

Charge Participation and Coarse Graining in VERSF

From derived history reductions to a test of gauge response

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General Reader Summary

This paper develops a possible explanation for why one underlying substrate can produce different force strengths. In VERSF, particles are persistent patterns in that substrate. Different particle patterns participate in different interactions, so a shared adjustment need not affect every interaction equally.

The established $K = 7$ history calculation uses a centre and six surrounding points. Colour participation covers 36 occupied states, weak participation 26, and hypercharge participation 47. One common substrate response gives reductions of 6.19%, 4.47% and 8.09%. The counts fix their relative balance; the inherited D41 calculation fixes their magnitude. No measured force strength selects these percentages.

The history calculation fixes how much the shared part of the response shrinks while leaving differences within the participating patterns untouched. Replacing that response with separate or partly separate responses changes the result. The shared response is therefore fixed for the patterns the calculation probes. This does not yet tell us how a force feels that response: different ways of coupling to the same response remain possible.

Applying that collective response to the starting charge coefficients 6, 6.5 and 10.5 gives 5.63, 6.21 and 9.65. This direct construction makes the proposed force relationship concrete. The remaining task is to establish that a force perturbation retains the same response through the source dynamics and coarse graining. It requires no deeper substrate layer or separate external medium. A further closure test shows why the states would all pull together if only one shared participation pattern can persist; applying that requirement to the force coupling remains the specific source check.

The paper establishes the unequal history response, the uniquely fixed collective subtraction on the participation span, and a conditional mapping to force coefficients. This does not prove uniqueness among every possible microscopic coupling. The weak-angle comparison is about 0.11% high at one loop and 1.38% high with higher-order transport; both remain conditional on the physical force identification.

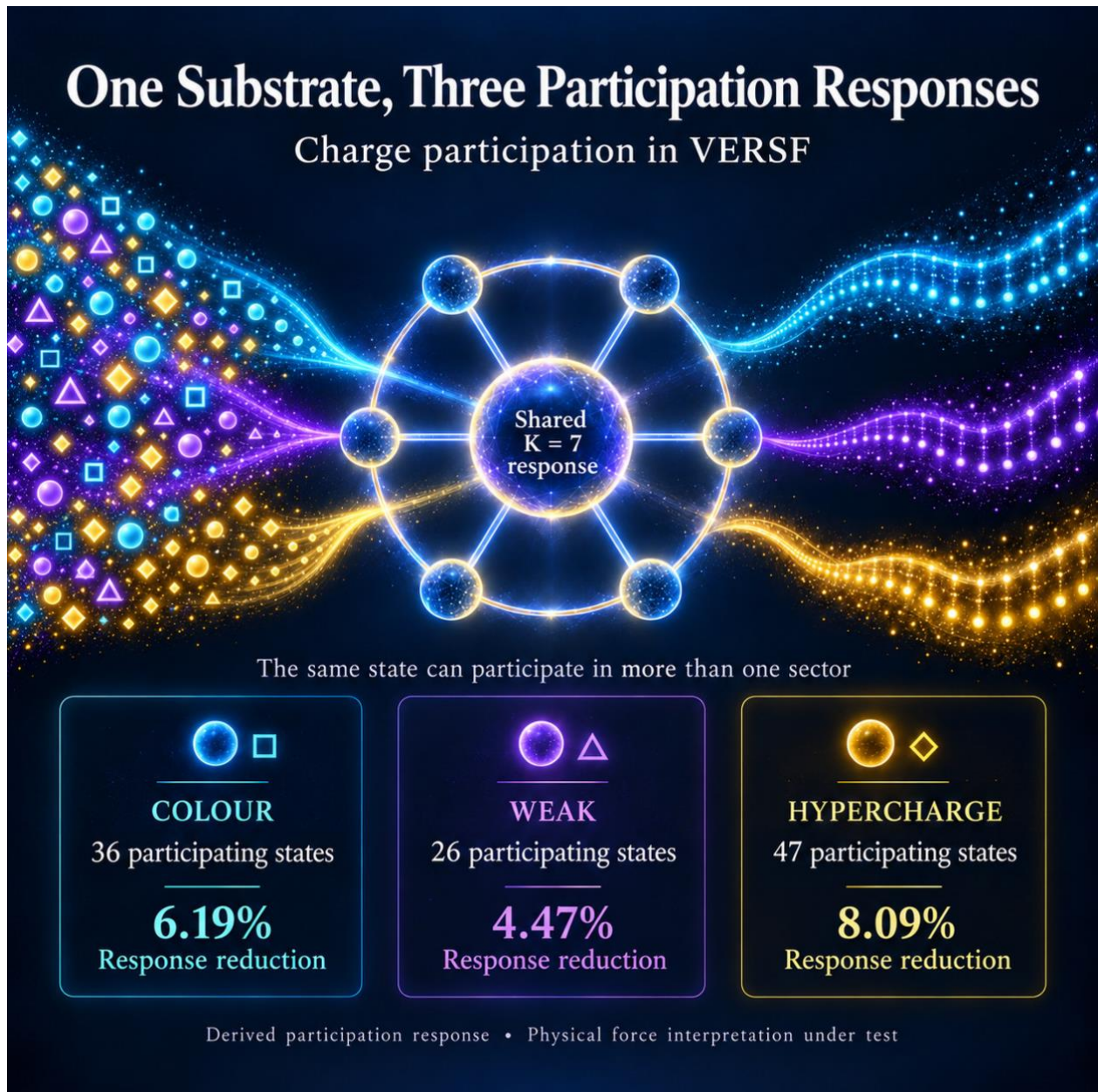


Figure 1. One substrate, three participation responses. The same occupied state can participate in more than one sector. The percentages show the derived participation-response reductions; their mapping to physical force coefficients is the attachment tested in Section 5. The coloured streams are schematic.

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Abstract

We connect the published $K = 7$ history reduction in VERSF to particle participation and formulate a definite test of its gauge interpretation. On the 49 occupied states, a shared positive response reproduces the complete D41 factor-space matrix. Its diagonal reductions are 6.1944%, 4.4738% and 8.0872%; their relative balance follows from participation counts 36, 26 and 47, and their magnitude from the inherited bath coefficient. The exact centred/mean decomposition identifies the component screened by the bath. Resolving the existing modes preserves the reduction, while a specified further coarse graining preserves it approximately for a geometrically forced reason. These are established conditional history results.

A direct construction on twelve separate generator channels reproduces the proposed gauge coefficients using the inherited response, without explicit bath variables. Uniform coherent participation gives the D41 fractions, whereas a diagonal, incoherent state-response control gives a common reduction $\epsilon/49$. This is an existence result conditional on the chosen embedding, not a derivation of that embedding from the physical action. The wider corpus supplies current–record interactions and activation mechanisms that may help establish the connection. Record-sensitivity mismatches reject specific statistical identifications, not the physical $K = 7$ reductions. The same-source gauge test and weak-angle comparison remain conditional on the physical attachment. A source-preservation theorem fixes the compression of every admissible history operator onto the participation span, excluding independent and partially dephased operator replacements there. It does not exclude a diagonal coupling to the unchanged history operator. A separate saturation theorem uniquely fixes the collective coupling matrix in the positive, unit-trace, fixed-support class, conditional on requiring the maximal D41 reduction. Neither result independently identifies the history response with gauge curvature. A canonical-wheel test confirms a unique persistent history mode, and a zero-mode theorem gives a sufficient condition for fully reinforcing coupling; transferring that condition to the physical gauge carrier remains conditional.

1 The argument and its physical target

VERSF treats particles and interactions as manifestations of one substrate. A common microscopic law can nevertheless produce unequal effective responses when different particle states couple to different parts of that law. The physical question is how to establish this inequality from the construction and then identify the response measured by a gauge field.

The argument has three established ingredients. First, the particle census fixes binary participation overlaps. Second, the published $K = 7$ bath elimination gives a definite history metric whose mean component is screened. Third, the broader source supplies an explicit current–record interaction, representation content and activation mechanisms capable of responding in all twelve gauge directions. The first two ingredients determine the D41 percentages; the third supplies a concrete candidate route to their physical transmission. Sections 2–5 assemble these results without substituting the reduced metric for the full interaction. This route remains open: its physical attachment is not established by the instrument alone, and the immediate-statistics calculation in Section 5.3 rejects the simplest proportional identification.

The word bath denotes unresolved internal modes in the source reduction [9, §5, HM1–HM4]; it does not require a separate external medium. Once their effect is represented by R , no additional bath interaction is needed to evaluate that response. Section 5.8 constructs a direct participation attachment and identifies its extra premise. The physical task is to derive the retained gauge response from the same substrate dynamics, whether internal modes are kept explicitly or represented by an effective operator. Section 5.6 gives the acceptance condition. VERSF treats $K = 7$ here as primitive substrate structure. The remaining identification is within that framework: it asks what the physical gauge perturbation retains, not what deeper layer causes the substrate. Section 5.9 tests which alternatives preserve the already-derived history source.

$K = 7$ denotes one hub and six rim vertices, not a complete graph or an independent specification of every response coefficient. Primitive Change Normalisation supplies the declared common primitive cost unit. The remaining test concerns the representation-resolved response in that unit. The inverse and transport calculations are retained in the appendices; the source review, inherited results and new diagnostic calculation are identified separately in Appendix C.

2 Particle content and the common response

2.1 Participation and charge are distinct quantities

We use factor order (C, W, Y) for colour, weak and conventional hypercharge. The occupied first-Fact carrier contains 49 states, with the census in Table 1. The labels Q, u, d, L, e denote the inherited matter representation sectors, H the Higgs sector and N two occupied neutral states. This preparation census is distinct from the full 50-dimensional operator carrier.

Table 1. Occupied states and binary participation signatures.

Sector	Multiplicity	Colour	Weak	Hypercharge
Q	18	1	1	1
u	9	1	0	1
d	9	1	0	1
L	6	0	1	1
e	3	0	0	1
H	2	0	1	1
N	2	0	0	0

A binary entry records whether a state participates in a factor; it does not record the magnitude or sign of its charge. Let X be the resulting 49×3 matrix. Its column sums, mean signature and Gram matrix are

$$n = X^T \mathbf{1} = (36, 26, 47)^T, \quad m = n/49, \quad (1)$$

$$H = X^T X / 49 = (1/49)[[36, 18, 36], [18, 26, 26], [36, 26, 47]]. \quad (2)$$

The ordinary squared-charge contractions on the charged matter-plus-Higgs carrier give the baseline vector $Z = (6, 13/2, 21/2)$ in conventional hypercharge units. These numbers and the participation counts in (1) serve different purposes. The integer-charge convention $q = 6Y$ gives $Zq = 36ZY$. In the multiplicative prescription examined here these are the coefficients before the D41 adjustment. They are not reclassified as already adjusted merely because an effective substrate description has eliminated internal variables.

2.2 Inherited history response

The published D41 reduction supplies [6]

$$W = dH - \Delta mm^T, \quad d = 0.0551296278772322, \quad \Delta = 0.004648154590676. \quad (3)$$

We suppress a common overall gain, which cancels from the response fractions; this cancellation does not determine an absolute energetic normalisation. The constants d and Δ are inherited $K = 7$ history results; they are not selected using measured gauge couplings.

The response in (3) is a conditional history and current metric. Its physical energetic interpretation must be established using the appropriate action and retained field. Keeping that distinction explicit allows the participation derivation to be stated without understating it or promoting it beyond its demonstrated scope.

3 Unequal responses from one shared substrate direction

Proposition 1 (shared-operator realisation). Let $u = 1/7$ be the unit uniform vector on the 49-state carrier and let $\varepsilon = \Delta/d$. The common operator

$$R = I - \varepsilon uu^T, \quad \varepsilon = 0.08431318638730784 \quad (4)$$

reproduces the full D41 matrix through

$$(d/49) X^T R X = W. \quad (5)$$

Proof. Equation (2) supplies the direct term. Since $X^T u = n/7$, the rank-one subtraction in (5) is $d \varepsilon n n^T / 2401 = \Delta m m^T$. Because $0 < \varepsilon < 1$, R is positive definite. Thus the realisation is a positive quadratic response, including all cross terms. ■

Proposition 1 is an identity for every pair (d, Δ) with $0 < \Delta < d$: any matrix of the form $dH - \Delta m m^T$ with $m = X^T 1/49$ is reproduced by a rank-one subtraction along the uniform direction. The proposition therefore does not test D41; it states that D41's subtraction has exactly this rank-one form. What it buys is the separation of the result into a structural part, fixed by the census, and a single strength ε , fixed by the inherited constants.

For factor A , hold the other two participation coordinates fixed. Its retained diagonal fraction is

$$r_A = W_{AA}/(dH_{AA}) = 1 - \varepsilon n_A/49. \quad (6)$$

Proposition 2 (ordering and the shortened direction). (a) For every ε in $(0, 1)$ the retained fractions satisfy $r_W > r_C > r_Y$: the ordering of the three reductions is fixed by the participation counts $26 < 36 < 47$ alone, and only their magnitudes depend on ε . (b) The generalised eigenvalues of (W, dH) are $(1 - 47\varepsilon/49, 1, 1)$. The single shortened direction is the indicator of the 47 charged states, which is the hypercharge participation column; the colour and weak reductions are the projections of that one shortened direction onto their participation columns.

Proof. (a) is immediate from (6). For (b), the generalised eigenvalues of $dH - \Delta m m^T$ relative to dH are 1 (twice) and $1 - \Delta m^T (dH)^{-1} m = 1 - \varepsilon (1^T X)(X^T X)^{-1}(X^T 1)/49 = 1 - \varepsilon \|P_X 1\|^2/49$, where P_X projects onto the column span of X . The hypercharge column is the indicator 1_{ch} of the charged states and the two neutral rows of X vanish, so $P_X 1 = 1_{ch}$ and $\|P_X 1\|^2 = 47$. ■

Equation (6) gives a direct explanation of the unequal reductions. A participation vector with more occupied entries has greater normalised overlap with the shared uniform direction, so its fractional

reduction is larger. There is one common response strength ϵ , not three fitted sector strengths, and Proposition 2(b) shows that there is also one shortened direction, not three.

Table 2. Derived diagonal history response with other participation coordinates fixed.

Factor	Participating states	Retained fraction	Reduction
Colour	36	0.938055618	6.194438%
Weak	26	0.955262391	4.473761%
Hypercharge	47	0.919128168	8.087183%

The weak-to-hypercharge retained-fraction ratio is 1.039313584. Three different diagonal percentages describe one shortened collective direction per real quadrature; they do not imply three independent bath mechanisms. The coincidence of the smallest generalised eigenvalue with the hypercharge retained fraction is Proposition 2(b), not an accident of the numbers.

An equivalent positive parent makes the relaxation explicit:

$$\mathcal{Q}(v, \eta) = (d/2)v^T v + \sqrt{\Delta} \eta u^T v + \frac{1}{2}\eta^2. \quad (7)$$

Minimising over η gives dR. Restricting $v = Xq/7$ then gives (3). Equation (7) is an algebraic realisation of the inherited response, not an independent reconstruction of the original microscopic energy action. Its value is that it exposes how the common relaxing direction generates the observed participation pattern.

3.1 Why resolving the existing modes does not change the result

The source calculation already includes uniform and nonuniform current-cycle contributions. Their contributions to d are 0.0405907994798115 and 0.0145388283974207, or 73.6279% and 26.3721%. It also eliminates six state-function bath modes [6, §§17.2–17.4].

Proposition 3 (mode resolution). If the mixed factor-to-bath block on one real quadrature is $B = mc^T$ and the bath matrix D is positive definite, then

$$BD^{-1}B^T = (c^T D^{-1} c) mm^T. \quad (8)$$

This follows by direct multiplication. Diagonalising D resolves the individual modal contributions but leaves their sum and factor-space direction unchanged. At the inherited source, $c^T D^{-1} c = \Delta$. For the two-quadrature construction, the corresponding factorisation returns $mm^T \otimes \Delta I_2$ under the stated source attachment.

Consequently the rank-one realisation is compatible with the original multiple bath modes, and resolving those same modes cannot change the fractions in Table 2. A different physical response would require a change in the source-defined coupling to the modes, in the direct term, in the dynamics or in the retained observable.

3.2 The distribution and the screened history component

The relative-birth-current theorem already supplies a conditional orientation law [12]. If the two endpoint innovations are jointly $U(49)$ -isotropic and their transported difference is nonzero, the resulting current ray is Haar distributed on the occupied projective space. Endpoint independence is unnecessary. Correlation between endpoints still affects the current magnitude, and an isotropic one-point law does not determine the joint distribution across edges or histories [13]. This establishes the orientation distribution on its stated premises without selecting a special fixed current vector.

CLSN-1 gives an exact connection between this geometry and D41 [6, §§17.21–17.22]. With m and H from (1)–(2), define the centred participation covariance C_h . The source identities are

$$C_h = (49/50)(H - mm^T), \quad d_r = d - \Delta, \\ W = d(H - mm^T) + d_r mm^T = (50d/49)C_h + d_r mm^T. \quad (9)$$

Thus the bath leaves the centred coefficient at d and reduces the mean component to $d_r = 0.0504814732865564$. The three percentages in Table 2 are different diagonal readings of this one reduction. Re-evaluation reproduces (9) to 3.47×10^{-18} . This connection is already present in the source; the existence of the distribution and the origin of the D41 percentages are not missing steps. The physical question concerns the subsequent mapping from this history observable to gauge curvature.

4 Exact coarse graining of the conditional response

A macroscopic response is defined by what is held fixed while unresolved variables adjust. We can test this explicitly within (7), without assuming in advance that the retained quantity is a physical gauge field.

Let E be a full-column-rank retained injection, and let the columns of V form an orthonormal basis for its Euclidean orthogonal complement. Write $v = Eq + Vz$. The coordinate q is held fixed and z is allowed to relax. Permitting this entire complement to relax is the additional prescription examined here; it is not a derivation of which auxiliaries the full VERSF gauge problem permits.

Proposition 4 (exact complement elimination). With $\rho = \|V^T u\|^2$, elimination of z from dR gives

$$K_{\text{eff}}/d = E^T E - [\varepsilon/(1 - \varepsilon\rho)] (E^T u)(u^T E). \quad (10)$$

Proof. Put $a = E^T u$ and $b = V^T u$. The retained block is $E^T E - \varepsilon a a^T$, the mixed block is $-\varepsilon a b^T$, and the auxiliary block is $I - \varepsilon b b^T$. Its inverse obeys $b^T(I - \varepsilon b b^T)^{-1}b = \rho/(1 - \varepsilon\rho)$. The Schur complement therefore gives (10). The denominator is positive because $\rho \leq 1$ and $\varepsilon < 1$. ■

Equation (10) says that eliminating the complement changes only the strength of the common subtraction, from ε to $\varepsilon/(1 - \varepsilon\rho)$, and never its direction. The size of the change is governed entirely by ρ , the fraction of the uniform direction that lies outside the retained span. Two extremes bound it: $\rho = 0$ leaves the response unchanged, and $\rho \rightarrow 1$ gives the maximal strength $\varepsilon/(1 - \varepsilon) = 0.0920764$, a 9.2% increase.

Corollary 5 (forced stability for participation coordinates). If the column span of E contains the charged indicator 1_{ch} , then $\rho \leq 2/49$, with equality when the span is supported on the charged states, and the coarse-grained strength satisfies $\varepsilon \leq \varepsilon/(1 - \varepsilon\rho) \leq \varepsilon/(1 - 2\varepsilon/49) = 1.00345\varepsilon$. In particular, for $E = X/7$ the reductions change by at most 0.028 percentage points and their ordering is preserved, whatever else the complement contains.

Proof. The uniform vector decomposes as $u = (1/7)1_{\text{ch}} + (1/7)1_{\text{N}}$, with 1_{N} the indicator of the two neutral states. If 1_{ch} lies in the retained span, the component of u outside that span is at most $(1/7)1_{\text{N}}$, whose squared norm is $2/49$, and equals it exactly when the span has no component on the neutral states. Since (10) depends on E only through ρ and $E^T u$, the bound follows. ■

Table 3. Effect of the specified additional complement relaxation for the participation injection, for which ρ equals two forty-ninths exactly.

Factor	Original reduction	Reduction after coarse graining
Colour	6.194438%	6.215829%
Weak	4.473761%	4.489210%
Hypercharge	8.087183%	8.115110%

The pattern is stable under this operation: hypercharge remains most reduced and weak response least reduced, and no measured coupling enters. Corollary 5 shows, however, that this stability is a consequence of the census geometry rather than a discovery about the dynamics. Because the hypercharge participation column is the charged indicator, the relaxing direction already lies almost entirely inside the retained span, and the 46-dimensional complement can only ever supply the two neutral directions. Table 3 therefore confirms consistency; it does not test the mechanism. The test with

discriminating power is the one in Section 5.2, where the retained span does not contain the charged indicator and p is close to one.

Eliminating η and z simultaneously in (7) agrees with sequential elimination to better than 2×10^{-15} in the normalised matrices. Equation (10) agrees with the block solve to better than 8×10^{-15} . Positivity and direct constrained minimisation also pass. These are numerical consistency checks, not physical error estimates. With constant quadratic blocks, Gaussian integration yields the same retained quadratic plus a coordinate-independent determinant term. Field-dependent physical blocks require their own determinant calculation.

5 Substrate response and its gauge interpretation

The physical proposal connects particle charge content through the $K = 7$ substrate response to gauge coefficients. The current–record construction supplies one candidate microscopic route. A direct effective construction is developed in Section 5.8. Neither formulation requires postulating an additional external bath; both must identify the response to the physical gauge perturbation.

5.1 The current record interaction and bath activation

The expanded RCHS-35 supplies an explicit covariant current–record instrument, QCA-1 [4, Part XIV, §§11–15]. On the fifty-dimensional carrier, for a nonzero current j and its ray projector p , it uses the twelve gauge generators T_a and the operators

$$p = jj^\dagger / \|j\|^2, \quad K_a = i[T_a, p], \quad S = \sum_a K_a^\dagger K_a, \quad s = \text{tr}(S)/2, \\ C_a = K_a / \sqrt{s}, \quad C_0 = \sqrt{(I - S/s)}, \quad \sum_{a=0}^{12} C_a^\dagger C_a = I. \quad (11)$$

The pointer representation contains a singlet and the gauge adjoint, with dimensions $1 + 8 + 3 + 1$. Terminal projectors record the particle-sector label. The source constructs the enlarged current-carrier isometry and verifies all twelve gauge intertwiners. A singlet-only environment is insufficient for its native transition census. These results are consistent with the wider non-Abelian bath transport construction [14]. They establish representation content and a concrete interaction, rather than a bath consisting only of the two real directions visible in D41.

Successive operations share the same current in the frozen-current construction. A history probability therefore integrates the composed operations at a common j . Replacing that integral by a composition of independently averaged operations would erase correlations and change the source. The single-opportunity test below respects its narrower role and does not make that replacement.

The later CLSN-1 continuations also show that recording changes accessibility [6, §§17.27–17.32]. On the inherited witness, the initial jump Gram has rank 13 on the 49 occupied states. Repeated native terminal recording expands the bright span to 38, leaving an eleven-dimensional persistent dark subspace at fixed current and flat links. Closure under all supplied gauge generators leaves five dark directions. These are reported source results; they do not imply that a selected physical trajectory visits every algebraically accessible direction.

Normalised QCA-1 is insensitive to a common rescaling of j , but its relative sector directions remain observable. A later raw-current candidate uses $i[T_a, jj^\dagger]$ together with operator survival, giving a completely positive magnitude-sensitive first-event operation. Its occurrence coefficient, preparation and physical interval remain to be selected; it must not be identified automatically with the primitive birth hazard [6, §§17.29–17.32; 15]. The corpus therefore advances both activation and magnitude response while retaining a precise physical-source requirement.

5.2 What the participation and generator controls establish

A control keeps the same operator R but replaces binary participation with signed generator eigenvalues. Choose one colour Cartan generator, one weak Cartan generator and conventional hypercharge on the same census, and let their columns form T . They satisfy

$$T^T T = \text{diag}(6, 13/2, 21/2), \quad T^T 1 = (0, 0, 1)^T. \quad (12)$$

The two traceless columns have zero overlap with the uniform bath direction, so their reductions under this probe vanish. The hypercharge reduction is 0.0163874% before complement relaxation and 0.0178931% afterwards; for this probe $p = 1 - 1/(49 \cdot 21/2) = 0.998$, so the relaxed strength is 0.0921, close to the maximal value, and the relaxation changes the probe's reading by 9.2%. The difference from Table 3 arises because the retained observable differs, not because the operator differs.

Proposition 6 (generator blindness of the subtraction). For any generator t of a non-Abelian factor, represented by its diagonal entries on the 49-state census in any basis, the D41 subtraction contributes $\varepsilon(u^T t)^2 = \varepsilon(\text{Tr } t)^2/49 = 0$, because every such generator is traceless. The subtraction is therefore invisible to every colour and weak generator probe exactly, not only to the Cartan elements chosen above, and it reaches hypercharge only through $\text{Tr } Y = 1$, giving $\varepsilon/49$ on a baseline of $21/2$.

Proposition 6 constrains the fixed uniform-direction realisation of Section 3. Its participation and signed-generator probes give structurally different answers, so neither can be promoted to a physical gauge response solely from that realisation. It is not a statement that the full bath is blind to colour and weak perturbations. The actual current-record instrument includes all twelve generators and depends on current orientation, as developed in Section 5.1. The coupled action must determine the retained physical observable and its complete response.

Nor can the full history matrix simply be reinterpreted as independent representation prices. For a central operator $W_{\text{cent}} = \sum_r \delta w_r P_r$, the binary support projectors satisfy $P_C P_Y = P_C$ and $P_W P_Y = P_W$. Its factor pullback must consequently satisfy $K_{CC} = K_{CY}$ and $K_{WW} = K_{WY}$ [8, §10.4]. The D41 subtraction violates these identities:

$$m_C^2 = 1296/2401 \neq 1692/2401 = m_C m_Y, \quad m_W^2 = 676/2401 \neq 1222/2401 = m_W m_Y. \quad (13)$$

This excludes that direct full-matrix price identification. It does not exclude every physical mechanism giving similar diagonal fractions. Likewise the nonzero weak-hypercharge history entry, 0.026886756, cannot simply be inserted as an unbroken $SU(2)$ - $U(1)$ scalar kinetic mixing term; the physical tensor structure must be respected.

5.3 Immediate interaction statistics and the D41 balance

We test whether the source orientation law, applied to the explicit native interaction, directly supplies the D41 balance. This calculation uses the inherited 49-state occupied census, with colour generators in fundamental normalisation, weak generators $\sigma/2$ and primitive $q = 6Y$. Their squared traces are 6 for each of eight colour generators, $13/2$ for each of three weak generators and 378 for q . The Abelian value becomes $21/2$ in conventional Y units.

For a Haar unit vector u in $N = 49$ dimensions, let $V_{\alpha\beta}$ be its symmetrised generator covariance. The exact second-moment identity gives

$$\begin{aligned} V_{\alpha\beta} &= \text{Re}\langle u | T_\alpha T_\beta | u \rangle - \langle T_\alpha \rangle \langle T_\beta \rangle, \\ E[V_{\alpha\beta}] &= [\text{tr}(T_\alpha T_\beta) - \text{tr}(T_\alpha) \text{tr}(T_\beta)/49]/50, \\ \text{Re } \text{tr}(K_\alpha K_\beta) &= 2V_{\alpha\beta}. \end{aligned} \quad (14)$$

Divide each diagonal covariance by its bare generator Gram and normalise weak to one. The exact balance is colour : weak : hypercharge = 1 : 1 : 0.9980563654. For the normalised QCA instrument, the relevant average instead contains V_{aa}/s . We evaluate this ratio before averaging, using 100,000 Haar rays with a fixed seed. The resulting conditional pointer block probabilities are (0.110426922, 0.045050948, 0.844522131), with batch standard errors (0.00006260, 0.00003607, 0.00009291). Dividing these by the total block Grams (48, 19.5, 378) gives the approximate relative balance 0.99578 : 1 : 0.96705.

The D41 fractional reductions instead have the exact balance 36 : 26 : 47, or 1.38461538 : 1 : 1.80769231. Neither immediate covariance nor normalised single-opportunity pointer statistics therefore supplies that balance through direct identification. The occupied preparation gives total pointer excitation probability 2/49, as reported by the source. This probability is not a completed-Fact rate or a gauge-action coefficient.

The result distinguishes observables. Equation (9) concerns binary sector participation in the inherited history reduction; equation (14) concerns generator covariance in a current instrument. Record statistics are not the physical response quantity being sought. Their different balance rejects only a direct numerical identification of the observables. It supplies no evidence against the $K = 7$ reductions or their physical interpretation. The relevant check follows the reductions through the coupled action, rather than requiring a record-sensitivity measure to reproduce them.

5.4 Why the fixed rank obstruction does not bound the full bath

The earlier rank restriction applies to a fixed linear attachment of the rank-two D41 update, with its two real quadratures, followed by the stated classical quadratic relaxation. Such an attachment cannot alone produce a rank-twelve positive gauge correction. It is not a theorem about the full bath. Orientation-dependent couplings, representation-valued bath operators and the explicit twelve-generator current–record interaction lie outside those premises. The new script finds rank twelve for the commutator Gram at a generic Haar witness, consistent with the source representation.

Gauge covariance constrains equality within a simple gauge factor, but does not fix equality or a prescribed balance between factors. On a single adjoint copy, the invariant response has the form $a_3 l_8 \oplus a_2 l_3 \oplus a_1 q_1$; paired link–record copies permit three symmetric two-by-two blocks [4, Part I, §1.8]. These are symmetry statements, not an assertion that the complete source leaves all coefficients arbitrary.

The completion programme also establishes the full tensor descent $T_f = c_H \otimes B_f$ on its stated branch [16]. That result must be retained when assembling the response; it does not by itself give every B_f or identify a neutral mass response with a gauge correction. Similarly, the corrected QCD/triality treatment distinguishes a closure eigenvalue of five from an actually derived gauge Schur subtraction of five [17].

The source supplies an explicit interaction beyond the reduced fixed-direction model. Representation content and pointer statistics illuminate that interaction, but they do not measure its relaxed gauge stiffness. The physical calculation must retain the established $K = 7$ reduction and determine its action-level attachment.

5.5 The complete response to be calculated

The existing action programme supplies the required reduction architecture [4, 8, 9]. For physical gauge-link perturbations a and admissible auxiliary variables, its quadratic response has the schematic form

$$K_a(\omega) = A(\omega) - B(\omega)D(\omega)^{-1}B(\omega)^\dagger. \quad (15)$$

The blocks must come from one admitted background and the same coupled current, conservation, record, completion and matter action. Physical constraints and null directions must be handled before inverting the auxiliary block; where necessary the inverse is taken on the physical quotient. Residual-curvature and metric derivatives, and any same-order determinant terms, must be retained. Terms already integrated out must not be counted again.

After the appropriate gauge-curvature normalisation, the reduced coefficients can be compared with the force relations. A zero mixed block at a reference point does not settle the entire response, since derivatives of that block can contribute. Conversely, a nonzero history susceptibility does not determine a gauge coefficient without its physical attachment [10, 11]. The available audits establish neither a general impossibility nor two fully admitted complete sources with different physical contrasts. In the

language of Section 5.2, the coupled action decides whether the retained field couples through participation, through generators, or through something that is neither.

When a history representation is used, the average must preserve the source-defined sequence, shared current correlations and terminal records. Independently averaging each opportunity would define another process. An equivalent effective-action treatment need not reintroduce eliminated coordinates, but must preserve their full response under gauge perturbation. The corpus's tensor descent and current-link reciprocity remain inputs. No additional subtraction is applied to a response already included in the effective operator.

Primitive Change Normalisation already supplies the common cost unit through $K\theta = tG$ and $s = 1/t$ [6]. The test below therefore does not require assigning metres or joules at the minimal level, nor does it require deriving the declared unit again. An independent energy-scale attachment is a separate requirement for comparison with running laboratory couplings.

5.6 An explicit acceptance condition for the gauge connection

Consider the admitted unbroken gauge background and one gauge-adjoint copy, with the physical constraints removed. Fix primitive hypercharge $q = 6Y$ and define the twelve-dimensional bare Gram G_0 . Under the proposed common baseline attachment, the source must return $G_{\text{bare}} = \text{csrc}G_0$, with csrc supplied by the primitive normalisation and the same source, not fitted to measured couplings. Define the proposed screened matrix by

$$\begin{aligned} G_0 &= \text{diag}(6I_8, (13/2)I_3, 378I_1), \\ G_{\text{target}} &= \text{csrc} \text{diag}(6r_C I_8, (13/2)r_W I_3, 378r_Y I_1), \\ r_A &= 1 - \varepsilon n_A/49, \quad \varepsilon = \Delta/d, \quad (n_C, n_W, n_Y) = (36, 26, 47). \end{aligned} \quad (16)$$

Let G_{phys} be the gauge-curvature matrix returned by the complete reduction in Section 5.5, in exactly this normalisation. The D41 diagonal attachment passes only if $G_{\text{phys}} = G_{\text{target}}$ within a justified numerical error bound and the specified source and background conditions hold. This tests the full invariant matrix, including the absence of forbidden inter-factor terms, rather than fitting three diagonal entries independently.

The primitive convention $q = 6Y$ gives $zq = 36zY$ and $G_0, qq = 36(21/2) = 378$. Hence $\delta_Y = 1 - zq/(378\text{csrc}) = 1 - zY/((21/2)\text{csrc})$: the factor 36 cancels exactly. Table 2 therefore supplies the same dimensionless r_Y in either convention, while the hypercharge entry of G_{target} in (16) is $378\text{csrc} r_Y$.

For an invariant result write $G_{\text{phys}} = \text{diag}(z_C I_8, z_W I_3, z_q I_1)$. Its fractional reductions are $\delta_C = 1 - z_C/(6\text{csrc})$, $\delta_W = 1 - z_W/((13/2)\text{csrc})$, and $\delta_Y = 1 - z_q/(378\text{csrc})$. The dimensionless checks can then be reported as

$$\begin{aligned} \delta_C/36 &= \delta_W/26 = \delta_Y/47 = \varepsilon/49, \\ E &= \|G_{\text{phys}} - G_{\text{target}}\|_F / \|\text{csrc}G_0\|_F. \end{aligned} \quad (17)$$

The equality of the first three quantities tests the relative pattern; their common value tests its magnitude. Agreement with the pattern alone is insufficient. The Frobenius residual E depends on the declared generator coordinates and weights blocks according to both dimension and coefficient size. In primitive q units the hypercharge baseline 378 is especially large. A small aggregate residual therefore cannot substitute for separate sector checks.

Let ΠA select factor A , with dimensions $dA = (8, 3, 1)$, bare weights $ZA = (6, 13/2, 378)$, and $\Delta G = G_{\text{phys}} - G_{\text{target}}$. Report the dimensionless block residuals $EA = \|\Delta G A A\|_F / (\text{csrc} ZA \vee dA)$, together with $E_{\text{max}} = \max_A EA$. For $A \neq B$, also report $EAB = \|G_{\text{phys}, AB}\|_F / [\text{csrc} \vee (ZA ZB) (dA dB)^{1/4}]$. Each sector and cross block must meet its justified tolerance; a weighted aggregate cannot conceal failure in one sector. These baseline-normalised residuals also remove the arbitrary factor associated with a consistent Y -to- q coordinate conversion.

Partial collectivity makes the pattern test more discriminating. For a positive unit-trace coupling matrix pA supported on the nA participating states, define $fA = 49 \text{ } u^\dagger pA \text{ } u / nA \in [0, 1]$. For a pure coupling $pA = vAvA^\dagger$ with unit vector vA , this reduces to $49 |u^\dagger vA|^2 / nA$. Then $\delta A = fA \text{ } \epsilon nA / 49$ and $\delta A / nA = fA \text{ } \epsilon / 49$. Equality of the three normalised reductions therefore requires $fC = fW = fY$. Their common value must also equal $\epsilon / 49$ to pass the full magnitude condition (17), which requires $fC = fW = fY = 1$. Equal but incomplete collectivity passes the relative-pattern test alone; unequal collectivity fails it even if every sector is collective. These statements retain the model's fixed ϵ and exclude additional response contributions.

The tolerance must come from numerical accuracy, sampling and regulator control. With the source, census and boundary prescription fixed, the attachment contains no adjustable sector corrections: ϵ and nA fix all three rA . The weak-angle value is a parameter-free consequence of that specified attachment and transport prescription once the two measured input strengths are supplied; this does not make it an unconditional or input-free prediction.

There are three distinct outcomes. A same-source return satisfying (16) establishes the diagonal attachment on the declared branch, subject to its regulator and physical-scale conditions. A definite different result replaces or rejects that attachment without invalidating the D41 history identity. Failure to specify or evaluate the complete joint source leaves the test unfinished. An adjustable bath chosen to match (16), or an independently averaged pointer law, does not count as a pass.

The acceptance condition does not assert that the source must return the diagonal ansatz. It makes the proposed bridge falsifiable while preserving the progress already made: the percentages have been derived in the history calculation, and the wider source supplies an interaction whose complete gauge response can test their physical role.

5.7 Record sensitivity is not physical gauge stiffness

The later ordered-record calculation [19, 20] retains sensitivity to all 72 curvature directions after profiling 693 normalised endpoint coordinates. Its statistical matrix is $F = A^T A$, where A is the probability derivative divided by the square root of the probability. Profiling removes changes that endpoint variations can imitate. This operation measures distinguishability under uncertainty; it is not the physical relaxation of the substrate.

A new audit [21] resolves the archived response into colour, weak and hypercharge sectors. After division by the generator Grams and normalisation to weak, the profiled balance is $0.133176 : 1 : 3.763248$. The retained fractions in Table 2 instead give $0.981987 : 1 : 0.962174$. These are different quantities. The comparison disproves only their proposed proportional identification at the archived witness; it is not a failed physical test of the $K = 7$ reductions.

The mismatch rejects proportionality between the tested record-sensitivity matrix and the proposed physical response at this witness. It does not reject the $K = 7$ reductions: the construction already gives the participation-dependent reductions used in the proposed force relationship. Establishing their exact appearance in the gauge kinetic coefficients remains the same-action check in Sections 5.5–5.6. The statistical test has a definite negative result for the proportionality proposal, while leaving that physical check open.

The distinction is mathematical as well as interpretive. A Fisher matrix differentiates log probabilities. The physical matrix in equation (15) differentiates the coupled action and eliminates its admissible auxiliaries. Both can involve Schur complements, but shared algebra does not identify their inputs or observables. A relation between them would require an additional source-derived theorem. No such equality is assumed here.

The audit uses the archived conventional-Y instrument, with generator Grams (6, 6.5, 10.5). A coordinate conversion preserving the same link U satisfies $\Theta Y = 6\theta q$. The hypercharge Fisher coefficient then gains a factor 36, as does its Gram, so their quotient and the displayed normalised balance remain unchanged. An explicit conversion reproduces 0.133176 : 1 : 3.763248 in both conventions. This comparison is therefore not made in mixed conventions. Replacing Y by q inside the Kraus sum would instead change the instrument and requires a separate calculation; it is not performed here. The rank and original derivative checks are inherited from [20], while the sector audit is in [21]. All 23 archive manifest entries pass their SHA-256 checks. These checks validate the statistical calculation, not a physical force prediction.

5.8 Direct collective participation without explicit bath variables

The following construction tests the multiplicative prescription directly. It uses the inherited R of (4), the census columns $x_A = X[:,A]$ and the bare charge coefficients ZA. It introduces neither a new bath coordinate nor a fitted sector strength. It does introduce a specified embedding of gauge coordinates into a response space; its status is a conditional algebraic realisation. Section 5.9 excludes changing the history operator on the participation span while preserving D41. The independent-state control instead retains the true R and changes the coupling to $\text{diag}(x_A)/n_A$. Its reduction $\epsilon/49$ remains possible at that coupling level; the source must decide which coupling is physically realised. The additional premise concerns carrying that response into the gauge coefficients, including the twelve-channel extension.

Let e_a label the twelve orthonormal generator channels, with $A(a)$ their colour, weak or hypercharge factor. Define the auxiliary response space as twelve copies of the 49-state participation space. On this space set

$$v_A = x_A/\sqrt{n_A}, \quad B e_a = \sqrt{Z_A} v_A \otimes e_a, \quad \tilde{R} = R \otimes I_{12}. \quad (17a)$$

The ordering of tensor coordinates is conventional. Since $\|v_A\| = 1$ and the generator channels are orthogonal, $B^\dagger B = G_0$. Direct contraction gives

$$G_{\text{direct}} = B^\dagger \tilde{R} B = \text{diag}(6r_C I_8, (13/2)r_W I_3, 378r_Y I_1). \quad (17b)$$

Here primitive $q = 6Y$ is used; conventional Y replaces 378 by 21/2. The common csrc of (16) multiplies the entire matrix afterwards. Proof: $v_A^\dagger R v_A = 1 - \epsilon |u^\dagger v_A|^2 = 1 - \epsilon n_A/49$. Orthogonal channel labels remove off-diagonal generator terms. Equal coefficients within each simple factor make the resulting quadratic form gauge invariant. $\tilde{R}$ is positive because R has eigenvalues 1 and $1 - \epsilon$. This proves the claimed algebraic realisation.

The conventional-Y execution gives coefficients (5.62833371, 6.20920554, 9.65084577). Its largest entrywise baseline error is 3.56×10^{-15} and its target identity error is 1.07×10^{-14} . These are floating-point verification errors. The primitive hypercharge coefficient is 347.43044756; its retained fraction is unchanged.

The extra premise is strong and specific: each generator couples to the equal-sign, equal-weight sum of its participating states, with orthogonal generator channels. This gives the maximal overlap with u among unit vectors supported on that sector. By Cauchy–Schwarz, $|u^\dagger v|^2 \leq n_A/49$, with equality only for a uniform vector up to a common phase. Thus, within this fixed-support, unit-norm construction, the D41 fraction requires collective participation before squaring. It is an additional response prescription, not a consequence of the charge Gram or an established quantum preparation.

The tensor extension has twelve independent shortened directions, one for each generator channel, each with the same fractional shortening ϵ . The D41 history update has one per real quadrature. The extension is not a linear pullback of that update and does not evade the restricted rank obstruction of Section 5.4. For a fixed quadratic Schur representation, the target correction has rank twelve, so the

mixed response must have rank at least twelve on the physical support. This is a countable source requirement. It does not imply twelve independent microscopic baths or equal microscopic stiffnesses: correlated modes and different couplings can produce the same effective matrix. Equal ϵ and participation alignment are the stronger requirements of this particular tensor realisation.

QCA-1's twelve pointer channels are a natural candidate to examine, but their count alone does not establish twelve energetic relaxation directions. The source must supply the rank, response strengths and participation alignment under the actual retained gauge perturbations. Gauge invariance of the constructed matrix alone is not a microscopic intertwining theorem.

A comparison removes the cross-state coherence while keeping the same support and baseline. For each factor replace $vAvA^\dagger$ by the diagonal unit-trace matrix $DA = \text{diag}(xA)/nA$. Then

$$rA_{\text{independent}} = \text{tr}(RDA) = 1 - \epsilon/49 = 0.9982793227. \quad (17c)$$

Every sector now has a 0.17206773% reduction. This control also has a precise charge-contraction interpretation on the stated census: $\sum_{a \in C} Ta^2 = (4/3)PC$ and $\sum_{a \in W} Ta^2 = (3/4)PW$, with traces $48 = (4/3)36$ and $19.5 = (3/4)26$. Therefore the normalised single-insertion contractions $\text{tr}(R\sum_a Ta^2)/\text{tr}(\sum_a Ta^2)$ give $\epsilon/49$ as their reduction. Hypercharge has unequal squared charges, so Y^2 is not proportional to PY ; nevertheless its diagonal contraction gives the same fraction because every diagonal entry of R is $1 - \epsilon/49$.

This identifies a restricted, generator-quadratic control rather than a theorem about every response second order in gauge fields. A general gauge-action Hessian includes correlations, propagators, mixed derivatives and allowed relaxation. The Casimir identities do not reduce all those contributions to $\text{tr}(R\sum_a Ta^2)$. Accordingly the uniform 0.1721% result cannot be asserted for every ordinary gauge-kinetic response. The collective construction adds cross-state terms absent from this diagonal trace prescription.

The native QCA-1 coupling is $K_a = i[T_a, p]$, not the all-positive participation column xA . Section 5.3 consequently does not realise (17a): its unnormalised immediate covariance gives $1 : 1 : 0.998056$ after Gram normalisation. Tracelessness contributes to that calculation, but the commutator still responds in non-Abelian directions; it is not the blind linear probe of Proposition 6. The next calculation must determine whether accumulated history and terminal recording generate the effective participation response of (17b), or whether a different source coupling is required. Neither channel count nor shared-current correlation alone settles that question.

The direct construction and the necessity test in Section 5.9 address different implications. The collective subtraction on the participation span is fixed by D41 for every history operator reproducing W . This does not select a coupling to that operator. Their promotion to (17b) additionally identifies the response to a physical gauge perturbation and supplies the generator-channel structure. A separate bath mechanism or deeper substrate layer is unnecessary. The source must establish that identification, or an equivalent effective response, with the inherited ϵ ; the shared-current correlations alone are not that theorem.

5.9 Collective participation required by the fixed history response

Two questions must be separated: which history operators reproduce D41, and how a gauge channel couples to the fixed history operator. Equations (3) and (9) fix $C = H - mm^T$ and $W = dC + (d - \Delta)mm^T$ [6, §§17.21–17.22]. The centred coefficient remains d and only the mean coefficient is reduced. The following theorem determines the operator compression seen by the participation vectors, without assuming a dephasing family.

Proposition 7 (participation-span characterisation of the history operator). Let X have the three participation columns of Table 1, let $P_X = X(X^T X)^{-1}X^T$ project orthogonally onto their span, and let 1_{ch}

be the indicator of the 47 charged states. For any Hermitian subtraction S , the history operator $R_S = I - S$ reproduces W if and only if $P_X S P_X = (\epsilon/49)1_{\text{ch}} 1_{\text{ch}}^T$, where $\epsilon = \Delta/d$. Positivity constraints on an admissible R_S do not change this equivalence.

Proof. Since X has full column rank, $X^T S X = \epsilon X^T u u^T X$ is equivalent to $P_X S P_X = \epsilon(P_X u)(P_X u)^T$ by multiplication with $X(X^T X)^{-1}$ and its transpose. The hypercharge participation column is 1_{ch} ; all columns vanish on the two neutral states. Hence $P_X u = 1_{\text{ch}}/7$, proving the assertion. This is the same charged-state direction as Proposition 2(b). The theorem fixes the compressed operator, not its full action on vectors in the span: couplings to the orthogonal complement and the complementary block are invisible to $X^T S X$, subject to any positivity constraints. ■

Corollary 7.1 (necessity of full collectivity in the dephasing family). For the continuous dephasing family below, preservation of the D41 centred coefficient requires $c = 1$. The mean coefficient and full response then agree as well.

$$R_{\text{c}} = I - \epsilon[c u u^T + (1 - c)I/49], \quad W_{\text{c}} = (d/49)X^T R_{\text{c}} X, \\ a_{\text{c}} = d[1 - (1 - c)\epsilon/49], \quad W_{\text{c}} = a_{\text{c}} C + (a_{\text{c}} - c\Delta)mm^T. \quad (17d)$$

Proof. Direct contraction gives (17d). Requiring $a_{\text{c}} = d$ gives $(1 - c)\epsilon = 0$, hence $c = 1$. The remaining coefficient is then $d - \Delta$. The matrices C and mm^T are linearly independent on this census, so their coefficients are separately fixed by the full W . All R_{c} are positive and share the same diagonal: failure at $c < 1$ is a failure to preserve the source response, not a positivity defect. ■

The retained sector fractions are $1 - \epsilon[1 + c(nA - 1)]/49$. At $c = 0$ the reductions are all 0.17206773%; at $c = 1/2$ they are (3.18325%, 2.32291%, 4.12963%); at $c = 1$ they are (6.19444%, 4.47376%, 8.08718%). Only the last case preserves both source coefficients. Direct matrix evaluation agrees with the original W to a relative Frobenius residual of 1.30×10^{-15} at $c = 1$. The analytic proof covers the whole interval, not only these examples [23].

The parameter c in (17d) changes the history operator. A numerically identical interpolation arises from keeping R fixed and using the coupling matrices pA, c below. Only in this latter interpretation does the overlap definition in Section 5.6 give $fA = [1 + c(nA - 1)]/nA$. At $c = 0$ this is $1/nA$, not zero. Equal diagonal response values do not make these two constructions the same operator or the same coupling.

Proposition 8 (maximal coupling on a sector). Let pA be any positive unit-trace coupling matrix supported on the nA participating states, and $vA = xA/vnA$. Its subtraction under R satisfies

$$1 - \text{tr}(RpA) = \epsilon u^\dagger pA u = (\epsilon nA/49) vA^\dagger pA vA \leq \epsilon nA/49. \quad (17e)$$

Equality holds exactly when $pA = vA vA^\dagger$. **Proof.** Positivity and unit trace bound the expectation in the unit vector vA by one. Equality leaves no trace weight on its orthogonal complement; positivity then also removes the cross blocks. ■ This extends the maximality statement from unit vectors to positive coupling matrices. It proves uniqueness conditional on attaining the maximal fraction in this class; it does not establish a microscopic quantum preparation.

A symmetry control separates coupling selection from history preservation. With R fixed, the matrices $pA, c = c vA vA^\dagger + (1 - c)\text{diag}(xA)/nA$ have identical diagonal participation, unit trace and invariance under every permutation within the participating support, for all c in $[0, 1]$. They nevertheless yield different reductions. Equal marginals and that symmetry do not select $c = 1$. Proposition 7 does not exclude these coupling controls, because they do not replace R . No claim is made that they satisfy every VERSEF microscopic axiom.

The implication for the force argument is precise. Independent operator replacement is excluded on the participation span, whereas the independent-state coupling of Section 5.8 remains a legitimate positive control with the true R unchanged. Requiring a gauge response to reproduce W would already identify

that physical response with the history object; Proposition 7 cannot supply this identification by assuming it. The source must select the coupling and generator-channel structure tested in Sections 5.5–5.8. No deeper cause of $K = 7$ is demanded by this distinction.

5.10 Closure and selection of a reinforcing coupling

The conservation-and-closure hypothesis asks whether the participating states must contribute together because they belong to one constrained substrate. Three tests separate the established persistent history mode, the information contained in its transition law, and a sufficient condition for a fully reinforcing gauge coupling [24].

The canonical wheel. HMGB-1 derives the seven-state kernel T_0 from its admissibility graph and equal weights among allowed moves [9, §§11A.1, 14A]. The hub has seven permitted transitions, each of weight $1/7$. Each rim state has four, each of weight $1/4$: itself, the hub and its two rim neighbours. Its stationary measure is $\pi = (7, 4, 4, 4, 4, 4, 4)^T/31$ and its spectrum is $\{1, 1/2, 1/2, -1/4, -3/28, 0, 0\}$. Thus T_0^t converges to the projector $f \mapsto (\pi^T f)1$, where $\pi^T f = \sum_i \pi_i f_i$. Rebuilding this kernel reproduces probability conservation and detailed balance to numerical precision. An alternating rim observable has eigenvalue $-1/4$; after ten steps its weighted norm is 9.536743×10^{-7} of its initial norm.

This is a concrete shared persistent history response: nonconstant observable modes decay. The constant observable is defined in $L^2(\pi)$. In Euclidean coordinates the symmetric transfer has Perron vector $\sqrt{\pi}$, which is not the uniform seven-vector. Neither seven-state object may be identified with a uniform coupling on 36, 26 or 47 occupied states without a source-derived map and its measure factors. The wheel establishes a persistent history mode, not that identification.

A control for what the history kernel alone fixes. The channel $E(\rho) = \text{diag}[T_0^T \text{diag}(\rho)]$ has Kraus operators $\sqrt{v(T_0)_{ij}} |j\rangle\langle i|$, where $\sqrt{v(T_0)_{ij}}$ here means $\sqrt{v(T_0, ij)}$ entry by entry. It preserves trace and implements the same population transition law, but removes off-diagonal coherence. Its stationary matrix is $\text{diag}(\pi)$, reproduced exactly in the numerical test. This control shows that the classical transition law and probability conservation alone do not determine amplitude coherence. It is not asserted to satisfy every VERSF microscopic axiom, and probability conservation is not a substitute for the full BCB conservation axiom.

Criterion 9 (selection by a unique persistent coupling mode). On a sector support of size n_A , let L_A be positive semidefinite with kernel exactly $\text{span}\{v_A\}$, where $v_A = x_A/\sqrt{n_A}$. If the physical coupling ρ_A is positive, has unit trace and satisfies $\text{tr}(L_A \rho_A) = 0$, then $\rho_A = v_A v_A^T$. Consequently $f_A = 1$ and its reduction under the fixed R is $\epsilon n_A/49$.

Proof. Positivity gives $\text{tr}(L_A \rho_A) = \|L_A^{1/2} \rho_A^{1/2}\|_F^2$. If this vanishes, the range of ρ_A is contained in the kernel of L_A . The one-dimensional kernel and unit trace fix $\rho_A = v_A v_A^T$. Proposition 8 then gives the stated reduction. ■

Remark (the transformation type determines the persistent weights). Let T_A be an irreducible, aperiodic row-stochastic law on a sector support, with stationary probability π_A . On observables, T_A has persistent right mode 1, regardless of π_A . On column measures, T_A^T has persistent mode π_A . In the amplitude coordinates defined by $D_{\pi_A^{1/2}} T_A D_{\pi_A^{-1/2}}$, the persistent mode is $\sqrt{\pi_A}$. This transformed operator is symmetric when the law is reversible; the similarity transform itself does not require reversibility. Uniform measure and amplitude modes occur exactly when T_A is doubly stochastic. The wheel has column sums $23/14$ at the hub and $25/28$ on each rim state, so only its observable persistent mode is equally weighted.

To apply Criterion 9 in the Euclidean coupling coordinates of Section 5.8, the observable case admits $L_A = (I_A - T_A)^T(I_A - T_A)$, which is positive semidefinite and has kernel $\text{span}\{1\}$. Thus zero cost forces the

collective coupling without requiring double stochasticity. The simpler $I_A - T_A$ is self-adjoint and positive semidefinite in $L^2(\pi_A)$ for a reversible law, but need not be so in Euclidean coordinates. Using that weighted version requires carrying the coupling and trace through the same metric conversion. Irreducibility fixes the persistent vector; it does not by itself require the gauge coupling to have zero support outside that mode.

The source check is consequently concrete: determine whether the coupling transforms as an observable, a measure or an amplitude, and establish that it is confined to the persistent mode. For a measure or amplitude coupling, also test double stochasticity of the sector law. The sector law must itself be derived: a submatrix of the full transition law need not be stochastic if transitions leave the participation support. If the source selects the observable picture with the persistent-support condition and the stated participation metric, the hub/rim asymmetry is no obstacle to equal weighting; in the measure and amplitude pictures it prevents equal weighting unless the derived sector law has uniform stationary measure.

For the explicit test choose $L_A = I_A - vAvA^T$. This is a sufficient-condition control, not an operator independently returned by the gauge source. It gives $\text{tr}(L_A pA) = 1 - fA$ exactly. The diagonal coupling I_A/nA has costs 35/36, 25/26 and 46/47 in colour, weak and hypercharge, while the fully collective coupling has zero cost. Half-collective mixtures have half the diagonal costs. The diagonal reductions are all 0.172067727%; the fully collective reductions are 6.194438%, 4.473761% and 8.087183%. All these mixtures commute with L_A , so commutator stationarity alone does not enforce the zero-cost condition.

The hypothesis therefore has a precise sufficient form: the physical gauge coupling must be supported entirely in a unique, equally weighted persistent mode on each participation support. Under that condition full reinforcement follows, without using measured couplings. The same-source task is to establish that the terminal-record and coarse-graining map imposes this condition on the gauge coupling, including the appropriate measure and generator-channel structure. HMGB-1 identifies the faithful defect lift as an obligation [9, §5, HM10], while its shared operational measure permits cross-channel superposition without selecting this coupling [9, §43A.3]. The test strengthens the proposed route but does not turn the seven-state history projector into a gauge-coupling projector by assumption.

6 Conditional comparison with the weak mixing angle

To assess the numerical consequences of one proposed attachment, the earlier calculation imposed $Z'A = rAZA$ at the source boundary. This diagonal ansatz uses Table 2, not Table 3. It does not follow from the complete history matrix alone, and it was examined after the comparison value was known. We retain it as a conditional comparison with its assumption stated explicitly; it is what SGW-3 calls the clamped reading of the D41 model, and the profiled row below is its relaxed reading [1, §43]. Section 5.8 supplies an explicit positive realisation of this ansatz and states the additional participation premise; it does not convert the conditional comparison into an independently derived physical prediction.

In conventional hypercharge units, the one-loop equations are

$$A(M_Z) = cZ' + bL/(8\pi^2), \quad b = (-7, -19/6, 41/6), \quad L = \ln(\mu/M_Z). \quad (18)$$

Here $A = (g_s^{-2}, g^{-2}, g'^{-2})$. The frozen inputs $\alpha_s = 0.1180$ and $\alpha_{em}^{-1} = 127.95$ determine c and L through the colour and electromagnetic constraints. The predicted weak angle is $A_2/(A_2 + A_V)$. The comparison value 0.23122 is used afterwards; it does not select the three reductions. The higher-order continuation includes the declared diagnostic input $y_t(M_Z) = 0.94$ [1, §43].

Table 4. Conditional boundary comparisons with the frozen weak-angle value 0.23122.

Boundary and transport	Calculated weak angle	Relative difference
Unscreened one loop	0.224426490312	−2.93812%
Diagonal D41 (clamped), one loop	0.231477770893	+0.111483%
Unscreened two loop plus top	0.227367379454	−1.66621%
Diagonal D41 (clamped), two loop plus top	0.23440586	+1.37785%
Profiled history (relaxed), two loop plus top	0.22874077	−1.07224%

The profiled-history row uses the alternative fractions (1, 1, 0.986635999) obtained by also relaxing the other history coordinates. It is not an instruction to integrate out other physical gauge factors. The clamped and relaxed rows answer different questions about one statistical model and are not additive corrections; neither is selected by its closeness to the comparator.

The one-loop diagonal comparison gives $c = 0.560137191823$ and $\mu = 1.25899 \times 10^{14}$ GeV, with $M_Z = 91.1876$ GeV. These are matching coordinates inferred from the two measured inputs, not independently predicted scale and normalisation. The two-loop diagonal result without the leading top term is 0.23436810; the corresponding profiled result is 0.22870564. The higher-order rows are inherited from the published continuation [1] rather than from a fresh integration in the coarse-graining test.

The bounds $0 \leq f_A \leq 1$ bracket each source coefficient between $ZA(1 - \epsilon_A/49)$ and ZA , but do not by themselves bracket the transported weak angle between the two equal- f_A endpoints. The weak angle depends on relative coefficients and on the matching scale and common multiplier inferred from the two input strengths. Independent variation of the three f_A must be propagated through that matching problem. Even a common- f interpolation needs its transport evaluated before a monotonic numerical bracket or a comparator-crossing value is quoted. All f_A must be returned by the source; selecting them to reproduce the measured weak angle would be a fit, not evidence for the mechanism. Evaluating all eight corners $(f_C, f_W, f_Y) \in \{0,1\}^3$ with the one-loop matching equations (18) gives a corner range of 0.212119 to 0.244163, attained at (0,1,0) and (1,0,1), respectively. Both lie outside the equal- f_A endpoint interval 0.224426 to 0.231478. This explicitly disproves that endpoint bracket for independently varying sector overlaps; it is a diagnostic of the conditional attachment, not a selection of physical f_A .

The 0.11% agreement is therefore not an established precision prediction. Its sensitivity to transport order is material, the diagonal proposal was investigated after comparator information was known, and the sign of the residual reverses between one and two loops. No experimental covariance, new threshold matching, finite scheme correction or complete Yukawa census is included. The numerical residuals do not constitute an uncertainty budget. No weak-angle prediction is claimed for Table 3.

7 Discussion and conclusion

One shared substrate response produces unequal history reductions because the participation vectors have different overlaps with its screened mean component. The full factor-space matrix, the counts 36, 26 and 47, and the inherited bath coefficient determine that result. The three percentages are therefore consequences of the conditional construction, not three independently fitted corrections. The exact centred/mean decomposition connects this result to the distributional geometry already established in the source.

The source-preservation theorem fixes the collective subtraction on the participation span for all history operators reproducing D41, with the dephasing family as a corollary. A distinct maximality theorem selects the rank-one collective coupling only if the maximal reduction is required. Neither excludes a diagonal coupling to the unchanged history operator. These restrictions come from the derived history

and the stated maximum, rather than comparison with measured force strengths; the physical coupling must still be established from the source.

The statistical diagnostics must be interpreted as comparisons of different observables. Neither immediate pointer statistics nor the ordered-record Fisher response is the physical coefficient sought here. Their mismatch with the D41 pattern cannot be used to reject the $K = 7$ force relationship. The calculations retain value as distinguishability tests, but the proposed force attachment must be assessed within the coupled physical action.

Equations (16)–(17) turn the remaining connection into a definite test. The full gauge curvature must reproduce both the invariant structure and the source-derived reduction magnitude without selecting the source from measured couplings. If it returns another balance, that balance must be reported and the diagonal attachment replaced or rejected. The conditional weak-angle comparisons remain useful diagnostics but cannot select the outcome.

The closure test makes the next obligation sharper. A unique uniform persistent mode would force the collective coupling if the physical coupling has no support outside it. The canonical history wheel supplies an analogous persistent-mode result, but its carrier and measure differ from the participating-state gauge construction. Section 5.10 identifies the required map without equating probability conservation, shared normalisation or stationarity with full reinforcement.

The paper establishes a differential history response, a source-preservation necessity result and a conditional direct realisation of the proposed force coefficients. The strength ϵ comes from D41's elimination of internal modes; expressing it with R requires no additional external bath or deeper physical layer. The unresolved claim is whether the same-source gauge dynamics and coarse graining carry that history response into the full physical gauge matrix. The inspected source explicitly retains that identification as conditional [6, §17.110]. The necessity result therefore strengthens the history mechanism without silently promoting it to a complete gauge-uniqueness theorem.

Appendix A Inverse targets and relative response contrasts

The earlier backward calculation remains useful as a target, independently of the forward mechanism. Let p_r be the effective response price per state in the 47-state order (Q, u, d, L, e, H) . Where the common-action price attachment is valid, the inherited contractions give

$$\begin{aligned} A_3 &= 3p_Q + (3/2)p_u + (3/2)p_d, & A_2 &= (9/2)p_Q + (3/2)p_L + \frac{1}{2}p_H, \\ A_Y &= \frac{1}{2}p_Q + 4p_u + p_d + (3/2)p_L + 3p_e + \frac{1}{2}p_H. \end{aligned} \quad (A1)$$

Define the relative contrasts

$$J = -2A_3 - 3A_2 + 3A_Y, \quad T = 466A_3 - 687A_2 + 159A_Y. \quad (A2)$$

Both vanish on the baseline vector $(6, 13/2, 21/2)$. Thus a common per-state price change, which adds a multiple of that vector, cannot be determined from these contrasts. This is not an equal additive shift in the three coefficients. At one loop T also annihilates the running direction b , whereas J changes with the matching scale ($j \cdot b = 44$). Neither may simply be held fixed under the higher-order transport used here.

On the imposed three-price slice $p_Q = p_L = m_L$, $p_u = p_d = p_e = m_R$ and $p_H = h$,

$$J = 18(m_R - m_L), \quad T = 6(-401m_L + 445m_R - 44h). \quad (A3)$$

Writing $c = A_3/6$ gives the exact inverse

$$m_L = c - J/36, \quad m_R = c + J/36, \quad h = c + (141J - T)/264. \quad (A4)$$

The six-price map has rank three, while its restriction to the two contrasts has rank two. Measurements of three couplings cannot reconstruct six independent prices. The following are alternative inverse families, not independently predicted substrate responses.

Table A1. Prices inferred from the frozen comparator under three imposed patterns.

Pattern	m_L	m_R	h
Universal matter	0.515401	0.515401	0.641925
Higgs follows right-handed matter	0.528906	0.515111	0.515111
Higgs follows left-handed matter	0.527578	0.515139	0.527578

The first family requires $h/m = 1.245486$ and $h - m = 0.1265239702$. Relative to a unit core, matter loses 0.484599 of its price and the Higgs 0.358075. The two chiral families require $m_R/m_L = 0.973918$ and 0.976423, with $m_L - m_R = 0.013795165$ and 0.012438878. Their sensitivities are $T = 2406(m_R - m_L)$ when $h = m_R$, $T = 2670(m_R - m_L)$ when $h = m_L$, and $T = -264(h - m)$ for universal matter. The common response near 0.52 is separate from these differential requirements.

Table A2. Corresponding boundary contrasts and matching coordinates.

Family	J	T	$\ln(\mu^*/M_Z)$
Universal matter	0	-33.402328	26.902390
Higgs follows right-handed matter	-0.248313	-33.191167	27.346699
Higgs follows left-handed matter	-0.223900	-33.211804	27.303015
Hypercharge-only relative change	-0.620376	-32.879926	28.012456

The fourth family imposes $A_3/6 = A_2/(13/2) = c$ and $A_Y = c(21/2)f_Y$, giving $c = 0.531907846$ and $f_Y = 0.962973896$. The hypercharge inverse-coupling coefficient is then 3.70261% below the common strong-weak response. This is a coefficient description, not proof that only one particle sector changes.

All four families reproduce the frozen endpoint under the published two-loop-plus-leading-top transport, with numerical replay errors below 6×10^{-13} . Twenty-four checks in the inverse-response archive cover contractions, ranks, inverse identities, forward controls and replay stability. Positive quadratic relaxation examples exist for each family, but were not identified with a physical VERSF action. Each matching scale is inferred jointly with its family; an independently derived physical scale could exclude a family.

At the fixed low-energy endpoint, correcting the unscreened reference 0.227367379454 to 0.23122 requires $\delta A = (0, 0.03922714155, -0.03922714155)$, $\delta J = -0.2353628493$ and $\delta T = -33.18616175$. The older gauge-only value -33.48185948 excludes the leading top term. These endpoint differences are not source-boundary corrections. The required endpoint increase of A_2/A_Y is 2.20407%. Directly applying the diagonal fractions at that endpoint gives 0.234212468288, a same-scale illustration distinct from Table 4.

Appendix B Transport and restricted mechanism controls

The existing transport calculations establish effects relevant to assembly of the physical response, but their percentages cannot be added as independent gauge corrections [4, 5]. In the four-variable current-link-record benchmark, elimination at fixed link coordinate gives

$$K(0) = 4w_C + 4w_B w_R / (w_B + 4w_R), \quad K_{\text{fixed}} = 4w_C + w_B. \quad (B1)$$

Unit weights change the link stiffness from 5 to 4.8. The separately retained current response is 48/53, a 9.433962% reduction rather than D41's 8.087183% generalised-direction reduction. Both are unit-weight diagnostics, not selected physical screening predictions. A conditional temporal extension has nonzero low-frequency inertia, but its masses and omitted mixed or odd-frequency terms are not fixed by the static benchmark.

For endpoint transport on the seven-vertex wheel, the native coarse edge conductance is $1/31$. Subdivision uses half-edge conductance $2/31$ and boundary masses $\text{diag}(7, 4, 4, 4, 4, 4, 4)/31$. With the explicitly diagnostic midpoint mass $1/31$, elimination gives

$$Q(z) = zM_b + A - B(D + zM_i)^{-1}B^T. \quad (B2)$$

The static limit recovers the coarse wheel. At $z = 0.3$, a static approximation has 5.14055% relative inverse-response error; retaining the first memory correction reduces it to 0.385541%. The full rational response agrees with the fine system, and a time-domain calculation retaining the initial interior state agrees to approximately 1.12×10^{-16} . Here z is a Laplace variable, not the squared frequency of a different action model.

The inherited carried-history moments give propagation variance 3.276486321746446, compared with 3.1140586444901475 for fixed charge, an increase of 5.21595%. This recomputes published moments rather than rerunning the original Kraus arrays. It is not evidence for a 5.21595% force correction or proof that fact momentum accounts for the weak-angle discrepancy.

The elementary two-field wheel response $k_{\text{rel}}(\lambda) = a\lambda + bc\lambda/(b\lambda + c)$ can suggest different mode attenuation. However, $k_{\text{rel}}(\lambda)/\lambda$ varies with λ , conflicting with promotion to the full primitive shape $K_\theta = tG$ merely by matching one mode [6]. Admitted nonfactorising witnesses share that full shape after PCN even when their current responses differ.

A further particle-count control assumes retained fractions $f_3 \leq f_2 \leq f_1$ for states carrying three, two and one factor types. Its charge contractions give $Z_3 = 3f_3 + 3f_2$, $Z_2 = (9/2)f_3 + 2f_2$ and $Z_1 = \frac{1}{2}f_3 + 7f_2 + 3f_1$. Consequently

$$r_w - r_Y = (176f_3 - 98f_2 - 78f_1)/273 \leq 0. \quad (B3)$$

This excludes that monotone count-only model for D41's ordering, without excluding the participation construction in Section 3, whose ordering (Proposition 2) comes from participation counts rather than from monotone fractions by factor multiplicity.

Restricted GRCE attachment tests return the baseline (6, 13/2, 21/2) for the uniform-profile branch with zero mixed block and (6, 8.125, 11.625) for the specified harmonic branch. They do not exclude the full physical construction. HMGBG distinguishes its physical heat transfer and complete defect and path-law lift from the canonical wheel benchmark [9]. Similarly, the free current-conservation block gives zero relative contrasts in its stated continuous-time fixed-measure prescription [3], not a general cancellation theorem.

Finally, the later full current-cycle score contains nonuniform components whose projection onto an older twelve-scalar-score span retains only 2.53128% of their squared norm, while retaining the entire uniform score [4, XV.18–19]. That diagnostic projection is not the full source response and must not replace the later calculation when assembling the action.

Appendix C Reproducibility and provenance

The participation and bath reductions, coarse-graining identities and conditional force comparison have distinct calculation records. Section 5.7 reports a statistical sector audit separately from the physical acceptance condition. No complete physical-action evaluation or new renormalisation-group integration is claimed.

Section 5.8 is reproducible from Table 1 and equations (4) and (17a–c): form each normalised binary column vA , place $\sqrt{ZA}$ vA in its own 49-component generator block, and contract the resulting 588×12 matrix with twelve copies of R . Verify $B^\dagger B$ against the bare generator Gram and $B^\dagger \tilde{R} B$ against (17b). The independent-state control is $\text{tr}[R \text{diag}(xA)/nA]$. No experimental inputs enter these operations. The 588 coordinates are an auxiliary response construction, not a claim about the native microscopic carrier.

The standalone script `calculate.py` in `Direct_Participation_Check.zip` [22] reproduces Section 5.8 in conventional Y and primitive q units, the rank-twelve target subtraction, the independent-state fractions and the diagonal Casimir contractions. The archive contains `results.json` and a scope note. Script SHA-256: 89417209db990541e831567b7fc186fc8dad7e22793aef1be3f7062aba6632e2.

The inverse-response, transport, D41 action, participation, mode-response, GRCE and coarse-graining archives retain the earlier checks. Their algebraic fixtures do not replace the microscopic bath arrays. The standalone bath-interaction script [18] reproduces the centred/mean decomposition and the Section 5.3 statistics; the gauge-sector script [21] reproduces the Section 5.7 audit. The following SHA-256 identifiers specify the available executables.

Bath interaction script [18] SHA-256:

810cb6cd97c7764cbb7eac3e8d7ac53db881f7ad0d36c3120dc5b938f5b475fa.

Gauge sector script [21] SHA-256:

3186c219426ad77a33395fe57a0b10b4bda58c6c08718e21007b75f0a85c5b59.

The new distribution and immediate-interaction results in Sections 3.2 and 5.3 are reproduced by `calculate.py` in `VERSF_Bath_Interaction_Check_21Oct2026.zip` [18]. The archive includes `results.json` and a scope note. It constructs the twelve generators, verifies their trace Gram and the D41 decomposition, evaluates the analytic Haar identity, and samples 100,000 rays with seed 20261021. It also verifies excitation probability $2/49$, positivity and rank twelve of the commutator Gram at one generic Haar witness. The source-reported activation dimensions, intertwiners and multi-opportunity history checks were read in the corpus and were not independently rerun by that script.

`Collective_Participation_Necessity_Test.zip` [23] contains `calculate.py`, `results.json` and `READ_ME.txt`. It reproduces the full dephasing family formula, the independent centred/mean coefficient recovery, positive and symmetric response controls, and the numerical examples in Section 5.9. The proof statements and their scope are included in the archive. Script SHA-256:

62df76829e86a83f7dd98b3e62927224fb924905c5b6d3176401265fc9d21fe8.

The review used corpus-wide searches followed by targeted reading of the bath, transport, current-record, completion and later correction sources. It does not claim a page-by-page reading of every corpus item. The source-conditioned D41 result, the conditional current-orientation law, the explicit native instrument, the new immediate-statistics diagnostic and the unexecuted full gauge test are kept distinct.

`Closure_and_Collective_Coupling_Test.zip` [24] contains `calculate.py`, `results.json` and `READ_ME.txt`. It reproduces the canonical seven-state kernel, spectrum, detailed balance, decay of an alternating rim mode, the stationary diagonal-channel control, and the sector coupling tests of Section 5.10. The source references and the distinction between the wheel and the sufficient-condition sector model are recorded in the note. Script SHA-256:

f1b8d67b7f47ac2d006f09229154b9b118b34dc2f1c686d6fb55f616fe41aa93.

References

- [1] K. Taylor. Physical Applicability and Irreversible Response in VERSF (SGW-3). 17 October 2026. Sections 13, 14, 20, 21, 28 and 43, Proposition 55.
- [2] K. Taylor. The Scale and Common Normalisation Free Gauge Relation in VERSF (SGRI-1). 9 October 2026. Sections 2 to 11.
- [3] K. Taylor. Gauge Response from the VERSF Master Action. 20 October 2026.

- [4] K. Taylor. Configuration Dynamics, Refinement Geometry and Record-Conditioned Curvature Response in VERSF. 22 September 2026. Parts II, VII.1, XIII.3 to XIII.11, XIV and XV.18 to XV.19. Also Part I §I.8 and Part XIV §§9–15.
- [5] K. Taylor. CLSN-1 Native Transport Cost and Refinement Derivation. Section 6.
- [6] K. Taylor. The Physical Changing Link Source Representation Resolved History Metric and Gauge Normalisation Closure Attempt in VERSF (CLSN-1). 6 October 2026. Sections 17.1 to 17.7, 17.86 and 17.106 to 17.110, and Appendix A13. The distribution, QCA and activation continuations are in §§17.21–17.32 of the source dated 9 October 2026.
- [7] K. Taylor. The Twelve-Sector Current-Rigidity, Source-Generated Rank-Six Current-Stiffness and Current-Link Schur Reciprocity Theorem in VERSF (RCHS-1). Sections 8 and 9 and Appendix A.
- [8] K. Taylor. Physical Matter-Higgs Record Weighting and the Gauge-Coupling Closure Gate in VERSF (SGW-2). 13 October 2026. Sections 10.4 to 10.7 and 11.
- [9] K. Taylor. The VERSF History-Measure, Generation-Geometry and Branch-Closure Theorem (HMGB-1). Sections 56A.2 to 56A.11. Section 5, premises HM1–HM4, defines the unresolved-mode carrier.
- [10] K. Taylor. Full-Corpus Review and Common-Source Attempt. Working note, 17 October 2026, pp. 1 to 5.
- [11] K. Taylor. Does the Existing Source Fix J and T. Source-identifiability working note, 17 October 2026, pp. 1 to 4.
- [12] K. Taylor. CRTF EX2K Relative Birth Current. 26 August 2026. Jointly isotropic endpoint innovations and relative-current Haar law.
- [13] K. Taylor. RCHS-2 Faithful Current-Link History-Metric Gate. 4 September 2026. Section 8 on endpoint correlations and current covariance.
- [14] K. Taylor. The Non-Abelian Bath-Transport Theorem Continuous Colour Gauge Dynamics and Full Gauge-Product Closure in VERSF. Section 0.8. See also The Bath Criterion.
- [15] K. Taylor. MBCI Source Normalisation and Scale Covariance Audit. 3 September 2026. Sections 1–4. The later operator-survival correction is in [6], §§17.29–17.32.
- [16] K. Taylor. Physical Bath Selection and Neutrino Mixing in VERSF. §§6.1–7 and subsequent source-selection qualifications.
- [17] K. Taylor. The Non-Perturbative QCD Scale and Triality-Gap Completion Theorem in VERSF. §§7–7A, pp. 19–25.
- [18] K. Taylor. VERSF Bath Interaction Check. Calculation record, 21 October 2026. Reproducible script, results and corpus-review note supplied as `VERSF_Bath_Interaction_Check_21Oct2026.zip`.
- [19] K. Taylor. RCHS-36M Record Conditioned Prediction and Curvature Response. 9 September 2026. Ordered terminal-record instrument and orientation profiling.
- [20] K. Taylor. RCHS-36N Ordered Record Curvature Response with Free Normalised Endpoints. 9 September 2026. Reproducibility package and archived derivative arrays.
- [21] K. Taylor. Gauge Connection Test. 21 October 2026 UTC. Sector audit of the RCHS-36N arrays, script and results in `Gauge_Connection_Test.zip`. Numerical sector comparison of record sensitivity, with its physical scope stated in Section 5.7.
- [22] K. Taylor. Direct Participation Check. 20 October 2026. Script `calculate.py`, results.json and scope note in `Direct_Participation_Check.zip`. Conditional tensor realisation and diagonal charge-contraction controls for Section 5.8.
- [23] K. Taylor. Collective Participation Necessity Test. 21 October 2026. Reproducible script, results and proof note in `Collective_Participation_Necessity_Test.zip`. Necessity within the fixed D41 response and the stated response-matrix classes.
- [24] K. Taylor. Conservation, Closure and Reinforcing Participation. 21 October 2026. Reproducible script, results and source note in `Closure_and_Collective_Coupling_Test.zip`. Canonical-wheel verification and a conditional coupling-selection test.