# THE MASTER MAP

## An Audit-First Navigation Guide to the *Conditional* Construction of 4D $SU(N)$ Yang–Mills with Mass Gap — the Audited-Ledger Edition

Polymer Activities ⇒ KP ⇒ Clustering ⇒ OS ⇒ Wightman, with named hypothesis loads at every node; including the Triangular Mixing Lock (corrected)*

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**Abstract**

This is the navigation guide and audit manifesto for the 2602-series programme on 4D $SU(N)$ Yang–Mills. Version 2 is the audited-ledger edition: the dependency graph, Clay/Jaffe–Witten checklist and threat model of v1 are retained, but every node is now pinned to its audited version and carries its named hypothesis loads; the claim is stated as what it is — a *conditional* assembly: relative to the declared external mathematics (abstract KP, OS reconstruction, lattice reflection positivity) *and* to the internal ledger {(H1), (H2)+$\beta_{\mathrm{LF}}$, (H3), (H2′), (H-LOC), per-scale decoupling, (H-R$\beta$), (H-P0′), structural+window loads, $\lambda \neq 0$ traceable}, the chain assembles OS0–OS4 and OS1 and reconstructs a Wightman QFT with mass gap. v1's "unconditional" (in any sense) is withdrawn. Version 2 also corrects two mathematical defects in v1's new material: the hypercubic harmonic's coefficient (3/5, the $d = 3$ value) is corrected to 1/2 in $d = 4$; and the Large-Field Annihilation Lemma's hypothesis $p_0(\bar{g}) \geq c/\bar{g}^2$ — attributed to a source whose actual profile is $(A_0 \log \bar{g}^{-2})^{p_*}$ — is replaced by the honest (H2′) trichotomy. The genuinely structural new content survives and is machine-verified: the marginal anisotropic sink at $d = 4$ is empty (exact group averaging over $W_4$ on $\mathrm{Sym}^2(\Lambda^2\mathbb{R}^4)$: quotient dimension 0, versus 1 at $d = 6$), hence renormalization mixing is triangular in the anisotropic channel and the $a^2 \times a^{-2} \to O(1)$ objection has no landing site.

*__Version 2.__ Audited replacement of v1 within the programme-wide verification pass (2602.0041 v3, 0051–0057 v2, 0063 v3, 0069–0077 v2, 0087 v3, 0088 v3, 0089 v2, 0091 v2, 0092 v2). Principal changes: (i) **F-UNCOND**: the title's "Unconditional Solution" and the §1.3 claim box are withdrawn — even in v1's internal sense ("no hidden assumptions beyond KP/OS/RP") the claim is false against the audited chain: the composed load set (2602.0092 v2) contains internal hypotheses not covered by the declared external inputs. (ii) **F-HARM** (mathematical error): the harmonic polynomial of §8.3 was written with the $d = 3$ coefficient 3/5; in $d = 4$ the correct coefficient is 1/2 (with 3/5 the claimed $L^2(S^3)$-orthogonality fails: $\langle h, 1\rangle = -1/10$); corrected and machine-verified. (iii) **F-P0-INFLATION** (serious): v1's Lemma 6.4 assumed $p_0(\bar{g}) \geq c/\bar{g}^2$ "as audited in Paper KP" — the actual (H2) profile of 2602.0091 v2 is $(A_0 \log \bar{g}^{-2})^{p_*}$ (log-power); the power-law hypothesis appears in no source and the correct statement is the (H2′) trichotomy. (iv) **F-CANIM**: the "shock absorber" constant $C_{\mathrm{anim}} = 512$ costs margin ($\kappa > 6.24$) relative to the exact audited counts ($\kappa > 3.08$); the margin table is now honest. (v) **F-STALE-§7**: the Pillar II synopsis ("unconditional LSI anchored at $N_c/4$", "DLR-LSI in full", "RG-Cauchy pointwise unconditional") is rewritten with the audited statuses. What survives fully: Lemma 8.1 (empty marginal anisotropic sink at $d = 4$ — now machine-verified by exact group averaging), the triangular mixing statement as its structural consequence, the Jacobian-free Ward posture, the threat model and the dependency graph (now version-pinned). Companion suite `verification/2602-0096/`, 6/6 PASS.

# 1 Scope, Posture, and External Inputs

## 1.1 What this paper is (and is not)

As v1: an audit map, not a technical layer — it fixes evaluation order and matches attack vectors to verification lanes. New in v2: the map itself has been audited, and its job description changes accordingly — it no longer certifies closure; it *routes* the auditor to the named open loads.

## 1.2 External mathematics (declared)

Kotecký–Preiss [1]; OS reconstruction [2]; lattice reflection positivity [3]. Unchanged.

## 1.3 The claim (corrected)

Relative to the external inputs above **and** to the internal audited ledger

$$\mathcal{L} = \{(\text{H1}),\ (\text{H2}) + \beta_{\text{LF}},\ (\text{H3}),\ (\text{H2}'),\ (\text{H-LOC}),\ \text{L6.2-import},\ (\text{H-R}\beta),\ (\text{H-P0}'),$$

$$\text{0069-structural} + \text{window},\ \lambda \neq 0 \text{ traceable}\},$$

the companion chain (2602.0088 v3, 0087 v3, 0091 v2, 0092 v2) assembles OS0–OS4 and OS1 and reconstructs a Wightman QFT with unique vacuum and $\Delta_{\text{phys}} \geq c_N \Lambda_{\text{YM}} > 0$ at weak coupling. *No element of $\mathcal{L}$ is implied by the external inputs; v1's "unconditional" is withdrawn in both the institutional and the internal sense.* [Suite check 6.]

# 2 The Companion-Paper Chain (Four Pillars, version-pinned)

Pillar 1: terminal KP block — 2602.0091 **v2** (source-mapped, conditional). Pillar 2: clustering/mass gap + OS0/2/3/4 — 2602.0088 **v3** (OS0/2/3 unconditional at lattice level; the rest conditional). Pillar 3: Symanzik/ anisotropy/insertions + the Triangular Lock — 2602.0087 **v3** (windowed/conditional) + §8 below (corrected). Pillar 4: OS1 via Jacobian-free Ward — 2602.0092 **v2** (conditional). The IR/LSI route and its consolidation: 2602.0041 v3/0051–0057 v2, 0053/0054 v2, 0089 v2 (windowed (H-CA)). Continuum capstone: 2602.0063 v3.

# 3 Dependency Graph and Checklist

The graph of v1 stands with version pins and status tags on every arrow (the corrected table is that of 2602.0092 v2 §5: OS0/2/3 load-free; OS4, OS1, gap, non-triviality conditional). The checklist's "Where" column now cites audited versions only.

# 4 Threat Model — statuses attached

T1 (Balaban black box): answered by 2602.0091 v2's source map — *at the price of* (H2)'s $\beta_{\text{LF}}$/profile loads; the answer is a routing, not a discharge. T2 (two-regularization collision): the two-layer contract survives as an *interface specification*; its quantitative content is the per-scale decoupling import (the L6.2 load of 0088 v3) and (H-CAUCHY)-class summability (0073 v2, conditional) — v1's "RG-Cauchy pointwise unconditional" is withdrawn. T3 (diagonal limits):

uniformity enters exactly at the named loads (KP block for volume uniformity; window for the LSI route — see 0089 v2's $(\text{H-CA})_{\text{win}}$ vs $(\text{H-CA})_\infty$ split). T4 ($a^2 \times a^{-2}$): blocked structurally by §8 — this one is a genuine kill, load-free, because it is representation theory [checks 1, 3].

# 5 Structural Statements — corrected

## 5.1 KP margin (F-CANIM corrected)

With the crude count $C_{\text{anim}} = (2d)^3 = 512$ the margin condition is $\kappa > \log 512 = 6.238$; with the exact audited counts (animals containing a fixed block in $d = 4$: 1/8/84 for $n = 1/2/3$, growth $\leq 2de = 21.75$) it is $\kappa > \log(2de) = 3.078$. The crude constant *costs* 3.16 of margin — v1's "shock absorber" framing is inverted; the honest table is in the suite [check 4]. The abstract mechanism (margin positive $\Rightarrow$ KP stable under sub-optimal constants) survives.

## 5.2 Large-field suppression (F-P0-INFLATION corrected)

v1's Lemma 6.4 assumed $p_0(\bar{g}) \geq c/\bar{g}^2$, attributing it to Paper KP. The actual audited profile is $p_0(\bar{g}) = (A_0 \log \bar{g}^{-2})^{p_*}$ (2602.0091 v2, (H2)); the power-law hypothesis appears in no source and is exponentially stronger. Under the true profile, $e^{-p_0(\bar{g})} \leq \bar{g}^m$ is the (H2$'$) trichotomy *per exponent* $m$: false for $p_* < 1$; $A_0 \geq m/2$ needed at $p_* = 1$; onset $\ell_* = ((m/2)/A_0^{p_*})^{1/(p_*-1)}$ for $p_* > 1$ [check 5]. v2 restates the lemma conditionally on (H2$'$)($m$) and strikes the super-polynomial claim.

## 5.3 Two-layer decoupling (interface contract — status)

The contract of v1 (layers interact only through Doob-type influence bounds; step differences $\leq Ca_k^2$) is retained as the *specification* the interface papers must meet; its quantitative realisation is conditional ((H-DEC/AT)-class per 0070/0072 v2; (H-CAUCHY) per 0073 v2/0063 v3). The gradient-flow companions remain unaudited (queue).

# 6 Pillar II Synopsis — audited statuses (F-STALE-§7)

Corrected synopsis, one line per claim of v1's §7: RG-Cauchy uniqueness: *conditional* ((H-CAUCHY); 0073 v2). Orbit-space Ricci $N_c/4$ via O'Neill: the constant is verified (0089 v2 check 1) but the "unconditional coupling-independent LSI" reading is withdrawn — the audited seed is Holley–Stroock with price $e^{-C/g^2}$ (0041 v3/0055 v2/0089 v2); the geometric route founders on the flat gauge directions (0089 v2, Rmk 3.3 there). Martingale decomposition: exact (verified repeatedly across the suites). Cross-scale damping $D_k \leq Ce^{-2\kappa}2^{-3k}$: arithmetic fine, inputs conditional ((H-YGZ)/(H-DOB-blk) class). RCD$^*$/blind singularities: audit pointer only, no load-bearing use. DLR-LSI "in full": *windowed and conditional* (0053/0054 v2; $(\text{H-CA})_{\text{win}}$, 0089 v2). Terminal gap / "OS4 unconditionally": conditional (0088 v3). RP/OS2: unconditional (Osterwalder–Seiler) — correct in v1.

# 7 Mathematical Lockbox: Triangular Mixing (corrected and verified)

**Lemma 7.1** (Empty marginal anisotropic sink; v1 Lemma 8.1 — **verified**)**.** *In $d = 4$, the space of gauge-invariant $W_4$-scalar operators of classical dimension 4 contains no $O(4)$-breaking element.*

*Machine verification* [check 1]: on $\mathrm{Sym}^2(\Lambda^2\mathbb{R}^4)$ (dimension 21, quadratic forms in the field strength), exact averaging over the 384 elements of $W_4$ gives invariant dimension **1**; random $SO(4)$ averaging plus a reflection gives $O(4)$-invariant dimension **1** (the $\varepsilon$-pseudoscalar drops in both cases under reflections); quotient $= 0$. Contrast $d = 6$ (quartic model, 0087 v3): quotient $= 1$. The sink is empty exactly at the marginal dimension.

**Theorem 7.2** (Triangular mixing; v1 Thm 8.5 — structural consequence)**.** $Z_{4\leftarrow 6}(\mathcal{O}_6^{W_4,\mathrm{aniso}}) \subset \{O(4)$*-invariant* $d = 4$ *data*$\}$*: with the* $d = 4$ *anisotropic target space* $= \{0\}$ *(Lemma 7.1), any quadratic divergence generated by the* $d = 6$ *anisotropic insertion can only renormalise the isotropic coupling. The* $a^2 \times a^{-2} \to O(1)$ *objection has no landing site [toy RG exhibit, check 3]. This kill is load-free (representation theory); what remains conditional is everything* quantitative *about* $c^{(k)}_{6,\mathrm{aniso}}$ *(0087 v3's loads).*

## 7.1 Symanzik basis and the harmonic (F-HARM corrected)

The anisotropic projector is evaluation against the hypercubic harmonic, which in $d = 4$ is

$$h_{\mathrm{aniso}}(p) = \sum_{\mu=1}^{4} p_\mu^4 - \frac{1}{2}\,(p^2)^2,$$

*not* $\Sigma p^4 - \frac{3}{5}(p^2)^2$ as in v1: on $S^3$, $\mathbb{E}[p_\mu^4] = 3/(d(d+2)) = 1/8$, so $\mathbb{E}[\Sigma p^4] = 1/2$ and orthogonality to $O(4)$-invariants forces the coefficient $1/2$; with $3/5$ one gets $\langle h, 1\rangle_{S^3} = -1/10 \neq 0$ and the projector is not a projector. ($3/5$ is the $d = 3$ value: $\mathbb{E}[\Sigma_3 p^4]_{S^2} = 3/5$.) Consistent with 0087 v3 (machine-verified there); re-verified here [check 2].

## 7.2 Jacobian-free Ward posture

Proposition 8.7 of v1 stands, aligned with 2602.0092 v2 (where the mechanism is exhibited exactly on the lattice Gaussian model).

# 8 Quantum-Information Bridge

As v1: declared non-load-bearing diagnostic. Unchanged; not audited beyond that declaration.

# 9 Auditor Workplan

The falsification points of v1 remain, now phrased against the ledger: each entry of $\mathcal{L}$ is a falsification point; the suites of `verification/2602-*` are the mechanical layer; the open analytic tasks are exactly the ledger entries (plus the unaudited gradient-flow companions). The map's promise is traceability, not closure.

### Note added in v2

Findings F-UNCOND (title, claim box, and §3.1's internal-sense "unconditional" withdrawn), F-HARM ($3/5 \to 1/2$, $d = 3$ value identified as the source of the error), F-P0-INFLATION (power-law $p_0$ hypothesis struck; (H2′) trichotomy restored), F-CANIM (margin table honest), F-STALE-§7 (synopsis re-tagged). Surviving and newly verified: Lemma 7.1 (empty $d = 4$ sink, quotient 0 vs 1 at $d = 6$), Theorem 7.2, the threat model as routing, the dependency graph version-pinned. Suite: `verify_2602_0096.py`, 6 deterministic checks, exit 0 iff 6/6.

## References


[1] R. Kotecký, D. Preiss, Comm. Math. Phys. 103 (1986) 491.

[2] K. Osterwalder, R. Schrader, Comm. Math. Phys. 42 (1975) 281.

[3] K. Osterwalder, E. Seiler, Ann. Phys. 110 (1978) 440.

[4] L. Eriksson, ai.viXra:2602.0091 **v2** (KP block, source-mapped).

[5] L. Eriksson, ai.viXra:2602.0088 **v3** (clustering/mass gap).

[6] L. Eriksson, ai.viXra:2602.0087 **v3** (Symanzik/anisotropy).

[7] L. Eriksson, ai.viXra:2602.0092 **v2** (OS1 Ward).

[8] L. Eriksson, ai.viXra:2602.0089 **v2** (LSI route consolidation).

[9] L. Eriksson, ai.viXra:2602.0063 **v3** (continuum capstone).

[10] L. Eriksson, ai.viXra:2602.0069 **v2** (structural bridge).

[11] L. Eriksson, ai.viXra:2602.0073 **v2** (RG–Cauchy, (H-CAUCHY)).

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[14] D. Bakry, M. Émery, Sém. Prob. XIX, 1985.

[15] M. Lüscher, JHEP 2010:08, 071.