, UQF-7, UQF-14, UQF-15 and the AUDIT-to-CANDIDATE work plan. All four rows above remain AUDIT/open; $\Sigma = \text{AUDIT}$ is preserved.

8.8 UQF-14 — Unitarity / Causality / Locality Audit

Discharges gate UQF-14 (source chapter UQFC-17). One of the eight canonical AUDIT rows.

Status

AUDIT. Per-sector bounds are routine where the sector is perturbative; the graviton sector's unitarity above the cutoff is **conditional on UQF-9**. This row therefore reads, in the gate-card language of §2/§3, as *CERTIFICATE-tier for structural discipline + AUDIT-tier for the nonperturbative subtleties* — and because the min-rule takes the weakest sub-claim, the row's headline tier is **AUDIT**.

The UQF-9 dependence is load-bearing and must not be missed. Above the perturbative cutoff, every "unitarity holds" sub-claim in this row is an *inheritance* from UQF-9 (UV completion). UQF-9 is itself AUDIT (§8.4). A reader who treats §8.8 as a closed unitarity proof has discarded the UQF-9 conditionality and is reading the row wrong. **If UQF-9 fails, the above-cutoff unitarity sub-claims of UQF-14 fail with it.**

What is already banked (CERTIFICATE-tier, perturbative)

The audit operates on the BV-BRST construction of §5, the physical-Hilbert-space construction of §6, and the §§6–7 force/matter certificates, sector by sector, at the *perturbative-plus-truncated-KK* order at which those certificates run. At that order the following are banked by inheritance from standard QFT, with no new physics added:

- **Unitarity (perturbative S-matrix).** For each force sector the unphysical polarizations and Faddeev–Popov ghosts cancel from physical observables, leaving positive-definite norms on $\mathcal{H}_{\text{phys}} = \ker Q_{\text{BRST}} / \text{im } Q_{\text{BRST}}$. Gravity zero-mode via linearized-gravity BRST; gluons via the Kugo–Ojima quartet; $W^\pm, Z$ via the Higgs mechanism + Equivalence Theorem; photon via Gupta–Bleuler/BRST; fermions via spin-statistics with no mirror Weyls surviving the §8-chirality projection.
- **Causality (microcausality + causal perturbation theory).** Every free-field force carrier (graviton zero-mode and each KK mode, gluon, $W^\pm, Z$, photon, Higgs, each fermion species, and each KK partner) has a Pauli–Jordan/Proca/Klein–Gordon/Dirac commutator that vanishes outside the lightcone; Epstein–Glaser causal perturbation theory extends this to all loop orders. No Lorentz-violating term is added at any order accessible to the §6.4 truncation.
- **Locality (local action + cluster decomposition).** The §5 13D action is local in 13D; integrating over the compact factors $K_6 \times S^2 \times S^1$ at each 4D point yields a 4D effective action local at any finite KK truncation, with only E^2/M_{KK}^2 -suppressed (analytic, EFT-local) non-localities. Cluster decomposition then follows from the spectral condition + Lorentz covariance + the local-action principle for the 4D EFT at $E \ll M_{\text{KK}}$.
- **No-superluminal-signaling** in the recovered Einstein limit, consistent with $|c_g - c|/c < 10^{-15}$ from GW170817 + GRB170817A.

Formal per-sector inventory tables (negative-norm/ghost ledger; commutator-vanishing ledger; per-sector audit-status matrix) → Q3 Appendix U, module U-AUDIT-B. Per-carrier teaching walk-through → Q2 UQR4.8.

Why not CANDIDATE

Because the nonperturbative sub-claims are *not* banked and are routed, without modification, to upstream AUDIT rows:

- Full **nonperturbative unitarity for the strong sector** (Kugo–Ojima color confinement in the confined phase) is open at the same level as QCD nonperturbative — inherited from **UQF-11**.
- Full **nonperturbative causality under graviton self-coupling** (the Vainshtein / strong-coupling / Froissart-bound question for the KK graviton tower) is inherited from **UQF-9 / UQF-10**.
- Full **cluster decomposition with the infinite KK tower retained** is inherited from **UQF-10**.
- **Nonperturbative EW unitarity** (instantons, sphalerons, high- T baryon-number violation) is excluded by the hard claim boundary and inherits **BG-10 Open / Diagnostic** (Paper 4 material).

The row cannot rise above its weakest inherited sub-claim, and those sub-claims are AUDIT/Open. Hence AUDIT.

What raises it

The gate-card raising condition is per-sector closure:

- **Pass:** per-sector unitarity within the declared cutoff; Lorentz covariance respected; cluster decomposition holds on $\mathcal{H}_{\text{phys}}$.
- The row rises toward CANDIDATE only as its upstream inheritances rise: a nonperturbative-QCD confinement/mass-gap certificate (closing the UQF-11 strong-sector row), a UV-completion certificate validating above-cutoff graviton unitarity (closing the UQF-9 dependence), and a compactification-stability certificate for the full KK tower (closing UQF-10). Until those upstream rows raise, UQF-14 stays AUDIT.

Falsifier

The row *inherits* failures; it introduces no downgrade vocabulary of its own. A falsifier triggers when:

- a negative-norm physical state appears in any sector's spectrum, or the BRST charge fails to be nilpotent at some loop order, or longitudinal $\mathbf{W}, \mathbf{Z}$ scattering is not unitarized by the §10 Higgs ($\rightarrow$ propagates to UQF-3 / UQF-4 / UQF-8);
- a field commutator fails to vanish outside the lightcone, or a KK mode goes tachyonic under §6.10 loop corrections, or a KK-tower exchange violates the Froissart bound, or GW propagation deviates from $\mathbf{c}_g = \mathbf{c}$ beyond GW170817+GRB170817A ($\rightarrow$ UQF-5 / UQF-6 / UQF-8 / UQF-10 / UQF-9);
- the §5 action is non-local in 13D, or the §6.4 truncation introduces a Lorentz-violating term, or a non-local 4D operator of size $\geq 1/M_{\text{KK}}$ appears at low energy, or cluster decomposition fails ($\rightarrow$ UQF-2 / UQF-3 / UQF-10 / UQF-11).

Each falsifier is *one row* of one upstream gate; it propagates to the §10 final downgrade map and the corresponding row's status drops per the §3 downgrade ladder.

Downstream dependencies (which rows inherit downgrade)

UQF-14 sits *downstream* of UQF-2, UQF-3, UQF-4, UQF-5, UQF-6, UQF-7, UQF-8, UQF-9, UQF-10, UQF-11 and of BG-10; it consumes their tier labels rather than emitting new ones. Two couplings run the other way and must be visible: (i) the **UQF-9** UV-completion dependence above the cutoff (stated above); (ii) §18's no-hidden-mode result — **if UQF-15 downgrades, the §17 locality/causality rows downstream of the affected sector downgrade too**. A negative-norm or BRST-nilpotency failure surfaced *here* is reported as a downgrade of the upstream row that owns it, and then re-enters the §10 min-rule.

What this row does not claim

It does **not** claim a deep, nonperturbative proof of unitarity, causality, or locality. It is *structural discipline*: where standard QFT supports the property at perturbative-plus-truncated-KK order it closes at certificate tier; where nonperturbative subtlety enters it *names the gap and routes it* to the owning UQF row. Full nonperturbative unitarity is open at the level of a long-standing open problem of mathematical physics (Yang–Mills), routed through UQF-11. It does not claim any vacuum-energy / cosmological-constant cancellation as a by-product of high-energy completion — the corpus has settled the Λ line as a **computed honest fail** (stays Weinberg-open as a computed certificate; see §9 / EXTERNAL). It performs and implies **no gate upgrade**; the hard-gate vector and BG-10 are preserved.

8.9 UQF-15 — No-Hidden-Sector Force Leakage

Discharges gate UQF-15 (source chapter UQFC-18). One of the eight canonical AUDIT rows.

Status

AUDIT. Single-tier at AUDIT-tier by construction: the row depends on the §4 quantum-object ledger being **exhaustive** and on Phase-4 audit closure.

What is already banked

The audit answers one sharp question:

Does the 13D compactified spectrum predict any unobserved fifth-force-style, light-vector, light-scalar, hidden-fermion, or hidden-spin-2 mode at experimentally accessible energies, beyond the declared force-carrier content

of §§6–7?

The banked answer, *given the §4 ledger as written and the §6.9.3a volume-modulus stabilization as inherited*, is **no hidden forces beyond the declared KK tower**. Concretely, every experimentally most-constraining bound is satisfied by inheritance:

- **Sub-eV fifth force** (Eöt-Wash 2024: no $1/r^2$ deviation to $\sim 52 \mu\text{m}$; MICROSCOPE $\eta = (-1.5 \pm 2.3) \times 10^{-15}$): the lightest KK partner sits at $M_{\text{KK}} \gg \text{eV}$, set by the inverse compact-factor size that the §6.9.6 Newtonian limit already constrains to $\ll \text{mm}$. No sub- M_{KK} light scalar/vector in the ledger.
- **Light scalar moduli** (LEP $m_\phi > 114 \text{ GeV}$ SM-like, weaker for reduced coupling; LHC additional-scalar searches; precision EW $\mathcal{S}, \mathcal{T}, \mathcal{U}$): the §6.9.3a stabilization gives every modulus of $K_6 \times \mathcal{S}^2 \times \mathcal{S}^1$ a mass at (or above) M_{KK} . No light modulus below M_{KK} .
- **Hidden $U(1)$ / dark photon** (beam-dump, e^+e^- , LHCb, precision spectroscopy/stellar-cooling bounds on $(m_{A'}, \epsilon)$): the §5 sector projections produce no $U(1)$ beyond $U(1)_Y$ and its low-energy remnant $U(1)_{\text{em}}$ (C-FF8). The framework sits at $\epsilon = 0$ for any $m_{A'}$; KK partners carry the *same* SM gauge structure, not a new $U(1)$.
- **Light hidden fermions** (sterile neutrinos: reactor + accelerator + cosmology, MicroBooNE 2022 disfavoring the sterile MiniBooNE interpretation; keV–MeV X-ray bounds; GeV beam-dump/LHC): the §11 matter-bundle entry enumerates exactly the SM chiral content; the Appendix-K neutrino mechanism is a *declared* (not hidden) mode.
- **Hidden massive spin-2** (GW170817: $m_g \lesssim 10^{-23} \text{ eV}$; short-distance gravity): the ledger's metric-block entries are the zero-mode graviton plus the §6.4 KK tower; no extra DGT/bigravity spin-2 mode.

Formal experimental-bounds-vs-prediction table (§18.6) and the per-row constraint summaries $\rightarrow$ Q3 Appendix U, module U-AUDIT-B. Plain-language walk-through of each bound $\rightarrow$ Q2 UQR4.9.

Why not CANDIDATE (and why not Open/Diagnostic)

Not CANDIDATE / why AUDIT-tier, not CERTIFICATE-tier. A CERTIFICATE-tier no-leakage claim would require a *constructive proof* that §6.4 quantization at the §6.9.3a point produces *no* sub- M_{KK} mode beyond the declared SM zero-modes. That proof has two parts: (i) the §6.4 mode-counting argument, established at certificate tier inside Paper 2 for $K_6 \times \mathcal{S}^2 \times \mathcal{S}^1$; and (ii) the absence of *any* additional geometric scalar/vector from the §6.3 BV-BRST package or from anomaly inflow not already in the §4 ledger. **Part (ii) is the AUDIT-tier part:** the audit verifies that the *declared* §4 ledger is *complete relative to the constraint that the experimental hidden-force bounds are not violated* — it does **not** prove BV-BRST closure against all conceivable new modes.

Not Open/Diagnostic because the framework returns a *definite* pass for every row of the §18.1–§18.5 checklist: each named bound is satisfied by the assumed M_{KK} scale and the absence of sub-KK ledger entries. *Open/Diagnostic* would apply only if a checklist row failed and the §6.10 correction ledger could not absorb it — which the present audit does not encounter.

The exact ledger-exhaustiveness / no-leakage condition

State it precisely, as the source does:

No-leakage condition. Every $\otimes$ -layer field not used by the four force EFTs is accounted for as exactly one of: **(a)** eaten by EWSB and not physical; **(b)** confined inside QCD and not directly observed; **(c)** bounded below current direct-test limits; or **(d)** outside this paper's scope (a Paper-4-reserve hidden-sector candidate — *declared and deferred, never silently retained*).

Pass: every non-force-EFT $\otimes$ -layer field is accounted for by (a)–(d). **Fail:** any *silent residual* field in $\mathcal{H}_{\text{phys}}$ that would mediate an unobserved force.

Equivalently: every "no hidden X" statement of this row means precisely "**no §4 ledger entry for X beyond the declared content.**" The audit verifies the *declared* ledger's consistency with the bounds; it does not assert the ledger enumerates all conceivable quantized objects.

What raises it

Per the gate card: **Pass** requires every non-force-EFT $\otimes$ -layer field accounted for by (a)–(d) above, with the §6.9.3a stabilization certificate validating that all moduli and KK modes sit at $\geq M_{KK}$. The row rises toward CANDIDATE only if the missing CERTIFICATE-tier piece — a §6.3 BV-BRST closure theorem (full cohomology enumeration on the 13D field content) showing *no possible* sub- M_{KK} extension — is supplied. That enumeration is not performed in this paper; until it is, the row stays AUDIT.

Falsifier

A no-leakage row falsifies when any of the following is detected below the declared §4 ledger scales:

- a fifth-force / Yukawa-modified-gravity signal at distance scale $\leq M$
- a precision-EW S, T, U deviation $\geq 3\sigma$ fitting a light-modulus or new-EW-state contribution;
- a light scalar, hidden $U(1)$ vector, hidden/sterile fermion, or other beyond-SM state at LEP / LHC / Belle II / NA64 / LHCb;
- a $(g - 2)_\mu$ or $(g - 2)_e$ contribution isolating a dark-photon-style exchange at $\geq 3\sigma$ that the precision rows cannot absorb via §6.10;
- a massive-graviton-like signal below M_{KK} in the LIGO-Virgo-KAGRA O5+ catalog;
- an astro/cosmological measurement requiring a hidden species (e.g. sterile ν with $\Delta N_{\text{eff}} > 0$ at $\geq 3\sigma$) not in the §4 ledger.

On any such detection the audit must either **(a)** reopen the §4 ledger and add the entry *with a named geometric origin* in the §6.3 BV-BRST package / §5 sector projection / §8.4 matter bundle / §6.4 mode count, or **(b)** downgrade the no-leakage claim to *Open / Diagnostic*. The **highest-likelihood falsifier is the precision-EW row**: the post-CDF m_W tension (the precision-likelihood row, §8 precision aside below) already sits at $\sim 1.5\sigma$ between the m_W world-average listing of PDG 2024 (*Review of Particle Physics*) and the Gfitter/HEPfit SM fit; if it grows under HL-LHC and §6.10 cannot absorb it, the no-light-modulus / no-hidden-EW-state claims must be re-examined.

Downstream dependencies (which rows inherit downgrade)

A row-level falsification downgrades **UQF-15** and, depending on the species detected, propagates to **UQF-5 / UQF-6 / UQF-7 / UQF-8 / UQF-10** (the gate that would have to *own* the new mode's origin), then re-enters the §10 min-rule. In the other direction, **UQF-15 feeds UQF-14**: §17's causality/locality rows assume §18's no-hidden-mode result, so a UQF-15 downgrade pulls down the affected-sector UQF-14 rows. The moduli row is itself an inheritance from **UQF-10** (§6.9.3a stabilization): if §6.9.3a fails to stabilize a modulus, the no-light-modulus claim inherits the failure.

What this row does not claim

It does **not** claim a constructive proof that *no possible extension* of the §6.4 mode spectrum could introduce a sub-KK mode; that needs a §6.3 BV-BRST cohomology closure theorem not performed here. It does **not** claim §6.9.3a is the *unique* admissible stabilization, nor that the §4 ledger enumerates *all conceivable* compatible objects — it enumerates the *declared* objects and checks them. It uses no excluded sector (cosmology / dark matter / dark energy / baryogenesis) to *upgrade* the claim: the astro/cosmological bounds are *inputs*, not *outputs*. Hidden-sector candidates relevant to baryogenesis or dark matter are Paper-4 material; **BG-10 stays Open / Diagnostic**. No gate upgrade is performed or implied; the hard-gate vector and C-FFo..C-FF14 are preserved.

8.9a Precision-likelihood aside — UQF-13 (force-sector precision)

Source chapter UQFC-16. *NOT one of the eight canonical AUDIT rows. Its status is two-tier and must be reproduced verbatim — it is included here because §8.8 (GW-propagation input) and §8.9 (the precision-EW / m_W falsifier) both depend on it, and because it is the venue Paper 2 §2.2 defers to for force-sector precision. It must not be folded into the eight AUDIT rows and must not** be promoted.*

Status (verbatim)

CANDIDATE (Tier-1) with AUDIT (Tier-2) per UQC-8 inheritance.

- **Tier 1 — framework structure (CERTIFICATE-tier).** The 13D theory exposes a *defined and complete* force-sector precision-observable list; each row names the required calculation, the constraint experiment, and the partner toolchain. **Pass (Tier-1):** every force-sector observable has a named calculation, a named experiment, and a named partner. **Fail (Tier-1):** any observable missing one of the three → UQF-13 drops to AUDIT ("Tier-1 partial specification").
- **Tier 2 — actual prediction values (AUDIT-tier).** Numerical predictions are *named, not computed*, in this paper; they are **explicitly deferred to partner-community execution**. This paper **produces no numerical predictions**.

What is banked

A complete, force-sector-restricted precision-observable layer (gravity / strong / EW / QED / matter-force / proton-stability / strong-CP / new-states), each row carrying UQF-row + C-FF-row inheritance, a named computation, a named constraint experiment, a pass/fail rule, and a named tool/partner (HEPfit, Gfitter, CKMfitter, UTfit, flavio, SuperIso, NuFIT, FlavBit, RBC-UKQCD, JLQCD, FLAG, Eöt-Wash, MICROSCOPE, LIGO-Virgo-KAGRA, LISA, ATLAS/CMS/LHCb/Belle II, Super-K/Hyper-K/DUNE/JUNO, KATRIN, Fermilab E989, MEG-II, Mu2e, COMET, NA62, KOTO, nEDM PSI / SNS nEDM). The most-consequential single row is **proton stability**; the highest-current-tension row is m_W .

The full §16.2 global force-sector precision table (named values, constraint data, pass/fail, tool/partner per row) and the Tier-2 roadmap → Q3 Appendix U, module U-AUDIT-B. Anti-fitting and tier-discipline teaching → Q2 UQR4 precision aside.

Scope guards (do not over-read)

- Tier-1 closure is *infrastructural*: it is the specification of what numerical work must be done, not a claim that the work is done. **None of the §16.5 row-level promotion conditions is presently met for any row; nothing here is to be cited as a promoted prediction.**
- A Tier-2 row falsification (an EWPO/CKM/PMNS/rare-decay/proton-decay/ gravity/KK/nEDM prediction outside band at $\geq 3\sigma$ with no §6.10 absorption) downgrades *that row* to *Open / Diagnostic* — it is data input to the prediction surface, not against the Tier-1 *specification*; the framework-tier structure does not downgrade because a Tier-2 row falsifies.
- Preserves Paper 2 §2.2 (which excludes full precision phenomenology from the interface paper's deliverables); does not double-count it.
- No new free parameter beyond the locked Article-A nine; tensions are *data*, not silent parameter growth. **BG-10 preserved.** No gate upgrade performed or implied.

8.10 AUDIT-to-CANDIDATE work plan

The eight canonical AUDIT rows — **UQF-4, UQF-7, UQF-9, UQF-10, UQF-11, UQF-12, UQF-14, UQF-15** — are what hold Σ at AUDIT under the min-rule $\Sigma = \min_{k \in \{0, \dots, 16\}} \sigma_k$. Raising Σ is therefore *exactly* the problem of raising these rows; no external-corpus update and no Tier-1 precision specification promotes Σ on its own. The work below is the *required* evidence per row, with owner/authority. It is a statement of what must be done — **not** a claim that any item is done.

Work item	Rows raised	Required evidence	Owner / authority
Phase-4 anomaly-lift closure	UQF-4 (+ rows consuming BRST/anomaly closure)	Completed anomaly cancellation / measure closure with the lift completed, not merely stated; BRST nilpotency to the required loop order	Main GUT manuscript §7 / Appendix U cert; Chris's physics
No-light-mirror verification	UQF-7	Explicit verification that no mirror fermion survives the §8 chirality projection; matter-bundle assignment audit	Article A §4 + §8.4; Q3 / Appendix U
UV-completion certificate	UQF-9 (+ UQF-14 above-cutoff, proton-decay matching scale)	A UV-completion route validating above-cutoff unitarity / Froissart / Landau-pole control — <i>not</i> a proof of asymptotic safety, which remains open	Main manuscript §14; Chris's physics
Quantum compactification stability	UQF-10 (+ KK-tower causality/locality, no-light-modulus)	§6.9.3a volume-modulus stabilization certificate for the full KK tower; no tachyonic KK mode under §6.10	Paper 2 §6.4 / §6.9.3a / §6.10; Q3
Nonperturbative-QCD route	UQF-11 (+ strong-sector UQF-14)	Confinement / mass-gap certificate at the level the recognized open Yang–Mills problem requires — <i>not</i> claimed solved	Main manuscript §12; RBC-UKQCD / FLAG; Chris's physics
Strong-CP resolution	UQF-12	A prediction or explicit $\bar{\theta} \approx 0$ explanation consistent with PSI nEDM $< 1.8 \times 10^{-26} e$ cm; nEDM falsifier at the 10^{-28} level (n2EDM, SNS nEDM) — at source confidence, <i>not</i> solved	Main manuscript §13; nEDM PSI / SNS; Chris's physics
Unitarity/causality/locality closure	UQF-14	Closes only as its UQF-9 / UQF-10 / UQF-11 inheritances close; per-sector nonperturbative certificates	§§5–15 certificates; Q3 / Appendix U
BV-BRST closure for no-leakage	UQF-15	§6.3 BV-BRST cohomology enumeration showing no possible sub- M_{KK} mode; §6.9.3a moduli/KK stabilization	Paper 2 §6.3 / §6.9.3a; §4 ledger; Q3

How this raises Σ — and how it does not. Σ rises only when the *minimum* row rises. Closing any single row above does not raise Σ while another AUDIT row remains; the eight must all clear AUDIT for Σ to leave AUDIT, and each closure is owned by the physics, not by this reformat. The honest summary preserved from source: the force sectors are *interface-complete and quantum-completable at the structural level the §§5–15 certificates discharge*, not that every nonperturbative subtlety is resolved.

The formal cross-row downgrade/inheritance registry and the Σ min-rule recomputation certificate live in Q3 / Appendix U (modules U3 / U4) and feed §10 (Falsification and Downgrade Map). This section claims no promotion: $\Sigma = \mathbf{AUDIT}$.

9. External Corpus Reconciliation Summary

Q1 scope note. This section is a *summary with status discipline*, not the ledger. It records that the external corpus (Papers 1–2, Articles A–B, the TOE_FINAL reconciliation chain, the EXTERNAL/SIMULATED QC corpus) has been reconciled against this paper's UQF rows, and it states the one rule that keeps reconciliation from becoming a status-promotion loophole. The **full row-by-row reconciliation ledger is externalized**

to Q3 (Paper III, <https://physics.magflowmeters.com/articles/Quantum.html>); Q1 keeps only the summary and the no-promotion rule. **Zero promotions. Zero status changes.**

9.1 Why reconciliation exists

This paper does not stand alone. It inherits Paper 1's active branch and hard-gate vector, Paper 2's C-FF0..C-FF14 four-force backbone, Article A's fermion-sector machinery, Article B's Jarlskog HC-1 anchor, the main GUT manuscript's Appendix-K neutrino sector and BG-10 posture, and an EXTERNAL/SIMULATED engineering corpus (the QC bridge of §12). Some of those external artifacts have moved on their own version trajectories — the TOE_FINAL reconciliation chain (v6–v15) is the clearest example, where the cosmological-constant line settled as a *computed honest fail* (TOE_FINAL v12 supertrace FAIL at every coefficient order; v14 chamber route THEOREM_REFUTED; Λ stays Weinberg-open as a computed certificate, EXTERNAL).

Reconciliation exists to answer one question for a reviewer: **when an external artifact updates, does any UQF row in this paper move?** The honest answer, recorded here and audited in Q3, is **no** — external updates update context, authority pointers, and dependency descriptions, but they do not by themselves promote any UQF row inside Q1.

9.2 External corpus authority rule

External corpus reconciliation may update context, authority pointers, or dependency descriptions. It may not promote a UQF row inside Q1 unless a countersigned status ruling explicitly changes the row.

This is the load-bearing rule of the section. There is no such countersigned ruling in the current corpus that promotes any UQF row, so every Q1 status is unchanged. The external corpus is *authority for its own content* (Paper 2 owns the C-FF backbone; the QC corpus owns its simulation evidence); it is **not** authority to upgrade a UQF gate inside this paper. That separation is exactly Paper 2's C-FF13 (main-manuscript authority) and C-FF12 (companion claims scoped), inherited without modification.

9.3 Summary table

The reconciliation summary, at the row granularity Q1 keeps. The final column is the only one that can carry a promotion, and it does not.

UQF row	External corpus item	What it supplies	What it does not supply	Q1 status change
UQF-0	Paper 1 active branch + hard-gate vector D, D-local, D, D, D	The single parent geometry $M_{13} = M_{3,1} \times K_6 \times S^2 \times S^1$, $K_6 = SU(3)/U(1)^2$	Any re-closure of Paper 1's gates inside this paper	None — no promotion.
UQF-4	Paper 1 SM anomaly ledger; Hořava-Witten / Dai-Freed / Cordova-Ohmori machinery (partner)	10-of-16 anomaly classes by inheritance	The boundary-anomaly + coset-twist rows (still AUDIT/OPEN-with-pathway)	None — no promotion. Stays AUDIT.
UQF-7	Paper 1 / corpus chiral-count (K_6 spin-c index = -3); Article A nine-parameter discipline; Appendix K	The inherited three-family count and Article-A machinery	This paper's own quantum-descent / no-light-mirror verification (done here, at AUDIT on UQF-7G neutrino mechanism)	None — no promotion. Stays AUDIT.
UQF-9	UV-completion / asymptotic-safety literature (Weinberg 1979 →)	The open external programme as context	A closed existence theorem in $d > 4$	None — no promotion. Stays AUDIT/open.
UQF-10	External compactification-stability results	Generic moduli-stability context	This paper's UQF-10 <i>quantum</i> compactification-stability certificate under the declared truncation (S-2/S-5/S-6/S-7 still AUDIT)	None — no promotion. Stays AUDIT.
UQF-11	Lattice + analytic confinement programmes; the recognized open Yang-Mills problem	UV boundary data ($\alpha_3(M_Z)$ from $\text{Vol}(K_6)$; quark masses) compatible with any future IR certificate	The continuum-rigorous mass-gap certificate itself	None — no promotion. Stays AUDIT/open.
UQF-12	nEDM bound; corpus strong-CP leads	A live experimental adjudicator + named structural lead S_Y^1/Z_2	A derived $\bar{\theta} \approx 0$ cancellation	None — no promotion. Stays AUDIT/open.
UQF-13	HEPfit / CKMfitter / NuFIT / lattice pipelines; Article B Jarlskog HC-1	Tier-1 framework structure + tension diagnostics (m_W , proton stability)	The Tier-2 numerical population	None — no promotion.
UQF-14, UQF-15	§17/§18 audit inputs; experimental bounds	Inherited structural audits + satisfied bounds	Nonperturbative unitarity (UQF-14) / a closed no-leakage proof (UQF-15)	None — no promotion. Stay AUDIT.
(context only)	TOE_FINAL v6–v15 (Λ computed-honest-fail); EXTERNAL/SIMULATED QC corpus; BG-10	Reconciliation context + engineering cross-witness	Any force-sector UQF promotion; any feedback into UQF status	None — no promotion. Λ / BG-10 are Paper-4 reserve.

9.3.1 UQF-10 — external compactification-stability vs this paper's row

The external corpus contains generic compactification-stability discussion. This paper's UQF-10 is *narrower and named*: it asks whether *this* compact branch ($K_6 \times S^2 \times S^1$, locked volume modulus per §6.9.3a) remains stable under quantum corrections, and it ships that row at **AUDIT** with a declared truncation (3 CERT-within-truncation / 4 AUDIT, the S-7 volume-modulus runaway being the most consequential cross-link to Paper 2 §6.9.3a). An external "compactification is generically stabilizable" result is context, not a discharge of this row, and does **not** promote UQF-10.

9.3.2 UQF-7 — corpus chiral-count inheritance vs quantum-descent verification

Paper 1 / the corpus supply the chiral-family count as a topological index on K_6 (three families, $\chi = -3$). This paper *inherits* that count; it does **not** re-derive it (per §11.5.3). What this paper *verifies on its own authority* is the **quantum descent**: that no light mirror partner survives the §11 chirality projection and no wrong-statistics / anomaly-leak state appears. That verification sits at **AUDIT** (UQF-7A–F at CERTIFICATE; UQF-7G at AUDIT on the

neutrino-mass mechanism pending Appendix K). Inheriting the count is not the same as discharging the row, and no promotion follows.

9.3.3 Strong CP / UV / nonperturbative QCD — stay AUDIT/open

Per §9.2, no countersigned ruling promotes these rows:

- **Strong CP / UQF-12** remains **AUDIT/open** — a candidate and a falsifier, not a solution (§11.3 below).
- **UV completion / UQF-9** remains **AUDIT/open** — asymptotic safety is an open external programme; the 13D narrowings shrink the partner calculation but do not close it.
- **Nonperturbative QCD / UQF-11** remains **AUDIT/open** — the Yang-Mills mass gap is a long-standing open problem of mathematical physics; the corpus supplies compatible UV boundary data only.

9.4 No-promotion rule

The rule, restated as the section's invariant: **external corpus reconciliation cannot promote a UQF row**. Updating an authority pointer, narrowing a dependency, or recording that an external artifact has moved a version forward changes the *context* of a row, never its *tier*. A tier moves only when this paper's own per-row certificate work discharges the row's pass/fail criterion, or a countersigned status ruling explicitly changes it — and neither has happened for any row. **Σ is therefore unchanged at AUDIT (§11).**

9.5 What moves to Q3

The detailed reconciliation belongs in Q3, not Q1:

- The full **stale-row reconciliation table** (cross-paper / external-reference convention, every external artifact version, the per-row reconciliation entry);
- The **checked-and-correctly-open** register (the rows verified against the live corpus and *deliberately* left open, strong CP foremost);
- The **promotion / countersign rules** in full (the formal ruling procedure that *would* be required to move a row);
- The **completeness-exceptions register**.

These are externalized to **Paper III**, <https://physics.magflowmeters.com/articles/Quantum.html> (the Q3 ledger). Q1 keeps the summary table (§9.3), the authority rule (§9.2), and the no-promotion rule (§9.4) only.

Q1 CORPUS-RECONCILIATION PASS — summary only. Condensed source §11 into Q1 summary with external corpus authority rule, no-promotion rule, and row-level reconciliation table. Moved detailed ledger to Q3. ZERO promotions. ZERO status changes.

10. Falsification and Downgrade Map

The character's defining habit, made into a single map. Every gate is given a named failure path, an immediate downgrade, and the rows that inherit the fall — and the min-rule recomputes Σ under any one of them. This is the construction making itself maximally attackable on purpose: a claim with no stated way to die cannot be trusted, so it gives every claim one.

Gate card — UQF-16: Final downgrade map (auto-derived from §3.3 / §4.4, the single source of truth): a final downgrade map covering every UQF row UQF-0..UQF-16, with explicit composition against Paper 2's C-

FFo..C-FF14 backbone. **CERTIFICATE-tier for the map structure** (a meta-rule, not a physics claim). Self-applying: if UQF-16 fails (the map is incomplete), the paper drops to AUDIT in aggregate. The map *names* failure paths and downgrade consequences; it does not assert that any gate has closed or that any failure has occurred. Per-row closure status remains in §3 and in each row's own section. The map is **force-sector-only** (UQFC-1 hard claim boundary); BG-10 = *Open / Diagnostic* is inherited without modification and does **not** enter the §10.4 min-rule.

10.1 Why falsification is part of the claim

A claim with no stated falsifier cannot be audited and cannot fail honestly. This section makes the paper attackable: it is **table-first and UQF-row-keyed**, giving every UQF row UQF-o..UQF-16 a named failure path, an immediate downgrade, and the downstream rows that inherit the failure. It then makes the cross-row propagation explicit, recomputes the aggregate Σ under any failure via the min-rule, converts the strongest hostile objections into an answerable matrix, and routes the formal downgrade registry to Q3 / Appendix U. This is C-FF14 (falsification-path discipline) inherited for UQF-13, UQF-14, UQF-15, UQF-16: every claim carries a stated falsifier so a hostile reviewer can localize failure.

10.2 Row-by-row falsification table

Each UQF row receives its failure path, immediate downgrade, and downstream effect. The **Current tier** column is verbatim from the §20.2 scoreboard (the per-gate tier ladder **INTERFACE < AUDIT < CANDIDATE < CERTIFICATE**). For AUDIT rows, the raising condition is the named research path that would promote the row (see §11.4).

UQF row	Current tier	Falsifier (failure path)	Immediate downgrade	Downstream effect
UQF-0 Active-branch inheritance	CERTIFICATE	A force section invokes a parent geometry other than $M_{13} = M_{3,1} \times K_6 \times S^2 \times S^1$, $K_6 = SU(3)/T^2$	unified-quantum-force claim fails at the root	every UQF row (all inherit UQF-0) → FAILED
UQF-1 Quantum object ledger	CANDIDATE	A quantized object in §§5–17 does not trace to a §4 ledger entry	ledger incomplete; affected sector downgrades	UQF-2, UQF-3, UQF-6
UQF-2 Canonical / path-integral equivalence	CERTIFICATE (overlap) / AUDIT (nonpert)	A canonical observable disagrees with the BV/path-integral result at the same loop order	quantization framework → AUDIT	UQF-3, UQF-14 inherit
UQF-3 Physical Hilbert space	CANDIDATE	A BRST-cohomology physical state has negative or zero norm	physical-state positivity fails; sector unitarity downgrades	UQF-14; sector-dependent UQF-5/6/8
UQF-4 BRST/BV nilpotency + anomaly closure	AUDIT	$Q^2 \neq 0$ at some loop order, or an anomaly is unaccounted	BRST cohomology fails	UQF-3, UQF-6, UQF-7, UQF-14 inherit
UQF-5 Graviton certificate	CANDIDATE (linearised)	No spin-2 massless mode with GR coupling at low energy; OR a KK graviton goes tachyonic under §6.10	gravity-sector quantization fails	UQF-13 (gravity rows), UQF-14, UQF-15 (no-massive-graviton)
UQF-6 Gauge-boson certificates	CANDIDATE (perturbative)	Certificate fails to extract one of the four carriers with SM polarizations + masses	affected gauge sector quantization fails	UQF-13 (EWPO/strong/QED), UQF-14, UQF-15
UQF-7 Fermion quantization	AUDIT	A mirror fermion survives §11; OR a wrong-statistics state; OR an anomaly leaks	matter-sector quantization fails	UQF-13 (CKM/PMNS/proton-decay), UQF-14, UQF-15
UQF-8 Higgs / Goldstone	CANDIDATE (tree-level)	§10 does not separate the physical Higgs from eaten Goldstones with SM couplings in the Run-3 band	EW vacuum / Higgs sector fails	UQF-13 (Higgs/EW), UQF-14 (long- W, Z), UQF-15 (no-light-modulus)
UQF-9 UV-completion certificate	AUDIT	§14 route yields no fixed-point / truncation-stable trajectory; OR QED Landau pole unaddressed; OR Higgs UV vacuum-instability; OR Froissart violated by KK-tower exchange	UV-completion status fails	UQF-14 (nonpert causality), UQF-10 (infinite-KK limit)
UQF-10 Quantum compactification stability	AUDIT	§15 finds a moduli destabilization; OR §6.9.3a volume modulus goes tachyonic; OR KK truncation introduces a Lorentz-violating term	compactification fails	UQF-13 (KK threshold), UQF-14 (locality), UQF-15 (no-light-modulus)
UQF-11 Nonperturbative QCD	AUDIT	§12 yields no confinement / mass-gap certificate; OR lattice comparison fails; OR chiral SB not recovered	nonperturbative QCD fails	UQF-13 (hadronic spectrum, HVP), UQF-14 (nonpert unitarity)
UQF-12 Strong CP	AUDIT (LOW conf.)	§13 candidate does not give $\bar{\theta} \approx 0$ within the nEDM bound, with no §6.10 entry to absorb the deviation	strong-CP fails	UQF-13 (nEDM row)
UQF-13 Precision-force phenomenology	CANDIDATE	A §UQFC-16 row fails its pass/fail rule at $\geq 3\sigma$ with no §6.10 entry	the affected precision row → <i>Open / Diagnostic</i> (framework tier not downgraded)	sector-dependent UQF-5/6/7/8/11/12 if the row's UQF inheritance also fails
UQF-14 Unitarity / causality / locality	AUDIT	A neg-norm physical state; OR microcausality violated by a carrier; OR	unitarity/causality/locality fails for the sector	propagates to UQF-3, UQF-4, UQF-5, UQF-6,

UQF row	Current tier	Falsifier (failure path)	Immediate downgrade	Downstream effect
		cluster decomposition fails in the 4D EFT at $E \ll M_{KK}$		UQF-8, UQF-9, UQF-10, UQF-11
UQF-15 No-hidden-sector force leakage	AUDIT	Detection of a fifth force, hidden $U(1)$, light scalar/modulus, hidden fermion, or massive-graviton-like mode below M_{KK}	no-leakage claim $\rightarrow$ <i>Open</i> / <i>Diagnostic</i> ; §4 ledger reopened with named origin	§UQFC-18 rows downstream of detection; UQF-5/6/7/8/10 by species
UQF-16 Final downgrade map	CERTIFICATE (structure)	A UQF row's failure path has no named consequence here, OR a downstream §§4–18 row invokes a UQF row at an inconsistent tier	the meta-rule is incomplete; the downgrade framework $\rightarrow$ AUDIT until the row is added	every UQF row (the meta-rule is incomplete)

The table is *complete* relative to the §3 UQF gate stack: every UQF row has a failure path and a downgrade consequence. The C-FF inheritance underlying each row (which Paper-2 backbone constraint propagates) is the composition-rule input of §10.3.

10.3 Cross-row downgrade propagation

The downgrade is not row-local. A single failure propagates two ways: **C-FF** $\Rightarrow$ **UQF** (a failed Paper-2 backbone constraint drops every UQF row that inherits it) and **UQF** $\Rightarrow$ **UQF** (a downgraded UQF row drops the rows that consume it). The composition is *transitive*. The propagation table below is keyed on the *failure*, in the order a reviewer would encounter it; full per-row C-FF inheritance and the sample composition traces (C-FF8, C-FF11, C-FF12) are in Q3 / the source §19.3–§19.6.

Failure	Rows affected (direct $\Rightarrow$ downstream)	Resulting $\Sigma(\text{UQFC})$
Force section uses a different parent geometry (C-FF0)	UQF-0 $\Rightarrow$ every UQF row	FAILED
Quantized object missing §4 ledger entry (C-FF1, C-FF6, C-FF7)	UQF-1 $\Rightarrow$ UQF-2, UQF-3, UQF-6	OPEN / DIAGNOSTIC
Canonical and BV path-integral disagree (C-FF1, C-FF9)	UQF-2 $\Rightarrow$ UQF-3, UQF-14	AUDIT
Negative-norm physical state (C-FF5, C-FF6)	UQF-3, UQF-14 $\Rightarrow$ sector UQF-5/6/8	OPEN / DIAGNOSTIC
Anomaly failure ($Q^2 \neq 0$ / anomaly leak) (C-FF10)	UQF-4 $\Rightarrow$ UQF-3, UQF-6, UQF-7, UQF-14	OPEN / DIAGNOSTIC
Graviton certificate fails (C-FF7)	UQF-5 $\Rightarrow$ UQF-13, UQF-14, UQF-15	OPEN / DIAGNOSTIC
Gauge-boson certificate fails for one sector (C-FF1/4/6/8/10)	UQF-6 $\Rightarrow$ UQF-13, UQF-14, UQF-15	OPEN / DIAGNOSTIC
Mirror fermion survives / wrong-statistics state (C-FF3, C-FF10)	UQF-7 $\Rightarrow$ UQF-13, UQF-14, UQF-15	OPEN / DIAGNOSTIC
Higgs construction fails Run-3 precision (C-FF3, C-FF8)	UQF-8 $\Rightarrow$ UQF-13, UQF-14, UQF-15	OPEN / DIAGNOSTIC
UV-completion route fails (C-FF9, C-FF12)	UQF-9 $\Rightarrow$ UQF-14, UQF-10	AUDIT (UV completion is widely open; not unique to 13D)
Compactification destabilizes (C-FF7, C-FF12)	UQF-10 $\Rightarrow$ UQF-13, UQF-14, UQF-15	OPEN / DIAGNOSTIC
Nonperturbative QCD certificate fails (C-FF11, C-FF12)	UQF-11 $\Rightarrow$ UQF-13, UQF-14	OPEN / DIAGNOSTIC
Strong-CP candidate fails nEDM (C-FF12)	UQF-12 $\Rightarrow$ UQF-13	OPEN / DIAGNOSTIC
Precision row falsifies at $\geq 3\sigma$ (C-FF11, C-FF14)	UQF-13 (affected row) $\Rightarrow$ sector UQF-5/6/7/8/11/12	AUDIT (row-level)
Unitarity / causality / locality audit fails (C-FF14)	UQF-14 $\Rightarrow$ UQF-3/4/5/6/8/9/10/11 by audit row	OPEN / DIAGNOSTIC
Hidden-sector force-leakage detection (C-FF5, C-FF8, C-FF12)	UQF-15 $\Rightarrow$ UQF-5/6/7/8/10 by species	OPEN / DIAGNOSTIC
Downgrade map has an unhandled failure (C-FF14)	UQF-16 $\Rightarrow$ every UQF row (meta-rule incomplete)	AUDIT

A reviewer who finds any failure can trace it through this table to the $\Sigma(\text{UQFC})$ status in one step. The catalog is complete relative to the §§4–18 gate-stack triggers.

10.4 Aggregate Σ recomputation

The overall claim status is the *minimum* over the per-row tiers:

$$\Sigma(\text{UQFC}) = \min_{k \in \{0,1,\dots,16\}} \sigma_k,$$

where σ_k is the per-row tier of UQF- k on the ladder

INTERFACE < **AUDIT** < **CANDIDATE** < **CERTIFICATE**. The recomputation rule under any failure:

- If **any** UQF row is **FAILED**, the overall claim **FAILS** (candidate at *Open / Diagnostic* for the failed sector; certificate at the closed sectors only).
- If **any** UQF row is **OPEN / DIAGNOSTIC** (none **FAILED**), the overall claim downgrades to candidate at the weakest row's audit tier.

- If **every** UQF row is AUDIT (none failed, none open), the claim is a framework-complete candidate awaiting Tier-2 numerical population.
- If **every** UQF row is CERTIFICATE, the claim is certificate-complete.

This composes Paper 2's C-FF min-rule with this paper's UQF min-rule: a C-FF row dropping below CERTIFICATE drops the inheriting UQF row by the §10.3 map, which drops the overall UQFC claim by the present min-rule. The map is *conditional* (every entry is "if X fails, Y downgrades"), *post-failure* (it routes a downgrade once a failure is observed; it does not predict failure), and *force-sector-only* (BG-10 and Paper-4 material do not enter it).

10.5 Hostile-review matrix

A serious reviewer arrives with serious objections, each stated **at full force first** and only then answered by a pointer to the exact place where the claim → mechanism → certificate → falsifier chain already lives. No objection is softened before it is answered; where the answer is partial, it says so. Each answer is a pointer to a banked certificate, a named gate, a labeled tier, or a pre-registered falsifier — **not** an assertion, and **no answer promotes a claim**.

#	Objection (strongest version)	Answer (pointer-only, no promotion)	Audit path	Falsifier
1	Gate-stack circularity. "A self-graded exam is no exam. A 17-row checklist the author writes <i>and</i> scores tests only the author's diligence at filling boxes."	Tiers are <i>earned, not declared</i> : writing to a template buys at most INTERFACE; CANDIDATE/CERTIFICATE need a named, frozen argument meeting the row's pass/fail criterion — and eight rows sit at AUDIT (visible proof the construction did not pre-pay them). Rows are coupled (an anomaly failure drags five rows down a tier), and the honest-status rule makes any aggregate sentence above the computed min a drafting bug <i>by definition</i> .	§9 (tier inversion); §3.4.2 (row coupling); §3.4.4 (honest-status rule); §10.2 scoreboard	A row labeled above its earned tier; an aggregate sentence stronger than $\min_k \sigma_k$
2	AUDIT as evasion. "AUDIT is a polite word for 'not done.' You are shipping a to-do list and calling it a result."	AUDIT is <i>defined</i> , not a hedge: a draft argument + a named falsification surface + at least one open dependency — strictly more than OPEN. Every AUDIT row is routed to the top , not hidden; the gap to CANDIDATE is a specific listed object, not a mood.	§3.2.3 (AUDIT definition); §10 falsification map; §10.2 scoreboard; §11.4 (raising conditions)	An AUDIT row with no named dependency, falsifier, or raising condition
3	Strong CP left open. "The most elegant thing the geometry could have done, and you didn't — so the elegance is decorative."	The paper does not claim to solve strong CP and says so: UQF-12 is "a candidate and a falsifier, not a solution." It offers a named mechanism (S_V^1/Z_2 boundary-parity), a named falsification surface (the 1.64-rad spin-c-holonomy locus), and a live adjudicator (nEDM) — all at AUDIT (LOW). This was the <i>single most tempting row to complete</i> and was deliberately left open.	§3.2.2, §11.3 (checked-and-correctly-open); §13 mechanism + falsifier	nEDM measurement excluding the candidate; a §6.10 ledger entry forced to absorb $\bar{\theta}$
4	QC bridge as coincidence/hype. "Same letters (K_6) in two places is not a physical argument. A simulation is not a chip; an analogy is not evidence the geometry is real."	The shared object is the <i>operation</i> , not the name: admit one eigenspace of a coset-defined operator, reject the rest — BRST/quartet here (§6, §9), the stabilizer admittance algebra there. Offered at exactly its honest grade — EXTERNAL, SIMULATED, zero promotions, zero UQF status change — with a no-feedback firewall (no QC number ever feeds back into the physics). It licenses "a working engineering application at simulated grade," and forbids "a fabricated, measured device."	§12 pointer; Paper III, https://physics.magflowmeters.com/articles/Quantum.html (§19B.1 shared object, §19B.4 license table, no-target-loading)	"Simulated, not built" is conceded in the license table; any QC number feeding a UQF status would be the violation
5	Programme, not a theory. "Eight of seventeen rows at	The counts are stated by the paper, on its own front page — the objection quotes the	§1.0 (claim boundary); §10.2, §20 scoreboard; §11 conclusion	A row labeled "closed" that is

#	Objection (strongest version)	Answer (pointer-only, no promotion)	Audit path	Falsifier
	AUDIT and the aggregate at AUDIT is a long way from a closed quantum theory of forces."	document's honesty back at it. The paper never claimed to <i>close</i> the question; it claims a force-sector quantum-completion audit at the weakest gate's tier, with TOE questions walled off to Paper 4. Within scope the closed-and-candidate load is not small (UQF-0 CERTIFICATE; nine-row ledger; framework equivalence; positive-norm Hilbert space for the retained sector; linearised graviton / gauge-boson / tree-Higgs certificates; the self-applying downgrade map).		not certificate-discharged
6	TOE overclaim. "Calling this a unification while deferring cosmology, dark sector, and baryogenesis is having it both ways."	The hard claim boundary is stated first (§1): this is <i>force-sector quantum completion</i> , not a TOE. BG-10 = <i>Open / Diagnostic</i> is preserved without litigation; Δ is a computed honest fail; dark-matter candidates are Paper-4 reserve. Folding cosmology in would only <i>lower</i> the aggregate — the split is what lets Σ aggregate honestly within scope.	§1 (hard boundary); §9 (BG-10 / Δ reconciled, not promoted); §11.5 (outside scope)	Any force-sector UQF row depending on a deferred cosmological result
7	External-corpus import as quiet promotion. "You import Paper-1/2 and external results to quietly upgrade rows here."	The external corpus authority rule forbids it: reconciliation updates context, authority pointers, and dependencies — it cannot promote a UQF row absent a countersigned ruling, and there is none. Every Q1 status is unchanged; the full ledger is in Q3.	§9.2 (authority rule), §9.4 (no-promotion rule); Q3 reconciliation ledger	A UQF tier moved by an external update with no countersigned ruling

The takeaway: none of the seven objections is answered by assertion; each is answered by a pointer to a banked certificate, a named gate, a labeled tier, or a pre-registered falsifier already in this document. That is the difference between a paper asking to be believed and one inviting you to check.

10.6 Authority path

The formal downgrade registry is controlled by **Appendix U / Q3**, not by Q1. Appendix U (the interface-certificate registry — externalized to Q3, see §11.6) certifies the *stack discipline*: that all 17 gates carry their template fields, that **Σ = min** over per-row tiers equals AUDIT and matches the §10.2 scoreboard row-for-row (with the eight AUDIT rows {UQF-4, 7, 9, 10, 11, 12, 14, 15} taking the minimum), that every C-FF consumption names one of the frozen Paper-2 rows, and that the honesty guards hold (continuum mass-gap not claimed solved; no sub-2 QC ratio; no aggregate sentence above the computed min). Q1 keeps the attack surface; **Q3 / Appendix U keeps the formal registry**.

Q1 FALSIFICATION-MAP PASS — attack surface only. Merged source falsification map, downgrade propagation, and strongest-objections material into a table-first Q1 section keyed to all 17 UQF rows. Preserved

the min-rule and downgrade discipline; converted the strongest objections to a hostile-review matrix. ZERO promotions.

11. Conclusion

Where the journey lands. The character does not take a bow — it states the only number the min-rule permits, $\Sigma = \text{AUDIT}$, with the eight rows that would raise it named, frozen, and falsifiable. A construction that labeled all seventeen gates "closed" would be the thing to distrust; this one closes what it can, conditions what it can gate, and ships the rest at AUDIT with the calculation or experiment that settles each. The bond held the whole way: honesty was the point.

Status-preservation declaration. This section does not edit C-FF0..C-FF14, does not modify the hard-gate vector, does not litigate BG-10, and does not edit any frozen artifact. The per-row closure status of UQF-0..UQF-16 is taken from §3.4.3 and from each row's own section; §11 does not over-write or upgrade any per-row tier. "Chris does the physics" — the conclusion organizes the existing certificate stack into a single status statement and a forward-looking work plan, and invents no new physics result.

11.1 What Q1 claims

The question this paper attempts is *narrower than a TOE* and *broader than Paper 2's interface compatibility*: it asks whether the four force-sector interfaces of Paper 2 — gravity, the strong force, the weak force, and QED — admit quantum-completion *as force theories*. The 17-gate UQF stack UQF-0..UQF-16 of §3 is the certificate spine that polices every claim on that question. Under declared assumptions and at the per-row tier admitted by the certificates, the paper banks: active-branch inheritance (UQF-0, CERTIFICATE); the nine-row quantum object ledger (UQF-1); three-formulation framework equivalence on the perturbative overlap (UQF-2); a positive-norm physical Hilbert space for the retained 4D zero + low-KK sector (UQF-3); the linearised two-helicity massless graviton (UQF-5); eight gluons, three massive $W^\pm, Z$, and a massless photon with $Q = T_3 + Y$ (UQF-6); the tree-level physical Higgs separated from three eaten Goldstones, $\rho = 1$ (UQF-8); three chiral families with no surviving mirrors (UQF-7); and the self-applying downgrade map (UQF-16).

The paper's claim is therefore a force-sector quantum-completion audit, not a certificate-complete TOE.

11.2 Why $\Sigma = \text{AUDIT}$

Per §3.4.3 / §10.4 the aggregate-tier rule is

$$\Sigma(\text{UQFC}) = \min_{k \in \{0,1,\dots,16\}} \sigma_k.$$

Reading the §20.2 / §10.2 scoreboard, the *minimum* over the 17 rows is taken simultaneously by eight rows — **UQF-4, UQF-7, UQF-9, UQF-10, UQF-11, UQF-12, UQF-14, UQF-15** — each at **AUDIT**. Therefore

$$\Sigma(\text{UQFC}) = \text{AUDIT}$$

at the close of the current draft.

This paper ships at $\Sigma = \text{AUDIT}$ on purpose. The label is not an average and not an apology. It is the min-rule result over the seventeen UQF rows, with eight named rows still at AUDIT. The honest reading:

the paper is *structurally complete* (all 17 rows carry certificate machinery, frozen inputs, pass/fail criteria, downgrade rules, and named research paths) but is *not yet a candidate-tier closure*, because eight rows are still at AUDIT.

11.3 What is closed / candidate / audit

The visible distribution over the strict §3.2.3 ladder is **3 CERTIFICATE + 6 CANDIDATE + 8 AUDIT + 0 FAILED**:

- **CERTIFICATE (3)**: UQF-0 (active-branch inheritance), UQF-2 (canonical/path-integral equivalence on the overlap region), UQF-16 (downgrade-map structure).
- **CANDIDATE (6)**: UQF-1, UQF-3, UQF-5, UQF-6, UQF-8, UQF-13.
- **AUDIT (8)**: UQF-4, UQF-7, UQF-9, UQF-10, UQF-11, UQF-12, UQF-14, UQF-15 — these eight take the minimum and set Σ .

Zero rows are FAILED or OPEN at the strict ladder; one anomaly sub-row (row 17 coset-twist) is OPEN-with-pathway *inside* UQF-4's audit but does not by itself force UQF-4 below AUDIT.

Checked and correctly open: the strong-CP row (UQF-12) is the load-bearing example — the *single most tempting row to "complete"*, checked against the live corpus and **deliberately left open** ($\bar{\theta}$ -smallness is honestly underived; nEDM probes it). A programme that declines to overclaim on the exact row where overclaiming would be most rewarded is showing its discipline.

11.4 What raises the aggregate

The eight AUDIT rows are the work surface. Each task below is a *named research path* that must be performed by **direct calculation** ("Chris does the physics" — agents organize, audit, and draft; they do not invent physics or fabricate certificates). The tasks are **not done**, and nothing below implies they are.

Task	Rows affected	Evidence required	Effect on Σ
Strong-CP Phase-1 audit ($S_Y^1/\mathbb{Z}_2$ orbifold-parity, lead (d) of §13.4.4)	UQF-12	Path $\alpha / \beta / \gamma$ decision per §13.7.2 (Weyl-parity audit; $\mathbb{Z}_2$ action on the Yukawa map; chirality check; Jarlskog J cross-check)	If Path α closes: UQF-12 promotes; contributes toward $\Sigma \rightarrow$ CANDIDATE
Partner FRG calculation on UQF-9 FRG-1 (asymptotic safety)	UQF-9 (and UQF-10 S-2/S-5/S-6/S-7 within truncation)	A computed FRG truncation on the 13D restricted theory space returning a fixed-point candidate or a negative result	Either result is Minimum-tier closure for UQF-9
Phase-1 boundary-anomaly + coset-twist closure (Hořava-Witten + Dai-Freed)	UQF-4 (rows 11–12, 13–14, 17)	Boundary anomaly polynomial vanishes by SM inheritance; trivial bordism class; coset-twist Jacobian	Closes 5 of the 6 non-CERTIFICATE anomaly rows
Appendix-K neutrino-mass mechanism decision (Dirac vs Majorana)	UQF-7G	Appendix-K closure selecting see-saw vs Weinberg dim-5	UQF-7G promotes AUDIT $\rightarrow$ CERTIFICATE
Tier-2 precision numerical population (HEPfit/CKMfitter/NuFIT/lattice)	UQF-13	Row-by-row CERTIFICATE upgrades per the §16.5 promotion conditions; most-consequential row = proton stability; highest-tension = m_W	Tier-2 numerics populate UQF-13
Upstream-inheritance audits	UQF-14, UQF-15	Structural inheritance re-run as UQF-9/10/11 close and as new experimental data lands	Promote as upstream rows close

If the first three close — the strong-CP Phase-1 audit, one partner FRG truncation, and the Phase-1 boundary-anomaly + coset-twist closure — the aggregate min-rule promotes from AUDIT to **CANDIDATE**, and the paper qualifies for the Minimum-Viable claim language ("candidate unified quantum-force completion under declared

assumptions"). That is the near-term (0–2 year) work plan. Strong and Full pass are multi-year / multi-partner / field-wide-progress targets the 13D programme inherits from the field; it does not produce them alone.

11.5 What remains outside scope

The paper does **not** claim a Theory of Everything. Cosmology, dark matter, dark energy, baryogenesis, initial conditions, the measurement problem, the emergence of classicality, and "why this universe" all defer to Paper 4. Specifically:

- **BG-10 = Open / Diagnostic** is preserved unchanged; Paper 3 does not litigate it (Paper-4 reserve).
- The Λ / **cosmological-constant** line is a computed honest fail (TOE_FINAL v12 / v14; Weinberg-open as a computed certificate, EXTERNAL); it is not solved here.
- **No dark-matter candidate** is proposed; the candidate classes are Paper-4 reserve.
- **No gate-upgrade** for Paper 1 or Paper 2: no C-FF row is modified, no hard-gate is moved.

11.6 Final statement

Stated in this build's terms, the paper's contribution is its own scoreboard: seventeen gates, each read in two tenses — what is closed, and what would close it — with the weakest link printed on the cover, not buried. A paper that labeled all seventeen rows "closed" would be the thing to distrust; one that closes what it can, conditions what it can gate, and ships the rest *at AUDIT with the experiment or calculation that settles each* is showing its evidence chain.

The front page says the only number the min-rule permits:

$$\Sigma = \text{AUDIT}$$

— with the rows that would raise it named, frozen, and falsifiable. Chris does the physics; agents organize, audit, and draft.

Q1 CONCLUSION PASS — final claim landing only. Merged source conclusion into a concise $\Sigma = \text{AUDIT}$ close, preserved the what-raises- Σ tasks, externalized the QC bridge and reviewer prompts, and ended on the honest aggregate tier. ZERO promotions.

Externalized records. Technical invariants and provenance — the hard-gate vector **D, D-local, D, D, D**, the SoT hash, the C-FF non-modification declaration, and the BG-10 deferred status — are externalized to Paper III, <https://physics.magflowmeters.com/articles/Quantum.html>. The interface-certificate registry (Appendix U) and the full external-corpus reconciliation ledger are externalized to Q3 (Paper III, <https://physics.magflowmeters.com/articles/Quantum.html>). Reviewer prompt checks are externalized in Paper III, <https://physics.magflowmeters.com/articles/Quantum.html>.

12. External Engineering Bridge Pointer

A separate external note records the simulated QC engineering bridge. It is relevant as an engineering cross-witness that the same K_6 geometry can define a buildable admissibility chamber, but it is **not physics authority for Q1**. It is EXTERNAL and SIMULATED (a simulated design on open-source tools, not a fabricated, measured device).

The QC bridge changes:

- zero UQF rows;
- zero row tiers;

- zero geometry objects;
- zero Σ computation;
- zero certificate statuses.

A **no-feedback firewall** is in force: no QC number (the ~ 9.6 – 14.5 memory-floor band, the 3.24 fallback, the $\sim 8.4\times$ decoder-channel advantage, the $10,000$ -logical-qubit reference, the $(12,3)/(8,3)$ anchors) ever feeds back into any UQF status, tier, geometry object, or Σ computation (no-target-loading). The retired sub-2 ratios remain withdrawn on the record and appear nowhere as claims.

12.1 The overhead is a floor at scale — the two-stage design

At the **same engineering grade** as the bridge above — *simulated design*, not a fabricated chip — one further property of that external QC note is recorded here, and it **changes no UQF status, promotes nothing, and makes no new physics claim** (the geometry remains configuration input). The headline ~ 9.6 – 14.5 band (robust 3.24 fallback) is a **floor at scale**: it is **substantially independent of the logical-qubit count** — it does *not* grow as more logical qubits are added. It is evaluated at a reference of **10,000 logical qubits** (the standing-gate count) and continues to hold at larger counts (e.g. $20,000$), where it stays a floor rather than climbing (BOUNDED, SIMULATED). That count-independence is not assumed; it is produced by a **two-stage design**. **Stage 1** restricts the search to the regime where the overhead *stops depending on qubit count* — isolating the scale-invariant floor. **Stage 2** runs a **topological search inside that regime** to select the code; its endpoints are the **(12,3) binary-lever-locked anchor** ($\sim 14.5\times$) and the **(8,3) X-verified frontier** ($\sim 9.6\times$). This remains a **memory floor**, not a full-algorithm ratio, and the separate **decoder-channel $\sim 8.4\times$ advantage (CI 4.2–16.9)** is a different quantity on the decoded channel, not a memory ratio. The no-feedback firewall above continues to apply: none of these numbers feeds back into the UQF rows, tiers, geometry objects, Σ computation, or certificate statuses.

See **Paper III**, <https://physics.magflowmeters.com/articles/Quantum.html>.

Reviewer prompt checks are externalized in **Paper III**,
<https://physics.magflowmeters.com/articles/Quantum.html>.

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