Source History Weighting and the Coarse Grained Gauge Action in VERSF

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History weighting, record memory and field response

General reader summary

VERSF proposes that completed events leave records that influence what happens next. This paper tests how that influence reaches fields, currents and particles in several explicit models. It establishes calculable response mechanisms and identifies the additional physical inputs needed before their results can determine force strengths.

In one quadratic event model, the response of three selected field directions remains close to its value without recording. The current follows the changing links in that experiment; it is not evolved as a separate dynamical field. The measured response does not reproduce a proposed direct conversion of the earlier D41 history reductions into a field cost. A separate compact-field experiment gives a much larger change in its own response. The difference shows why field motion, finite-event response and physical force strength must be kept distinct.

Other calculations let the current and an internal record phase adjust together. They show exactly how preserving a specified record pattern increases the field's restoring cost, while reading a discrete outcome alone need not freeze that phase. A further calculation places field, current, record and fermion response on a common spatial lattice. At its stated inputs, the fermions lower the hypercharge field stiffness by about 0.68 per cent. A quadratic history extension preserves this static result by an exact identity and reveals memory from the variables removed during coarse graining.

These are conditional model results. No measured force strength chooses an input, but the full source has not yet selected every cost, background, recording condition or spatial attachment used in the tests. Section 19.9 states what a physical force prediction must additionally establish. The paper supplies working calculations for that task without issuing measured force strengths.

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Abstract

This paper asks how the recording of a completed event in the seven-state cell changes the coarse-grained gauge response, and evaluates a series of explicit restrictions using the archived VERSF sources. The native current-dependent recording operation returns a coupled finite-event response on a declared quadratic branch. One colour Cartan direction, one weak Cartan direction and hypercharge share the current, pointer channels and completion clock, with inherited starting coefficients $(6,13/2,21/2)$. Across 512 histories in each of two oscillator bases, their diagonal response ratios are 0.99952 ± 0.00144, 0.99755 ± 0.00151 and 0.99919 ± 0.00046 relative to the no-record prediction. A local quadratic D41 surrogate is not reproduced. Field energy rises by 0.169 ± 0.011 model units without a resolved diagonal energy-curvature correction. Common spatial history reduction and static closed-cover weighting separately preserve the stated D41 participation fractions. Explicit energy-transfer and recording constructions, including a pathwise balanced store, distinguish record retention from a hard polar-phase constraint. The scalar parent gives coefficient $3/2$ with a free polar record and 2 with its phase fixed. A principal interaction reproduces the inherited current stage on all twelve archived edges to 1.26×10^{-14}, but is an inverse construction rather than a physical source-selection theorem. Nonlinear propagation and an explicit field-to-record-pattern map supply conditional transmission mechanisms.

The fermion calculations extend this response analysis onto spatial carriers. Composition changes the specified magnetic and ordered electric matching coefficients by approximately -0.001872 and $+0.002676$ per Weyl index; their inherited census contractions remain distinct until common space-time matching. Coupled current–record fluctuations give an electric coefficient $b_{\mathrm{E}} = 3.27265 \times 10^{-6}$ on fourteen modes of an $8^3 \times 16$ box; quadratic fermion feedback raises this small correction by 0.609 per cent. An unexpanded two-coordinate determinant integral independently tests the normalised weighting. On a common $7^3 \times 14$ spatial construction, exact seven-site covariance blocking includes current and record relaxation and the transverse fermion two-point matrix. At the stated momentum, its two hypercharge stiffness ratios are 0.993166 and 0.993171 relative to the bosonic reference. Direct parent reduction, determinant factorisation, gauge controls and source-weight derivatives verify this finite result. An explicit joint Gaussian history extension preserves the static correction as an exact quadratic identity and exposes temporal memory after spatial blocking. This is a consistency test, not a selection of the physical weighting; first and mixed transfer derivatives are retained. The constant diagonal phase metric, spatial construction and static branch remain specified premises; full completion, physical history weighting and the irreversible joint recording operation are not evaluated by this restriction. No measured coupling selects an input, no additional common conversion constant is fitted, and no physical force-strength triple is issued.

1 Question and result

The task is to derive the representation-resolved gauge response after coarse graining one joint law of links, currents, records and matter. This paper establishes several conditional responses, tests proposed identifications between them, and specifies the physical inputs still required. It reaches a coupled finite-event probe and a finite common-carrier fermion correction. Neither calculation returns a physical force-strength triple. The source constructions are used on the carriers and branches for which they were supplied [1–6; 14–16].

Part I (Sections 2–14) treats the archived scalar parent and its native history law. It checks the conserved-current lift, reduces the exact-Fold edge covariance, and proves that a fixed current response alone does not determine the retained link action. The nonlinear score calculations include correlations, current relaxation and changes of covariance. Common spatial reduction and static closed-cover weighting preserve the D41 participation form under their stated hypotheses. A paired-rank test excludes identifying that response with the factor-blind Gaussian parent by the same linear readout.

Part II (Sections 15–18) evaluates recording, field motion and event energy. The selected colour, weak and hypercharge drive-response ratios on the quadratic branch are 0.99952 ± 0.00144, 0.99755 ± 0.00151 and 0.99919 ± 0.00046. These agree approximately with the no-record prediction. The specified both-coefficient and magnetic-only D41 surrogates differ by about 32–197 reported Monte Carlo standard errors. The electric-only surrogate has a smaller effect, but its hypercharge prediction remains about 4.3 reported standard errors above the coupled result; weak sensitivity must not be described as statistical agreement. Section 17.4 states the scope of this comparison.

The energy and record calculations establish separate mechanisms. Recording transfers energy to the tested field subsystem, and explicit enlarged implementations balance that transfer under declared Hamiltonians and preparations. On the scalar parent, allowing current and polar-record relaxation gives a uniform-mode stiffness of 3/2; preserving the record phase raises it to 2. A discrete recorded outcome does not by itself impose that constraint. The physical record map, energy supply and joint evolution must therefore be identified together.

Part III (Section 19) assembles fermion response on spatial carriers. The composition construction gives magnetic and ordered electric increments of approximately −0.001872 and +0.002676 per Weyl index relative to the stated reference. On the common $7^3 \times 14$ carrier, the two hypercharge stiffness ratios are 0.993166 and 0.993171. The joint-history extension preserves these static ratios by a quadratic identity; its additional result is the temporal response and memory left by spatial reduction. The sensitivity calculation shows why the chosen source weights remain material inputs. Section 19.9 collects the requirements for a physical prediction.

Standing scope. No measured coupling, mass or force strength selects an input, covariance or branch. PCN fixes the inherited common action unit; absence of a fitted multiplier does not establish uniqueness of the remaining model choices. The archived scalar parent has three scalar slots, not the twelve Standard Model generator directions. Finite-event susceptibilities, information Grams, disturbance kernels and gauge-action Hessians are distinct observables. Statistical errors and small numerical residuals describe the stated computations, not uncertainty in the physical attachment. The full physical response requires a faithful gauge carrier, a source-selected background and weighting, and a consistent recording condition.

1.1 Terms and source labels

D36 and D41. D36 denotes the archived directed seven-state address law. D41 denotes the inherited participation-dependent current-history response; it is not a measured force coefficient.

E2 and FB. E2 is the two-dimensional wave-number-two wheel subspace used in the finite tests. FB denotes the factor-blind weighting whose relation to the native participation response is tested in Sections 12–13.

PCN and EPM1. PCN denotes the inherited primitive common action normalisation. EPM1 is the conditional identification of matter propagation with source-even stationary traffic used in Section 14.3.

MASD and HMGBC. MASD supplies the master substrate action and defect construction [7]. HMGBC supplies the history-measure and full operational-transfer architecture [5]. Their complete physical execution is distinct from the scalar restrictions evaluated here.

PFDMI. The Primitive Field Dependent Marked Instrument programme supplies the native current-dependent recording construction and its declared prescriptions [47].

Part I Statistical history models on the archived scalar parent

2 The inherited joint event construction

The primitive joint-kernel construction takes a positive measure over a discrete event mark and a configuration increment. For the link and current components, its inherited semidirect update is

$$(U, j) \mapsto (VU, \eta + Vj). \quad (1)$$

The record, matter and completion updates must act on the same event carrier. The native current-dependent recording operation already exists [26]; Sections 15–17 evaluate it with the inherited stopping rule and a stated moving-field attachment. Its joint composition with every other physical update remains to be evaluated. Pushing the event measure through this map gives an off-diagonal raw transfer; the inherited normalisation then gives a stochastic history law [2; 3, Section 17.79]. The map specifies how supplied increments compose. The distribution of those increments is additional source content, not a consequence of the multiplication rule alone.

The later parameter-closure construction supplies a conditional operational heat proposal. In a rank-stable tangent chart its quadratic form is

$$\xi \mid D \sim \mathcal{N}\big(a_t E_D D,\, a_t G_{\mathrm{op}}^{-1}\big), \qquad W_{\mathrm{core}} = E_D^{\mathrm{T}} G_{\mathrm{op}} E_D. \quad (2)$$

Here D is a realisable defect perturbation, E_D is its operational minimum-norm lift and G_{op} is the operational tangent metric. Equation (2) is inherited, including its conditional status [4, Sections 64.4.1B–H]. The covariance and the likelihood normalisation must be carried together. It is not necessary to invent a Gaussian rule for the next calculation.

HMGBC supplies the complete source architecture: an operational carrier and measure, a Dirichlet generator, an upstream reference potential, persistent-record projection, full defect differential and refinement maps [5, Sections 56A.1–5]. Its raw heat transfer is constructed from that operational generator and reference potential. A weighted residual-square action chosen later is not automatically the upstream potential. HMGBC also separates history information from the physical action response and explicitly identifies the remaining embedding, background, tilt and physical-source obligations [5, Sections 16 and 56A.11].

The primitive joint-update continuation retains these distinctions. Normalised current-ray statistics can be blind to a common rescaling while event activity and mixed changes remain responsive [6]. Neither that restricted blindness nor the preservation of a current Gram determines the complete field response.

This paper therefore uses (2) to test its actual linear lift and uses a declared quadratic continuation to examine the remaining extension problem. It retains PCN as the inherited common action-unit premise. No new physical conversion constant is introduced.

3 Conserved current lifts on the complete finite parent

Let J denote the complete six-defect Jacobian of the archived scalar parent at its common-zero configuration. Its rows contain closure, current, conservation, composition, bond and completion residuals. The archive has 226 configuration coordinates and 243 defect coordinates. Removing its 39 analytic kinematic null directions gives a quotient of dimension 187. The defect differential has rank 183; the potential supplies the remaining stabilisation [7]. These dimensions are reconstructed from the source functions rather than copied into the matrix calculation.

For the operationally orthonormal control, put

$$E = J^{+}, \qquad W_0 = E^{\mathsf{T}}E, \qquad P = EJ. \quad (3)$$

The plus denotes the Moore–Penrose inverse. Thus P projects onto the complement of $\ker J$, and $J^{\mathsf{T}}W_0J = P$. The potential is retained separately. The equality is an operational whitening identity and is not a physical gauge-coupling value [4, Section 64.4.1E].

Let D_{inc} be the vertex–edge incidence matrix and $C_{\triangle}$ the face–edge cycle matrix. Their dimensions are 7×12 and 6×12. The six cycle eigenvalues are $(1,2,2,4,4,5)$. If F is an orthonormal face eigenbasis, an orthonormal conserved edge basis is

$$V = C_{\triangle}^{\mathsf{T}}F\,\mathrm{diag}(1,2,2,4,4,5)^{-1/2}, \qquad D_{\mathrm{inc}}V = 0, \qquad V^{\mathsf{T}}V = I_6. \quad (4)$$

Proposition 1 (exact conserved current lift). On this archived common-zero parent, let L inject any real linear combination of the cycle columns (4) into a real or imaginary current coordinate, with every other configuration coordinate zero. Let Y inject the same columns into the corresponding current-defect rows, with every other defect row zero. Then

$$JL = Y, \qquad EY = L, \qquad Y^{\mathsf{T}}W_0Y = L^{\mathsf{T}}L. \quad (5)$$

Proof. A pure current change enters the current defect with coefficient one. Its conservation defect vanishes by (4), and the other four defect families do not change. Hence $JL = Y$. Any vector in $\ker J$ has zero closure variation, so its link variation is a graph gradient. The vanishing current defect then makes its current variation a graph gradient as well. Vanishing conservation makes that gradient divergence-free. On the connected wheel it is zero. Consequently a pure cycle-current vector is orthogonal to $\ker J$, giving $EJL = PL = L$. The metric identity follows from (3). ■

There are six spatial cycle modes, three scalar slots and two real current quadratures. All 36 directions pass (5). Selecting the cosine and sine face harmonics at wave number two gives an E_2 doublet in each slot. The resulting six-direction injection passes both the rank and image-projector tests. Repeating it in the imaginary-current quadrature gives the same result. Directed-edge rotation and reflection preserve the doublet and act orthogonally on it.

This independently reproduces the inherited current-lift result on this finite parent. Identifying this spatial doublet with the full source's marked-current carrier still requires the physical attaching map. Equality of dimensions and matching dihedral representation types do not establish that map.

4 Exact Fold weighting and the cycle response

4.1 Three distinct quadratic quantities

The infinitesimal operational proposal uses the coefficient

$$g_{E_2} = \frac{24(1+\cosh\alpha_\star)}{5(1+3\cosh\alpha_\star)} = 2.18303228994, \qquad \alpha_\star = 0.959001109719975. \quad (6)$$

Equation (6) is a continuous-limit quantity. The exact-Fold source instead requires $\Sigma_F = H_\theta^{-1} - P_+ H_\theta^{-1} P_+^{\mathsf{T}}$ for the linear update $x_{n+1} = P_+ x_n + \epsilon_n$ [2, Sections 12–15]. On endpoint E_2, $p = -0.099388227586084$, $\Sigma_F = (1-p^2)/(24/5)$ and $G_F = \Sigma_F^{-1} = 4.847887528915$. The stationary inverse covariance is $H_\theta = 24/5$. Innovation precision, stationary stiffness and infinitesimal operational precision are distinct objects. None is assigned to the independent physical cycle current by identifying their dihedral representation labels.

Remark (one eigenvalue, two constructions). The endpoint autocorrelation p above and the EPM1 attenuation μ of Section 14.3 are the same number. Both are the E_2 eigenvalue of the additive reversibilisation of the archived D36 law: the hub row of that law is uniform and so invisible to the wave-number-two rim harmonic, while on the rim the symmetrised law has self weight $p_{self} = 0.200305886207$ and equal neighbour weights $(p_{forward} + p_{backward})/2 = (0.522615879875 + 0.076772347711)/2$, so that $\mu = p_{self} - (p_{forward} + p_{backward})/2 = -0.0993882275861$, which agrees with both quoted values to every printed digit. The same formula gives $1/2$ for the first rim harmonic and -0.399082 for the alternating one. The identity is a statement about the two constructions as executed; whether the update P_+ of [2] is defined as that reversibilisation or coincides with it on E_2 is a statement about [2].

The covariance relation uses the unit RCHS energetic branch as input; recovering that stiffness from its stationary covariance is an internal consistency check. The exact endpoint interpretation remains conditional on EPM1. PCN independently fixes the primitive action unit on its stated event carrier [3, Sections 17.106–17.108]. It does not turn these different statistical probes into the same observable.

4.2 Reduction of the full edge covariance

Let C_e be the positive twelve-edge innovation covariance returned by PJCK-1's three-tap rim construction [2, Section 14], with rim edges first. Its blocks are $C_R = a_0 I + a_1(S + S^{\mathsf{T}}) + a_2\left(S^2 + (S^{\mathsf{T}})^2\right)$, $C_S = b_0 I$ and zero rim–spoke cross block. Solving the four endpoint mode equations gives $a_0 = 0.024523939062557$, $a_1 = 0.013273766094793$, $a_2 = 0.003040791987633$ and $b_0 = 0.003238849444075$. The computation solves the equations directly rather than substituting these rounded values.

The endpoint mass is the tilted stationary law $\pi = (7, 2+2\cosh\alpha_\star, \ldots, 2+2\cosh\alpha_\star)/(19+12\cosh\alpha_\star)$. With $A = \mathrm{diag}(\pi)^{-1/2} D_{\mathrm{inc}}$, the test reproduces $A C_e A^{\mathsf{T}} = \Sigma_F$. Using the untilted wheel masses would give a different answer. The former nearest-rim/common-spoke class is indefinite when solved at full-Fold grade; the positive construction must be retained as specified.

Let U_g be an orthonormal basis for $\mathrm{im} D_{\mathrm{inc}}^{\mathsf{T}}$ and let V be the cycle basis (4). In this basis define $C_{gg} = U_g^{\mathsf{T}} C_e U_g$, $C_{gc} = U_g^{\mathsf{T}} C_e V$ and $C_{cc} = V^{\mathsf{T}} C_e V$. The gradient–cycle cross norm is 0.02249591848. The marginal cycle covariance is C_{cc}, while conditioning on zero gradient innovation gives $C_{c|g} = C_{cc} - C_{gc}^{\mathsf{T}} C_{gg}^{-1} C_{gc}$.

Table 1. Cycle variances of the constructed edge law in orthonormal coordinates.

Cycle eigenvalue and multiplicity	Gradients integrated	Gradients fixed
1, one mode	0.05715305523	0.05715305523
2, two modes	0.01899788131	0.00592552438
4, two modes	0.00448148233	0.00381655094
5, one mode	0.00340267772	0.00337510856

Both cycle covariances have rank six and are positive. For a mode with cycle eigenvalue ℓ, rim variance r and spoke variance b_0, the exact expressions are $v_{\mathrm{marginal}} = [r + (\ell - 1)b_0]/\ell$ and $v_{\mathrm{conditional}} = \ell r b_0/[(\ell - 1)r + b_0]$. Independent precision-space Schur elimination gives C_{cc}^{-1} after gradient integration and $C_{c|g}^{-1}$ when gradients are fixed. The determinant factorisations are verified in both representations.

Carrier qualification. The identity $V^{\mathsf{T}} D_{\mathrm{inc}}^{\mathsf{T}} = 0$ excludes a direct gradient-to-cycle injection. It does not imply $V^{\mathsf{T}} C_e V = 0$ for a full edge covariance. Conversely, a positive cycle block in a constructed edge-noise realisation is not a derivation that those noise variables are the physical MASD current, link or record increments. The endpoint pushforward and positivity checks establish compatibility; the complete source must establish that physical identification. Table 1 is therefore not a table of force coefficients.

4.3 Exact endpoint history integration

For one stationary endpoint mode, $\mathrm{Cov}(x_i, x_j) = H_\theta^{-1} p^{|i-j|}$. The average of N observations has variance $H_\theta^{-1}\left[N + 2\sum_{h=1}^{N-1}(N-h)\,p^h\right]/N^2$, so $N\mathrm{Var}(\bar{x}_N)$ tends to $H_\theta^{-1}(1+p)/(1-p)$. Direct inversion of the complete stationary history precision verifies the expression for 1, 7, 49 and 343 observations in all four endpoint mode classes. A finite-window error bound is checked rather than treating the finite block as the limit.

The calculation includes the initial stationary distribution. Its information for a common shift of the stationary mean is $H_\theta + (N-1)(1-p)^2/\Sigma_F$. This also differs from the innovation-shift information. No autonomous cycle-history law is inferred from the endpoint process: the source has supplied an endpoint drift, not a drift for every latent circulating edge coordinate.

4.4 Operational lift control

For the separate current-lift compatibility control, choose

$$G = I + \left(g_{E_2} - 1\right) L L^{\mathsf{T}}. \quad (7)$$

Here (6) is retained explicitly as an infinitesimal control coefficient, and L is the six-current injection of Section 3. Identity on its complement and placement on this current carrier are declared control choices. Weighted minimum-norm inversion gives $E_G Y = L$ and $Y^{\mathsf{T}} E_G^{\mathsf{T}} G E_G Y = g_{E_2} I_6$. This verifies the algebra of a specified completion; it does not transfer endpoint fluctuation normalisation into the physical current sector. Sections 5–8 return to the orthonormal control core (3).

5 The D41 current response in normalised coordinates

In colour, weak and hypercharge participation coordinates, the inherited matrices are

$$H = \frac{1}{49}\begin{pmatrix} 36 & 18 & 36 \\ 18 & 26 & 26 \\ 36 & 26 & 47 \end{pmatrix}, \qquad m = \frac{1}{49}\begin{pmatrix} 36 \\ 26 \\ 47 \end{pmatrix}, \qquad W_{\mathrm{D41}} = dH - \Delta m m^{\mathsf{T}}. \quad (8)$$

We use $d = 0.0551296278772322$ and $\Delta = 0.004648154590676$, with no measured coupling. These are the existing history response and its provenance, not a new physical force determination [1, 9].

The native information-rate calculation retains the old defect, current and unresolved score directions in one joint Gram. Eliminating the unresolved score block, with the old defect parameters held fixed, recovers the current principal block W_{D41} in each real quadrature. The nonlinear profiled KL-rate Hessian agrees with that block to 4.4×10^{-13} in Frobenius norm. Its diagonal reductions are 6.19444%, 4.47376% and 8.08718%. Stationary history lengths 1, 7, 49, 343 and 2401 preserve the KL cost per Fold. Thus normalisation of total probability does not remove D41. These are current-history results; the physical gauge contraction still requires the complete joint source. Appendix A identifies the reproducible ten-check calculation.

Whiten the unrelaxed current Gram and include the two E_2 components. Define

$$B = \frac{\Delta}{d}\left(H^{-1/2} m m^{\mathsf{T}} H^{-1/2}\right) \otimes I_2. \quad (9)$$

It has two nonzero eigenvalues, both equal to

$$\beta = \frac{\Delta}{d}\, m^{\mathsf{T}} H^{-1} m = \frac{\Delta}{d}\frac{47}{49} = 0.08087183184. \quad (10)$$

Writing $R = \left(\sqrt{d}\, H^{1/2}\right) \otimes I_2$ gives $R^{\mathsf{T}}(I - B)R = W_{\mathrm{D41}} \otimes I_2$ exactly. The bright direction means the one factor-space combination changed by the rank-one subtraction; the second copy is its other E_2 component. The number in (10) is a generalised current-history eigenvalue, not a physical hypercharge coefficient.

In the following test, (9) is imposed as the common six-current restriction. The change of coordinates R is bookkeeping on that restriction. It does not identify the scalar archive with the full matter representation or allow arbitrary mixing of physical gauge factors.

6 Complete parents with the same current response

Let X inject the same six spatial E_2 directions into the archive's retained link phases. The source differential gives $PX = X$, $PL = L$ and $X^{\mathsf{T}}L = 0$. Both injections are orthonormal. The potential Hessian G_V annihilates these link and current directions. Put

$$A_\gamma = L + \gamma X, \qquad W_\gamma = E^{\mathsf{T}}\left(I - A_\gamma B A_\gamma^{\mathsf{T}}\right)E, \qquad \mathcal{H}_\gamma = G_V + J^{\mathsf{T}} W_\gamma J. \quad (11)$$

The scalar γ labels an explicit extension family. It is not a fitted VERSF parameter and no value is selected as physical. All six defect families and their mixed blocks remain present through J and W_γ.

Proposition 2 (same current restriction with different retained responses). If $\beta(1 + \gamma^2) < 1$, (11) is positive on the stabilised physical quotient, its defect metric has the original realisable support, and

$$Y^{\mathsf{T}} W_\gamma Y = I - B. \quad (12)$$

Eliminating all other quotient coordinates at fixed retained link coordinate gives

$$K_\gamma = I - \gamma^2 B(I - B)^{-1}. \quad (13)$$

Proof. The nonzero eigenvalues of $A_\gamma B A_\gamma^\top$ are $\beta(1+\gamma^2)$ twice. This proves positivity and shows that no new defect null direction is created on im$J$. The support statement follows because E annihilates the orthogonal complement of that image. Since $EY = L$, restricting (11) to Y gives (12). On the selected link and current coordinates the parent block is

$$\begin{pmatrix} I-\gamma^2 B & -\gamma B \\ -\gamma B & I-B \end{pmatrix}. \quad (14)$$

All remaining quotient coordinates decouple from this block, although their positive determinant is retained. The Schur complement of $I-B$ is (13). ■

The entire six-current D41 restriction is therefore identical for every row below, not only its diagonal or trace. The retained bright-mode reduction is $\gamma^2\beta/(1-\beta)$.

Table 2. Exact reductions in the declared complete scalar-parent family.

Extension parameter	Current bright reduction	Retained link bright reduction
$\gamma = 0$	8.08718%	0%
$\gamma = 0.5$	8.08718%	2.19969%
$\gamma = \sqrt{1-\beta}$	8.08718%	8.08718%
$\gamma = 1$	8.08718%	8.79875%
$\gamma = 2$	8.08718%	35.19502%

The matching row is an algebraic control, included because (13) determines it exactly. It is not evidence that the source chooses $\gamma = \sqrt{1-\beta} = 0.95871172318$. The sign of γ is invisible to the retained Hessian, although it changes the mixed block. The positivity interval also shows that this is not an instability argument.

Corollary 2.1 (equal transfer condition in this family). On the D41 bright subspace, $K_\gamma = I - B$ if and only if $\gamma^2 = 1-\beta$.

The corollary is specific to (11). A general source parent need not have a single extension parameter. In general it must return its own link block, mixed block and auxiliary block, and their Schur combination or nonlinear replacement. Positivity, the current restriction and the finite lift do not evaluate those blocks.

The family preserves the stated scalar kinematic quotient and dihedral doublet structure. Full non-Abelian gauge invariance, the complete CAR/Fock carrier, the physical event law and source provenance have not been certified for it. Consequently these matrices are sufficiency controls for the tested data, not competing physical VERSF theories.

7 Exact integration of finite histories

A static comparison could miss a correction generated by complete history integration. We therefore perform that integration for every parent in (11). Six link coordinates are retained. The other $187 - 6 = 181$ physical quotient coordinates are integrated, including the current, record and completion directions.

At fixed retained coordinate x, complete the square in the quadratic potential:

$$S_\gamma(x,\eta) = 1/2\, x^\top K_\gamma x + 1/2\, \big(\eta - \eta_*(x)\big)^\top H_{\eta,\gamma}\big(\eta - \eta_*(x)\big). \quad (15)$$

Choose the flat auxiliary heat metric as a declared continuation of this quadratic control. The raw transfer contains its Gaussian heat prefactor and the half-potential factors at both ends, in the form prescribed by HMGBC. The auxiliary Hessian is constant in x for this quadratic family. This is an exactly solvable family; it is not an uncontrolled expansion of the full nonlinear physical source.

Let ω_j^2 be the 181 positive eigenvalues of $H_{\eta,\gamma}$ and put $\mu_j = 2\mathrm{arsinh}(\tau\omega_j/2)$. For M periodic steps, direct Gaussian integration gives the free-energy rate

$$F_{M,\tau}(x) = 1/2\, x^{\mathsf{T}} K_\gamma x + \sum_{j=1}^{181} \left(\frac{\mu_j}{2\tau} + \frac{\log\left(1-e^{-M\mu_j}\right)}{M\tau} \right). \quad (16)$$

Proposition 3 (history persistence of the retained response). For this quadratic family and periodic histories,

$$\nabla_x^2 F_{M,\tau} = K_\gamma \quad \text{for every } M \geq 1 \text{ and } \tau > 0. \quad (17)$$

The same Hessian holds after the long-history limit and the temporal small-step limit.

Proof. Translating every auxiliary time slice by the same $\eta_*(x)$ removes the mixed potential term. The periodic heat differences and flat integration volume are unchanged by that translation. The remaining determinant is independent of x, giving (16) and (17). For positive auxiliary frequencies the finite-history term tends to zero. Also $\mu_j/(2\tau) \to \omega_j/2$, so the limiting pressure is $1/2\, x^{\mathsf{T}} K_\gamma x + 1/2 \sum_j \omega_j$. ■

Table 3. Executed history checks and their scope.

Quantity	Execution
Complete auxiliary spectrum	181 positive modes for each of five extensions
Time steps	$\tau = 1,\ 1/2,\ 1/4$
Periodic history lengths	$M = 1,\ 7,\ 49$
Independent cyclic block Schur checks	All five extensions, three steps, lengths 1 and 7
Analytic history limit	Equation (17), all positive steps and finite lengths
Spatial refinement	Not executed by this temporal test

The explicit cyclic block calculation independently verifies the retained Hessian before using the closed pressure formula. It operates on the coupled twelve-coordinate block; the other 175 auxiliary coordinates supply their full spectral determinant and cannot change the x Hessian because they decouple. Thus the complete finite Gaussian history does not choose among the extensions. A physically specified temporal metric, nonlinear potential or mixed history law could change the result; those require their own source calculation.

8 Probability normalisation and action response

A normalised proposal and a raw action transfer carry different information. For a Gaussian proposal with mean θ and variance σ^2, the score is $(\xi - \theta)/\sigma^2$. Its information is $1/\sigma^2$, whereas the negative logarithm of its integrated probability is zero. The expected second derivative of the log likelihood cancels the score variance exactly.

More generally, if $S(\theta, z)$ includes the negative logarithm of the full weight relative to a parameter-independent reference volume, then

$$\partial_a\, \partial_b[-\log Z] = \langle S_{ab} \rangle - \mathrm{Cov}(S_a, S_b). \quad (18)$$

Field-dependent reference-volume factors must be included in S or differentiated explicitly. A score covariance alone is not the whole expression. The source's Fisher-to-action bridge remains a separate physical statement [5, Section 16; 8, Part I].

The numerical control integrates the Gaussian normalisation directly and verifies the cancellation. Multiplying the same normalised proposal by $e^{-a\theta^2/2}$ leaves its normalised transition law unchanged but adds raw pressure curvature a at every history length. This is a standard identification test, not a claim that the complete VERSF source permits an arbitrary added potential. Its purpose is to prevent stochastic normalisation from deleting the raw contribution the physical action calculation needs.

9 Joint response from the source equations

9.1 The complete history derivative

The source already supplies the coupled differentiation machinery. RCHS-35 Part III and RCHS-35D [8, 17] differentiate all six defect families with independent currents and full matrix records. They retain the direct link variation of continuity on a current-carrying background, the supported polar factor and motion of the occupied subspaces. Those inherited derivatives are used here; the missing physical response is not an absent bond or current equation.

HMGBC constructs the full transfer from the operational generator and the reference potential. For a supported finite-regulator positive transfer, write its Perron equation and normalised kernel as

$$\mathbb{T}r = \lambda r, \qquad K(x,y) = \frac{\mathbb{T}(x,y)r(y)}{\lambda r(x)}. \quad (19)$$

For a joint physical variation v, differentiation gives

$$s_v(x,y) = \frac{\mathbb{T}_v(x,y)}{\mathbb{T}(x,y)} + \frac{r_v(y)}{r(y)} - \frac{r_v(x)}{r(x)} - \frac{\lambda_v}{\lambda}. \quad (20)$$

The derivatives r_v and λ_v are determined by the differentiated Perron equation. For a stationary Markov source on its complete state, the conditional scores have zero conditional mean and their information-rate Gram is

$$G(v,w) = \sum_{x,y} \pi(x) K(x,y) s_v(x,y) s_w(x,y). \quad (21)$$

The sums include the source's marks and unresolved outputs. For a continuous carrier they are integrals with its operational measure. Any memory needed for a Markov description must remain in the state; otherwise the scores condition on the complete past. Initial-distribution terms do not change the stationary rate when their contribution per step vanishes. Equations (19)–(21) are the inherited source-to-history construction [3, Sections 9–10; 5, Sections 16 and 56A]. They determine an information response. Its identification with an energetic gauge response retains the source's action and coarse-graining conditions.

In the primitive representation (1), the raw transfer is the pushforward of the joint event measure. Its derivative contains both the derivative of the updated configuration and the derivative of that measure. The mixed derivative also contains their cross terms [6, Section 1]. Fixing the update weights while differentiating the field map would therefore omit part of the joint response. The same physical law must provide all these terms.

The authoritative physical lift is the full defect differential together with its transported increments on the complete carrier [5, Sections 56A.4–5]. A wheel/internal tensor product, or a map into the archived eighteen retained score coordinates, is a finite-model construction unless its physical identification is

proved. The full source need not factor through that reduced score system. The existing holonomy and record-operation constructions constrain the identification and are retained [8, Part XII.7].

9.2 Correlated link and auxiliary fluctuations

Consider the Gaussian tangent sector on a fixed stable quotient. Let θ be a retained link increment and let η contain the innovations of the other responding variables. Write

$$\mathrm{Cov}\begin{pmatrix}\theta\\ \eta\end{pmatrix} = a_t\begin{pmatrix}P_\theta & B_{\theta q}\\ B_{\theta q}^{\mathsf{T}} & D_q\end{pmatrix}, \qquad \delta q = F_q\theta + \eta. \quad (22)$$

Here $P_\theta > 0$ and the full covariance is positive. The symbols in (22) are covariance blocks, distinct from the projector P of Section 3 and the D41 subtraction B of Section 5. For the current component, the semidirect update gives $F_q\theta = X(\theta)j$, with X the anti-Hermitian left-increment generator. It must be converted consistently to any right-link tangent convention. The record and completion components require their actual source update. No complete physical F_q is inferred from the current formula alone.

Define the conditional innovation covariance and conditional response map by

$$S_q = D_q - B_{\theta q}^{\mathsf{T}}P_\theta^{-1}B_{\theta q}, \qquad R_q = F_q + B_{\theta q}^{\mathsf{T}}P_\theta^{-1}. \quad (23)$$

The positive Gaussian law then has quadratic cost

$$Q(\theta,\delta q) = \frac{1}{2a_t}\Big[\theta^{\mathsf{T}}P_\theta^{-1}\theta + \big(\delta q - R_q\theta\big)^{\mathsf{T}}S_q^{-1}\big(\delta q - R_q\theta\big)\Big]. \quad (24)$$

Proposition 4 (correlated joint mean response). Hold the full covariance fixed while a source perturbation changes the mean in the direction $(v, M_q v)$. The Gaussian information matrix for this mean shift is

$$G_{\mathrm{mean}} = \frac{1}{a_t}\Big[P_\theta^{-1} + \big(M_q - R_q\big)^{\mathsf{T}}S_q^{-1}\big(M_q - R_q\big)\Big]. \quad (25)$$

Its additional positive term vanishes in every retained direction if and only if $M_q = R_q$. In a particular direction v, the condition is $\big(M_q - R_q\big)v = 0$.

Proof. Conditioning a joint Gaussian innovation on θ gives mean $B_{\theta q}^{\mathsf{T}}P_\theta^{-1}\theta$ and covariance a_tS_q. Adding the transported contribution $F_q\theta$ gives (24). Contract its precision with the mean-shift column $\binom{I}{M_q}$ to obtain (25). Positive definiteness of S_q gives the vanishing conditions. ■

For $B_{\theta q} = 0$, (25) recovers the independent-innovation expression of CLSN-1 Section 17.78. If only kinematic co-motion $M_q = F_q$ is imposed, the remaining term is

$$G_{\mathrm{mean}} - a_t^{-1}P_\theta^{-1} = a_t^{-1}P_\theta^{-1}B_{\theta q}S_q^{-1}B_{\theta q}^{\mathsf{T}}P_\theta^{-1}. \quad (26)$$

Thus co-motion alone does not establish cancellation in a correlated law. Equation (26) also does not establish a nonzero physical correction: the source must return the covariance blocks and its actual mean response. Correlation changes the condition to motion along the conditional mean.

Freely minimising (24) over δq gives $\delta q = R_q\theta$ and retained precision P_θ^{-1}/a_t. This statement concerns that isolated Gaussian cost. The other source terms can constrain the responding variables and prevent that minimum. Gaussian integration also retains the factor involving $\det S_q$; its field dependence contributes to the integrated action. A fixed-covariance mean response is therefore not the complete answer when the covariance changes.

For a Gaussian family with full transported covariance Σ, the covariance contribution to the Fisher matrix is

$$(G_{\mathrm{cov}})_{ij} = 1/2\,\mathrm{Tr}\big(\Sigma^{-1}\Sigma_i\Sigma^{-1}\Sigma_j\big). \quad (27)$$

Here Σ_i differentiates every covariance dependence, including transport. Non-Gaussian histories require their actual scores and higher cumulants. The covariance blocks may be defined at a declared coarse grain; none of these identities requires a dimensionful force strength at the primitive distinguishability level.

9.3 Reduction of the complete physical parent

For a field-dependent residual metric, write $\Gamma_D = 1/2\; d^{\mathsf{T}}Wd$ and $J\xi = Dd[\xi]$. The inherited full second variation is

$$D^2\Gamma_D[\xi,\zeta] = (J\xi)^{\mathsf{T}}W(J\zeta) + d^{\mathsf{T}}Wd_{\xi\zeta}$$
$$+(J\xi)^{\mathsf{T}}W_\zeta d + (J\zeta)^{\mathsf{T}}W_\xi d + 1/2\; d^{\mathsf{T}}W_{\xi\zeta}d. \quad (28)$$

Only at a common residual zero does (28) reduce to $J^{\mathsf{T}}WJ$. Potential, matter, measure, support and all other source terms must enter the same parent once, with their mixed blocks [8, Part III; 17]. A vanishing first current score at one background does not remove the other terms or prove a zero of the full coarse-grained response.

On a stable quadratic quotient, let g denote the retained gauge coordinates and a the variables actually designated for elimination. The complete stationary response is

$$K_g = \mathcal{H}_{gg} - \mathcal{H}_{ga}\mathcal{H}_{aa}^{+}\mathcal{H}_{ag}. \quad (29)$$

The range condition and physical constraints are required. Records designated for retention remain outside a. Field-dependent Gaussian determinants and non-Gaussian fluctuations require the integrated response (18), rather than stationary elimination alone. The history-information and energetic-action constructions agree only under the source's stated identification conditions [5, Section 16].

D41 enters through the appropriate restriction of this same source response. Adding its screened penalty to a parent that already contains that elimination would count it twice. Conversely, retaining D41 only as a current principal block does not return the mixed gauge columns. The eleven exact symbolic checks in Appendix A verify (23)–(26), the auxiliary elimination and the off-zero chain rule. They do not select the physical covariance, background or force coefficients.

10 Nonlinear response of the native history law

10.1 The finite law and its mixed derivatives

We use the same marked exponential history family that reproduces D41 in Section 5 [18]. It has twelve old wheel-score coordinates r, six participation-current coordinates c and twelve unresolved score coordinates b. The old labels in each real quadrature are C, J, T, R, B and H. They denote oriented closure circulation, isotropic spoke activity, a first radial harmonic, an alternating rim record-composition harmonic, an oriented rim bond harmonic and local persistence. These are specified wheel harmonics; the labels do not identify them with complete matrix-valued MASD field variations.

Let p_x be the reference marked transition law and S its thirty conditionally centred scores. With $q = (r, c, b)$, the positive family and reverse KL rate are

$$p_{q,x} = \frac{p_x e^{S\cdot q}}{Z_x(q)}, \qquad \mathcal{F}(q) = \sum_x \pi_x \{\log Z_x(q) - \mathbb{E}_{p_x}(S \cdot q)\}. \quad (30)$$

The stationary reference law π is held fixed. Stationary reference path KL is the history length times (30); derivatives of a changing physical stationary law are not included by this identity. Define $\Phi(r, c) = \min_b \mathcal{F}(r, c, b)$ on the smooth branch through zero. This is nonlinear score-space minimisation, distinct from integration over a physical bath measure.

Let G be the joint score Gram, $A_b = G_{bb}$ and $C_b = G_{(r,c),b}$. The linear profiled lift, lifted scores and Hessian are

$$\mathcal{L} = \begin{pmatrix} I \\ -A_b^{-1} C_b^{\mathsf{T}} \end{pmatrix}, \qquad E = S\mathcal{L}, \qquad \mathcal{W} = \mathcal{L}^{\mathsf{T}} G \mathcal{L}. \quad (31)$$

The current block is exactly the two-quadrature D41 block. Write $\mathcal{T} = D^3\Phi(0)$ and $\mathcal{Q} = D^4\Phi(0)$. Then $\mathcal{T}_{ijk} = \mathbb{E}(E_i E_j E_k)$. If $\beta_{ij} = \mathbb{E}(S_b E_i E_j)$, the fourth derivative is

$$\mathcal{Q}_{ijkl} = \kappa_{4,ijkl} - \beta_{ij}^{\mathsf{T}} A_b^{-1} \beta_{kl} - \beta_{ik}^{\mathsf{T}} A_b^{-1} \beta_{jl} - \beta_{il}^{\mathsf{T}} A_b^{-1} \beta_{jk}. \quad (32)$$

Here κ_4 is the fourth cumulant conditional on each starting row, averaged with π afterwards. A global fourth cumulant would give a different model. The three subtraction terms retain the second-order readjustment of the minimised scores. The archive contains the full 18^3 and 18^4 tensors; independent minimisation and finite differences check their mixed components.

10.2 A symmetry zero with a nonzero quadratic response

Proposition 5 (half-turn parity of the profiled history response). With only one old T, R or B coordinate r_a active, the native family satisfies $\Phi(r_a, c) = \Phi(-r_a, c)$. Consequently $\mathcal{W}_{ac} = 0$ and $\mathcal{T}_{a,cc} = 0$. No such conclusion follows for $\mathcal{Q}_{aa,cc}$.

Proof. Rotation by three rim sites preserves the reference transition law, stationary weights, participation marks and current profiles. It reverses T, R and B, leaves C, J and H unchanged, and preserves the unresolved score span. Relabelling the event sum and the minimised coordinates therefore leaves Φ invariant. Differentiation gives the stated zeros. ■

This tests the source arrays themselves. It does not infer a zero from the imaginary part of a Hermitian expectation. For the first quadrature, the R and B first-derivative norms are below 1.4×10^{-17} and 5.0×10^{-18}, while their second-derivative norms are 0.11658214 and 0.00716957. The even H coordinate has respective norms 0.00737964 and 0.01450154. Thus the linear zero does not exclude a nonlinear current-response channel.

10.3 The nonlinear gauge to current contraction

The archived probe uses its fifty-coordinate census representation and endpoint background, with $\kappa = 1/31$. Insert $U_e = \exp(i\theta_e^a T_a)$, where $\theta_e^a = \sum_m V_{em}\, \theta_{ma}$ and V is the six-cycle basis (4). The edge current and its second derivative are

$$j_e(\theta) = \frac{\rho_t - U_e(\theta)\rho_s}{31}, \qquad \partial_{ma}\, \partial_{nb} j_e(0) = \frac{V_{em}V_{en}}{62}\{T_a, T_b\}\rho_s. \quad (33)$$

Cycle projection followed by the archived minimum-norm coefficient map gives $c(\theta)$ in a chart centred at $c(0) = 0$. Define $A_g = Dc(0)$ and $\mathcal{C}_{ij}^{\alpha} = \partial_i \partial_j c_\alpha(0)$. There are 72 probe coordinates, six cycles times twelve generators. Direct differentiation of the profiled cost gives

$$K_{ij}(r) = [A_g^{\mathsf{T}} \Phi_{cc}(r,0) A_g]_{ij} + \sum_\alpha \Phi_\alpha\,(r,0) \mathcal{C}_{ij}^{\alpha}. \quad (34)$$

Its old-coordinate derivative at zero is $A_g^{\mathsf{T}} \mathcal{T}_{a,cc} A_g + \sum_\alpha \mathcal{W}_{a\alpha}\, \mathcal{C}^{\alpha}$. The second term is the curvature of the current map multiplied by the residual current force. It can dominate away from a stationary background; that does not make it a physical stiffness or a positive Fisher matrix. The calculation checks both terms against the nonlinear link insertion. The endpoint background and coefficient chart are declared finite probes, not a selected physical vacuum.

10.4 Averaging and relaxation of the current background

For a supplied old-coordinate measure ν and positive concentration χ, define the conditional coarse cost

$$\Gamma_\chi(c) = -\chi^{-1} \log \int e^{-\chi \Phi(r,c)}\, \nu(dr). \quad (35)$$

Neither ν nor χ is selected as the physical source law here. Let μ_0 denote the actual weighted law at $c = 0$. Differentiation retains the negative fluctuation term:

$$\left(\Gamma_\chi\right)_{cd}(0) = \mathbb{E}_{\mu_0}(\Phi_{cd}) - \chi\, \mathrm{Cov}_{\mu_0}(\Phi_c, \Phi_d). \quad (36)$$

Proposition 6 (response after small fluctuations and current relaxation). Hold χ fixed and assume $\mathcal{W}_{cc} > 0$. Let μ_0 be centred, with small covariance V_{ab}, higher moments of the corresponding small-amplitude order, and regularity sufficient to differentiate (35). Old indices a, b range over twelve coordinates; current indices c, d, e, f range over six. The nearby stationary current background is

$$c_e^* = s_{e,ab} V_{ab} + \text{higher orders}, \qquad s_{e,ab} = -\,1/2\, (\mathcal{W}_{cc}^{-1})_{ef} \mathcal{T}_{abf}. \quad (37)$$

At that background its response is

$$\left(\Gamma_\chi\right)_{cd}(c^*) = \mathcal{W}_{cd} + \mathcal{D}_{ab,cd} V_{ab} + \text{higher orders}, \quad (38)$$

$$\mathcal{D}_{ab,cd} = 1/2\, \mathcal{Q}_{abcd} - \chi/2\, (\mathcal{W}_{ac}\mathcal{W}_{bd} + \mathcal{W}_{ad}\mathcal{W}_{bc}) + \mathcal{T}_{cde} s_{e,ab}. \quad (39)$$

Proof. Expanding $\mathbb{E}_{\mu_0} \Phi_c$ gives $1/2\, \mathcal{T}_{abc} V_{ab}$ at leading order. Solving its stationarity equation gives (37). Expanding (36) gives the first two terms of (39); evaluating the Hessian at the shifted background adds the third. Symmetry of V supplies the displayed symmetrisation. ■

The terms of (39) are the changing current response, the score-covariance subtraction and the effect of shifting the background. A noncentred law also requires its mean terms. For a single odd T, R or B fluctuation, Proposition 5 makes the covariance subtraction vanish at this order, so its leading coefficient is independent of χ. The fluctuation variance itself is still unselected.

Table 4. Frobenius norms of the leading response per unit old-score variance in the first quadrature.

Score	Current background fixed	Current background relaxed
R	0.05829107	0.02876716
B	0.00358479	0.00319098
H	0.00762385	0.01089050

For H, Table 4 uses $\chi = 1$ as a verification convention; R and B are independent of it at this order. The numbers are coefficients of a small variance, not predictions obtained by assigning that variance a physical value of one. Complete matrices and cross-covariance components are archived. They are not a common rescaling: different current directions can increase or decrease.

Direct small two-point averaging and independent current minimisation verify (37)–(39). These verification distributions are not proposed as the physical source law. For the odd-channel test, $\chi = 1,7,49$ gives the same result, as the parity requires. The surviving nonlinear response is therefore an executed result within this family. It does not identify the six participation-current coordinates with the twelve gauge generators or establish the collective D41 force reductions.

10.5 The state populations after unresolved score minimisation

The stationary reference in (30) can be checked against the stationary population of the deformed kernel itself. Write $K_q(x, y)$ for $p_{q,x}$ summed over the two real fibres and five participation marks. The six nonconstant state functions ϕ_j used by the bath form a complete basis together with the constant. Their scores are

$$\beta_j(x, y) = \phi_j(y) - \big(K\phi_j\big)(x), \qquad \mathbf{\Phi}_{xj} = \phi_j(x). \quad (40)$$

Each fibre carries $\sqrt{2}\,\beta_j$ on that fibre and zero on the other. The bold matrix $\mathbf{\Phi}$ in (40) is distinct from the profiled cost Φ.

Proposition 7 (preservation of the stationary population). On every smooth branch of the minimisation in Section 10.1 with the reference connected support retained, the aggregate kernel has stationary population π. This holds for arbitrary retained (r, c) on that branch.

Proof. Conditional centring removes the reference score mean. Summing the two fibre gradients of (30) gives the exact identity

$$\nabla_{b_0}\mathcal{F} + \nabla_{b_1}\mathcal{F} = \sqrt{2}\,\big(\pi K_q - \pi\big)\mathbf{\Phi}. \quad (41)$$

Both gradients vanish at the bath minimum. The difference $\pi K_q - \pi$ also annihilates the constant, since K_q is stochastic. Completeness of the seven state functions forces $\pi K_q = \pi$. Irreducibility gives uniqueness. ■

Thus the conditional Fisher matrix weighted by the deformed kernel's stationary population equals the fixed-π matrix pointwise along this branch. Its twelve-direction bath reduction and smooth derivatives agree as well. This establishes consistency of the event weighting in Section 10; it does not equate Fisher information with the complete physical action Hessian.

The execution [19] tests 24 mixed old/current deformations of norms 0.03, 0.1, 0.3 and 0.7. The largest change in stationary population, measured by total variation, is 2.64×10^{-16}. The corresponding marked event traffic changes by as much as 0.11428. Without bath minimisation, the same probes change state populations by as much as 0.06669. These probes verify the identity; they are not a proposed physical fluctuation distribution. The population remains 0.189424 at the hub and 0.135096 at each rim state.

10.6 Event fluctuations and physical field fluctuations

At the reference law the lifted event scores $E = S\mathcal{L}$ in (31) have zero conditional mean. Scores on distinct steps are therefore orthogonal martingale differences, even though the underlying states are correlated. For N stationary events,

$$\overline{E}_N = \tfrac{1}{N}\textstyle\sum_{t=1}^{N} E_t\,, \qquad \mathrm{Cov}\big(\overline{E}_N\big) = \tfrac{\mathcal{W}}{N}. \quad (42)$$

Table 5. Per-event variances of the lifted old scores in the inherited coordinates. The values repeat in each real fibre.

Pattern	Observable	Variance
C	Oriented circulation	0.29048531
J	Spoke activity	0.07871699
T	First radial harmonic	0.08118160
R	Alternating record-composition score	0.25552250
B	Oriented rim bond score	0.08118160
H	Persistence score	0.15246712

The full covariance, including current and cross terms, is archived. An independent enumeration of all two-step marked paths gives covariance $2\mathcal{W}$ for their summed scores. For a stationary path with a parameter-dependent initial law, the full Fisher matrix also contains the initial-population score term in addition to N times the conditional transition Gram; this identity is checked separately.

Equation (42) concerns observed scores. The covariance V in (37)–(39) instead concerns the parameters r that deform the law. Neither $\mathcal{W}/N$ nor its inverse is thereby selected as V. Table 5 therefore closes the event-statistics calculation without assigning physical field-amplitude variances. The stationary-population theorem leaves the nonlinear response of Section 10.4 intact. Section 11 separately evaluates a field-current map and covariance, without substituting the event variances of Table 5 for field amplitudes.

11 Field fluctuations and the native history model

11.1 The field to event map

The field calculation [20] uses the complete archived scalar parent of Section 3, with 226 coordinates, 243 residuals and the 187-dimensional kinematic quotient. It evaluates the unit residual metric used in the scalar controls and the operational minimum-lift core of (3), separately. The background, constitutive coefficient and potential parameters are the archived unit fixture. Neither metric is identified with the complete physical W_{prim}; the core does not include a physical bath subtraction.

Let x be the quotient coordinate and Q_{kin} its orthonormal injection into the 226 fields. In each scalar slot and real current quadrature, apply the cycle readout V^{T} of (4). The combined injection P_j has 36 orthonormal columns; its readout annihilates the inherited kinematic nulls. The current coefficients are

$$p = P_j^{\mathsf{T}} Q_{\mathrm{kin}} x. \quad (43)$$

Here p denotes current coordinates, not the marked transition probabilities of (30). The independent current remains a field of the parent; (43) does not impose its constitutive equation before reduction.

The archived current-score rule assigns a cycle cochain value to each forward edge event, its negative to the reverse event, the same participation mark and real-fibre normalisation as Section 10, and subtracts the row mean. We extend that rule linearly over all 36 current coordinates. This is a specified extension of the native insertion, not a derivation of the full physical transition kernel. Write U for its event-score columns. Eliminating the same twelve bath scores gives

$$U_{\mathrm{eff}} = U - S_b A_b^{-1} \langle S_b, U \rangle, \qquad G_j = \langle U_{\mathrm{eff}}, U_{\mathrm{eff}} \rangle. \quad (44)$$

The pairing averages the outer product of score columns over the stationary marked event law. The reduced current Gram has rank 36. Direct finite differences of the normalised kernel verify the score map, including the row normalisation.

11.2 Exact representation and the enlarged current carrier

The eighteen efficient score columns E of (31) cannot represent all these changes. Their best projection and its residual are

$$B_p = \mathcal{W}^{-1}\langle E, U_{\mathrm{eff}}\rangle, \qquad U_\perp = U_{\mathrm{eff}} - EB_p, \qquad B_{\mathrm{field}} = B_p P_j^{\mathsf{T}} Q_{\mathrm{kin}}. \tag{45}$$

Proposition 8 (field to score decomposition). For the stated current insertion, the field-induced event variation is $EB_{\mathrm{field}}x + U_\perp P_j^{\mathsf{T}} Q_{\mathrm{kin}} x$. Its current Gram satisfies

$$G_j = B_p^{\mathsf{T}} \mathcal{W} B_p + \langle U_\perp, U_\perp\rangle, \qquad \langle E, U_\perp\rangle = 0. \tag{46}$$

Proof. Substitution of (45) gives the normal equation $\langle E, U_\perp\rangle = 0$. Expanding the Gram then removes the two cross terms and yields (46). Composing with the field readout (43) gives the first statement. ■

Numerically, B_p has rank 14 and the residual Gram has rank 30. Six current combinations are represented exactly; 22 are orthogonal to the small chart; the remaining eight have both represented and residual parts. Under the unit parent's marginal current covariance, the residual carries 43.52 per cent of the expected native-score quadratic norm; the minimum-lift core gives 45.26 per cent. These percentages quantify statistical projection loss in this construction, not missing force strength.

Retaining the twelve old score coordinates together with all 36 current coordinates gives a rank-48 Gram. The eighteen-coordinate family embeds exactly in this enlarged family. In particular, the six D41 score columns agree event by event, and their Gram remains $I_2 \otimes \left(dH - \Delta m m^{\mathsf{T}}\right)$. The archive supplies the embedding and all maps. Thus the extension removes this current representation loss without changing D41. It does not identify the old R and H score labels with physical record or completion fields merely because their names coincide.

11.3 Coarse current sizes in the complete scalar parent

For each stated residual metric W_D, define the quotient Hessian $\mathcal{H}_q = J_q^{\mathsf{T}} W_D J_q + V_q$, including the potential. Insert the density derivative into the original continuity defect using T_ρ. Before eliminating any field, the harmonic frequency precision is

$$\mathcal{D}(\omega) = \mathcal{H}_q + \omega^2 M + i\omega\left(F - F^{\mathsf{T}}\right), \qquad M = T_\rho^{\mathsf{T}} W_D T_\rho, \qquad F = J_q^{\mathsf{T}} W_D T_\rho. \tag{47}$$

This is the continuity-only construction discussed in [8, Section IV.17], evaluated on the two metrics stated here. Their ranks need not coincide with the candidate metric used in that source. The direct operational kinetic sector is not silently added or counted twice.

Put $P_q = Q_{\mathrm{kin}}^{\mathsf{T}} P_j$ and $L_j = \mathcal{H}_q^{-1} P_q$. Both executions give $T_\rho L_j = M L_j = F L_j = F^{\mathsf{T}} L_j = 0$. Therefore $\mathcal{D}(\omega) L_j = P_q$, and the transverse current covariance is independent of frequency on this branch. The result is also checked by direct inversions at five frequencies. For a window of length τ in the source parameter,

$$C_j = P_q^{\mathsf{T}} \mathcal{H}_q^{-1} P_q, \qquad \mathrm{Cov}\left(\overline{p}_\tau\right) = C_j/\tau. \tag{48}$$

The field is white in this transverse sector of the continuity-only model, so (48) concerns a smeared mean, not a pointwise variance. An independent elimination of all 151 complementary quotient coordinates and the complete determinant identity verify C_j.

Table 6. Coefficients of the coarse current variance in the unit residual parent. Entries are τ times the variance of a window mean, in the inherited current coordinates. Each row repeats in the three scalar slots; modes with $\ell = 2$ or 4 have multiplicity two.

Cycle eigenvalue	Real current	Imaginary current
1	1.000000	1.666667
2	1.000000	1.375000
4	1.000000	1.208333
5	1.000000	1.171429

The exact imaginary-current entry is $1 + (\ell + 1)/[\ell(\ell + 2)]$. In the same coordinates, the link and record coefficients are $(\ell + 1)/[\ell(\ell + 2)]$ and $1/(\ell + 1) + 1/[\ell(\ell + 1)(\ell + 2)]$, respectively; their cross coefficient is $1/[\ell(\ell + 2)]$. These values include the other fields' adjustment. The minimum-lift core instead gives $C_j = I_{36}$. The sizes are consequently determined within each specified parent but have not been selected as the complete physical source's sizes.

11.4 Conditioning and the long window limit

A gauge effective action integrates hidden variables conditional on the retained gauge field. The marginal covariance in Table 6 has already integrated that field too. If θ denotes the eighteen retained scalar link-cycle coordinates, its conditional current susceptibility is

$$C_{j|\theta} = C_j - C_{j\theta} C_\theta^{-1} C_{\theta j}. \quad (49)$$

Both stated parents give $C_{j|\theta} = I_{36}$. Their conditional means differ: the unit residual parent gives mean real current zero and mean imaginary current $-\theta$, whereas the minimum-lift core has zero current-to-link mean map. Equality of the conditional covariances therefore does not establish equal gauge actions. The mean response, direct term and determinants remain required.

Pushing (49) into the eighteen-coordinate chart also produces correlations between its old and retained-current coordinates. Their cross-covariance coefficient has Frobenius norm 2.76997817535612, in addition to the nonzero residual of (46). Substituting only the old-old block into (39) would omit both contributions. The enlarged representation and complete conditional law must be used together.

For a more general stable stationary Gaussian history, a long uniform window has the susceptibility limit

$$\tau \operatorname{Cov}(\overline{x}_\tau) \to \mathcal{D}(0)^{-1} = \mathcal{H}_q^{-1}. \quad (50)$$

Equation (50) assumes continuity of the spectral covariance at zero and sufficient bounds for the averaging filter to converge. It follows by applying that filter to the spectral covariance. A separate unit-operational-metric harmonic control verifies the limit analytically and by quadrature: its relative current-covariance differences from the limit are 0.164, 0.0235 and 0.00335 at windows 7, 49 and 343. This control is not installed as the physical temporal completion. For nonlinear physical histories, the required zero-frequency covariance must be obtained from those histories; it is not automatically the inverse of the bare residual Hessian.

12 Source weighted current fluctuations

12.1 The published conditional weighting

Parameter Closure supplies a nontrivial weighting on the full scalar defect carrier [4, Sections 75–76]. Its six-mode irreversible law and typed lift can be reconstructed from the same archived arrays used in Section 10. The lift retains **Premise FB**: within each defect sector, each scalar bath coefficient acts identically on all operational score directions. This premise is inherited and conditional. Applying the lift to the field map of Section 11 evaluates a published weighting without selecting it as the complete physical weighting [21].

Let $a_a = \langle B_a, B_a \rangle$ and $c_{aA} = \langle B_a, S_A \rangle$ be the source's bath precisions and bath–defect couplings. The six bath scores are orthogonal, their coupling has rank four, and its second-harmonic pair is exactly dark. On the 187-coordinate quotient, put $S_{\mathrm{op}} = J_q^{+}$, $R_D = J_q S_{\mathrm{op}}$ and $D_a^{\mathrm{FB}} = \sum_A c_{aA} P_A$. The published lift is

$$W_{\mathrm{core}} = S_{\mathrm{op}}^{\mathsf{T}} S_{\mathrm{op}}, \qquad C_a = S_{\mathrm{op}} D_a^{\mathrm{FB}} R_D, \qquad W_{\mathrm{FB}} = W_{\mathrm{core}} - \sum_a C_a^{\mathsf{T}} C_a / a_a. \tag{51}$$

The realisability projector is retained, as are all cross blocks generated by (51). The reconstructed metric has rank 183 and is positive on its supported range. With the inherited potential, the quotient Hessian has minimum eigenvalue 0.177054952068, reproducing the published return. The scalar fixture, its operational inner product and its common-zero background retain their stated scope.

The corresponding joint Gaussian matrix contains all 187 field coordinates and $6 \times 187 = 1122$ lifted bath coordinates. With C_x the vertical stack of $C_a J_q$, $A_Q = \mathrm{diag}_a(a_a I_{187})$ and $\mathcal{H}_{\mathrm{core}} = J_q^{\mathsf{T}} W_{\mathrm{core}} J_q + V_q$, it is

$$\mathcal{H}_* = \begin{pmatrix} \mathcal{H}_{\mathrm{core}} & C_x^{\mathsf{T}} \\ C_x & A_Q \end{pmatrix}, \qquad \mathcal{H} = J_q^{\mathsf{T}} W_{\mathrm{FB}} J_q + V_q. \tag{52}$$

Direct factorisation of this 1309-dimensional matrix reproduces $\mathcal{H}^{-1}$ in its field block and verifies $\det \mathcal{H}_* = (\det A_Q)(\det \mathcal{H})$. Holding the eighteen link-cycle coordinates fixed before eliminating the other 169 fields and all 1122 bath coordinates gives an independent 1291-dimensional reduction. Its current covariance, mean and retained link Hessian agree, with the determinant included. This executes the published quadratic lift as one coupled parent; it does not identify that parent with the full HMGBC history operator. The a_a remain static score precisions, not independently inferred oscillator masses.

12.2 Conditional sizes and the field to event response

Define two contractions of the inherited coupling,

$$s_J = \sum_a \frac{c_{aJ}^2}{a_a} = 0.0743186477814, \qquad t_{JC} = \sum_a \frac{c_{aJ} c_{aC}}{a_a} = -0.0504455289495. \tag{53}$$

Proposition 9 (conditional current law of the factor blind parent). On the stated scalar fixture, fixing the retained link-cycle coordinates gives a current covariance $\gamma_J I_{36}$, where $\gamma_J = (1 - s_J)^{-1}$. The real current has mean zero. An imaginary-current mode with cycle eigenvalue ℓ has conditional mean $m_\ell \theta_\ell$, with m_ℓ given by (55).

Proof. A pure conserved-current change enters only the current-defect rows, so $C_a J_q P_q = c_{aJ} P_q$. Only the radial bath row has a nonzero c_{aJ}, and that row has zero record-composition and bond coefficients. Hence the current precision at fixed links is $(1 - s_J) I_{36}$ and its cross precision with record cycles vanishes. In a transverse imaginary mode, minimum-norm reconstruction of the closure and bond residuals gives the

link coefficient $[(\ell+1)c_{aC}+c_{aB}]/(\ell+2)$. Contracting it with c_{aJ}/a_a gives the current–link cross precision $-s_J+t_{JC}(\ell+1)/(\ell+2)$. Completing the square proves the covariance and mean. ■

In the continuity-only history of Section 11.3, this conditional current sector is white. The weighted lifts satisfy the same temporal-null identities, and independent frequency inversions verify the conditional covariance. Thus, for a smeared window of length τ in the source parameter,

$$\begin{aligned}\mathrm{Cov}(p \mid \theta) &= \gamma_J I_{36}, \qquad \gamma_J = 1.0802853461434,\\ \mathrm{Cov}\big(\overline{p}_\tau \mid \text{fixed link history}\big) &= \frac{\gamma_J}{\tau} I_{36}.\end{aligned} \tag{54}$$

The first covariance in (54) is the static susceptibility. The second is the coarse history variance; no finite pointwise variance is assigned to the white field. For another stable Gaussian temporal completion with the same zero-frequency conditional precision, γ_J is the long-window coefficient under the hypotheses of (50). Neither statement supplies a physical spatial limit. The 8.0285 per cent increase concerns variance relative to the unscreened operational core. It is distinct from the 7.43186 per cent current-precision reduction s_J and from the D41 force-interpretation fractions.

The mean coefficient is

$$m_\ell = \frac{s_J - t_{JC}(\ell+1)/(\ell+2)}{1-s_J}. \tag{55}$$

Table 7. Conditional mean and reduced scalar-link stiffness under the published factor-blind weighting. Each row repeats in all three scalar slots; the modes at $\ell=2$ and 4 each occur twice. The conditional current variance coefficient is γ_J in every row.

Cycle eigenvalue	Mean current per link change	Scalar link stiffness
1	0.1166157233	0.7894485159
2	0.1211570204	0.7834334964
4	0.1256983176	0.7730303494
5	0.1269958310	0.7692702485

The published three diagnostic stiffnesses are reproduced at their selected spatial modes. Table 7 lists spatial responses repeated across scalar slots, not a physical colour–weak–hypercharge triple. The marginal imaginary-current coefficients are 1.09751158, 1.09902213, 1.10072448 and 1.10125059, respectively. They differ from (54) by the variance of the conditional mean, exactly as $C_j = C_{j|\theta} + MC_\theta M^{\mathsf{T}}$ requires.

Let M denote the full 36-by-18 mean map determined by (55). The complete current-to-event map of Section 11 carries both parts of the conditional law:

$$\begin{aligned}A_{\mathrm{event}} &= U_{\mathrm{eff}} M,\\ \Sigma_{\mathrm{event}} &= U_{\mathrm{eff}} C_{j|\theta} U_{\mathrm{eff}}^{\mathsf{T}}/\tau.\end{aligned} \tag{56}$$

The mean map has eighteen independent link-response directions. The expected squared native-score norm is $1.59149164167/\tau$, including the component outside the small chart. Its residual share is 45.2582 per cent, and the old/current cross-covariance coefficient in that chart has Frobenius norm 2.99236683197. These are statistical quantities for the stated current insertion. Physical record, completion, matter and measure contributions are not identified by this current restriction, and neither (56) nor its Fisher contraction is the complete gauge action.

12.3 Testing identification with the participation response

The factor-blind current response must be compared with the native response as a pair of forms, before and after eliminating their respective baths. Comparing only one positive form would not discriminate, since any two positive forms admit an invertible congruence. The factor-blind pair is $\big(I_{36}, (1-s_J)I_{36}\big)$. For the participation-dependent insertion, define

$$G_{j,0} = \langle U, U \rangle, \qquad \mathcal{B}_j = G_{j,0} - G_j = C_{bj}^{\mathsf{T}} A_b^{-1} C_{bj}. \quad (57)$$

Proposition 10 (inequivalence of the two current response pairs). No simultaneous invertible linear change of the 36 current coordinates identifies the factor-blind pair with $\big(G_{j,0}, G_j\big)$ in the executed native current model.

Proof. The factor-blind subtraction $s_J I_{36}$ has rank 36. Direct reconstruction of (57) gives rank $C_{bj} =$ rank$\mathcal{B}_j = 12$. A simultaneous invertible congruence preserves the rank of the difference, so the pairs cannot coincide. ■

The generalised reduction spectrum provides an independent check. Relative to $G_{j,0}$, the native subtraction has 24 zero eigenvalues and nonzero values 0.00752805419 twice, 0.0242796298 four times, 0.0454092121 four times and 0.101142049 twice. The factor-blind spectrum instead has s_J in all 36 directions. On the six inherited D41 directions the subtraction ranks are two and six, respectively. The native diagonal fractions remain 6.194438, 4.473761 and 8.087183 per cent, each repeated for the two real components; neither the D41 event insertion nor its Gram is altered.

This rejects the proposed identification by a common change of coordinates. It does not assert that the two constructions originally measured the same physical quantity, exclude an additional source-derived attaching map, or bound the complete physical bath. The source itself retains the internal structure suppressed by Premise FB as an open physical return [4, Section 76.6]. A physical extension must determine that structure and its correlations from the same history law; inserting D41 fractions into an unrelated block would not provide the derivation.

A separate convention check prevents an unwarranted inversion of statistical quantities. For the operational Gaussian proposal, put $L_D = J_q J_q^{\mathsf{T}}$. The natural exponential source η produces mean defect drift $L_D\eta$, so a prescribed mean drift D uses $\eta = L_D^{+} D$. Consequently

$$(L_D^{+})^{\mathsf{T}} L_D L_D^{+} = L_D^{+} = W_{\mathrm{core}}. \quad (58)$$

This identity is checked on the full realisable defect range. Increment covariance and mean-drift Fisher curvature can therefore be inverses without disagreeing. It neither repairs the paired-rank mismatch nor supplies a force-normalisation constant.

13 Participation under native history coarse graining

13.1 The joint statistical carrier and retained readout

The native history law can be reduced without replacing its participation structure by Premise FB. We reconstruct sixty raw score coordinates from the inherited transition kernel, stationary measure and event marks: twelve old statistical scores, thirty-six cycle-current scores and twelve state-function bath scores [22]. The current scores are the insertion of Section 11 before bath elimination. Each is a product of a participation indicator and a spatial score in one of the two real fibres. The old and bath scores are independent of that participation mark. These are statistical parameters; their labels do not identify them with the complete physical record, completion or matter fields.

Let E_{D41} be the archived orthonormal 36-by-6 D41 profile matrix. It uses the same 12-by-2 spatial and fibre profile F_D in each factor. The retained current coordinate is $E_{\mathrm{D41}}^{\mathsf{T}} p$. Holding the other thirty coordinates fixed gives $E_{\mathrm{D41}}^{\mathsf{T}} G_{\mathcal{N}} E_{\mathrm{D41}}$; integrating them in the quadratic model gives $\left[E_{\mathrm{D41}}^{\mathsf{T}} G_{\mathcal{N}}^{-1} E_{\mathrm{D41}}\right]^{-1}$. This specifies the observable and the operation being compared. It does not select that readout as the complete physical gauge observable.

13.2 Preservation of the participation form

Use the participation matrices H and m of (8), and put $h = m_Y = 47/49$. The nested supports give $He_Y = m$ and hence $m^{\mathsf{T}} H^{-1} m = h$. Eliminating a chosen set $\mathcal{N}$ of the mark-independent nuisance scores produces

$$G_{\mathcal{N}} = H \otimes Q_{\mathrm{sp}} - mm^{\mathsf{T}} \otimes L_{\mathrm{sp}}. \quad (59)$$

Here Q_{sp} is the positive 12-by-12 spatial and fibre Gram. If $A_{\mathcal{N}}$ is the nuisance Gram and $D_{\mathcal{N}}$ its cross Gram with the spatial scores, then $L_{\mathrm{sp}} = D_{\mathcal{N}}^{\mathsf{T}} A_{\mathcal{N}}^{-1} D_{\mathcal{N}}$. The factor m in the current cross block follows from mark independence. No coefficient in (59) is fitted to a target reduction.

Proposition 11 (participation under a common spatial reduction). Suppose Q_{sp} and $Q_{\mathrm{sp}} - hL_{\mathrm{sp}}$ are positive definite, and $F_D^{\mathsf{T}} F_D = I_2$. Define

$$\begin{aligned} \overline{Q} &= \left[F_D^{\mathsf{T}} Q_{\mathrm{sp}}^{-1} F_D\right]^{-1}, \\ \overline{Q}_s &= \left[F_D^{\mathsf{T}} \left(Q_{\mathrm{sp}} - hL_{\mathrm{sp}}\right)^{-1} F_D\right]^{-1}, \\ \overline{L} &= \left(\overline{Q} - \overline{Q}_s\right)/h. \end{aligned} \quad (60)$$

Integrating the unretained current coordinates using the same profile in each factor gives, up to the ordering of the two real fibres,

$$\overline{G}_{\mathcal{N}} = H \otimes \overline{Q} - mm^{\mathsf{T}} \otimes \overline{L}. \quad (61)$$

Proof. Whiten the factor Gram by $H^{-1/2}$ and put $v = H^{-1/2} m$. Since $v^{\mathsf{T}} v = h$, the shared factor direction has spatial precision $Q_{\mathrm{sp}} - hL_{\mathrm{sp}}$, while the two orthogonal factor directions have precision Q_{sp}. A common spatial readout reduces them separately to $\overline{Q}_s$ and $\overline{Q}$. Undoing the factor whitening yields (61). ■

On the supplied source arrays, both two-by-two matrices are scalar: $\overline{Q} = \overline{d} I_2$ and $\overline{L} = \overline{\Delta} I_2$. Consequently

$$\overline{G}_{\mathcal{N}} = \left(\overline{d} H - \overline{\Delta} mm^{\mathsf{T}}\right) \otimes I_2, \qquad \delta_A = \frac{\overline{\Delta}}{\overline{d}} \frac{n_A}{49}. \quad (62)$$

The ordering in (62) groups the real fibres within each factor. The diagonal deficit δ_A is measured against $\overline{d} H$, and $n_A = (36,26,47)$. Thus this reduction preserves the participation ratio but can change its common magnitude. Mark-dependent nuisance scores or a factor-dependent readout are outside Proposition 11; their physical presence must be evaluated, not set to zero by this theorem.

13.3 The executed reduction and the comparison baseline

With the old scores fixed, bath elimination and the clamped current profiles reproduce $d = 0.0551296278772322$ and $\Delta = 0.004648154590676$. Integrating the other thirty current coordinates instead gives $\overline{d} = 0.055076228668117$ and $\overline{\Delta} = 0.004826646326898$. Table 8 also allows the old statistical scores to respond. All entries use the corresponding unscreened dH or $\overline{d} H$ baseline, so their total reductions have ratio 36: 26: 47.

Table 8. Total diagonal reductions relative to the unscreened participation Gram. The last two rows integrate the other current coordinates and freely profile the twelve old statistical scores. These percentages are information responses, not physical force reductions.

Reduction	Colour %	Weak %	Hypercharge %
Bath; other currents fixed; old scores fixed	6.19444	4.47376	8.08718
Bath and other currents; old scores fixed	6.43854	4.65006	8.40588
Old scores and other currents; bath fixed	72.55078	52.39778	94.71907
Old scores, bath and other currents	72.55203	52.39869	94.72071

The large last-row values include the response absorbed when old statistical parameters can change. They are not additional D41 bath effects. Comparing the last two rows against the already-relaxed third-row baseline gives incremental bath reductions of **0.004583%, 0.001909% and 0.031103% (computed from the unrounded entries)**. These incremental fractions need not follow 36: 26: 47, because their denominator is already screened. The distinction is essential when interpreting preservation of the total participation form.

Direct reduction of the complete sixty-coordinate score Gram to six retained coordinates agrees with sequential bath, old-score and current elimination. The determinant identity retains all fifty-four hidden directions. For stationary reference histories of lengths 1, 7, 49 and 343, with the initial reference law held fixed, the Hessian is NG and the reduced Hessian is $N\overline{G}_{\mathcal{N}}$; the history exposure does not alter the relative response. Independent nonlinear minimisation of the row-normalised exponential event law reproduces this Hessian at the reference point. The Gaussian integral is exact for the quadratic model. Nonlinear profiling does not evaluate the full nonlinear marginal integral or its field-dependent determinants.

13.4 The complete Gaussian parent cannot repair the mismatch

Proposition 10 compares current restrictions. Integrating further fields could in principle change such a comparison, so we test the entire archived FB parent. Let $\mathcal{H}_0$ and $\mathcal{H}_1$ be its positive unscreened and typed Hessians on the 187-dimensional quotient, including the same potential. Their positive subtraction has rank 183 and a four-dimensional kernel. The covariance difference $D = \mathcal{H}_1^{-1} - \mathcal{H}_0^{-1}$ is likewise positive with a four-dimensional kernel.

Proposition 12 (rank bound under a common Gaussian readout). If $D \succcurlyeq 0$ has kernel dimension four, then every common full-row-rank 36-by-187 readout R_c obeys

$$C_i = R_c \mathcal{H}_i^{-1} R_c^{\mathsf{T}}, \qquad \operatorname{rank}(C_0^{-1} - C_1^{-1}) = \operatorname{rank}\big(R_c D R_c^{\mathsf{T}}\big) \geq 32. \tag{63}$$

Proof. Since D is positive, $\ker\big(R_c D R_c^{\mathsf{T}}\big)$ consists of vectors whose image under the injective map R_c^{T} lies in $\ker D$. This kernel has dimension at most four. The inverse covariance difference has the same rank as $C_1 - C_0$, because multiplication by C_0^{-1} and C_1^{-1} is invertible. ■

The native current subtraction (57) has rank twelve, below the bound of thirty-two. It therefore cannot be obtained as the common linear Gaussian marginal of this FB pair. Four random readouts verify the inequality; a readout retaining the four protected covariance directions and thirty-two others attains the bound. The numerical rank premise is well separated: the smallest positive eigenvalue of $\mathcal{H}_0 - \mathcal{H}_1$ is 0.0005685173, while its four zero eigenvalues have magnitudes below 1.5×10^{-16}. Its rank is unchanged at tolerances 10^{-12}, 10^{-10} and 10^{-8}.

This excludes repairing the identification merely by integrating additional fields of the same Gaussian pair. It assumes the same deterministic readout in both parents. Added physical fields, additional observation noise, a different joint law and nonlinear coarse graining are outside the statement. The two constructions are not asserted to have measured the same physical observable originally.

13.5 Conditional field transmission and physical scope

The conditional mean map M of (55) can be carried through each native information form $G_{\mathcal{N}}$ without installing it as a new physical action. The pullback $M^{\mathsf{T}} G_{\mathcal{N}} M$ has rank eighteen in every tested case. Its trace is 0.0115314 without nuisance relaxation, 0.0111649 with the bath, 0.0085140 with the old scores and 0.0070063 with both. The corresponding expected score powers per inverse window are 1.6460022, 1.5914916, 1.1900931 and 0.9692520. The bath row reproduces (56). The archive supplies the complete matrices [22].

These are information contractions through the inherited conditional field mean. Adding them as independent penalties to the FB action would require a separate source argument and could count the same history response twice. The calculation makes no such addition. Its physical completion requires the joint record, completion and matter scores and their cross blocks on the same changing-field history, with the measure and eliminated determinants retained. The existing native gauge/current map and participation-sensitive radial tangent are inherited inputs [23–24], not new arbitrary choices. The unresolved selection concerns their complete joint physical weighting and spatial coarse-graining limit.

14 Completion time and joint history weighting

14.1 The first complete closed cover

The source distinguishes a microscopic update from a completed record. On its executed D36 branch, completion occurs when the trajectory has visited the entire seven-state cell and returned to its starting point [8, Section VII.24]. We apply this stopping rule to the native marked law of Section 13 [25]. The initial anchor a is drawn from the reference stationary law π, held fixed when the source parameters vary, and self transitions are retained. With X_t the wheel state, the stopping time is

$$\tau = \inf\{n \geq 1 : X_n = a,\ \{X_0, \dots, X_n\} = \{0, \dots, 6\}\}. \quad (64)$$

The last return transition is included. The augmented transient state consists of the current vertex and the set already visited. It has 255 reachable states for the hub anchor and 204 for each rim anchor. Direct absorbing-chain evaluation gives mean durations 20.6188715184863 and 21.4316407267046, respectively. Their stationary mixture reproduces the source value

$$\overline{\tau} = \mathbb{E}_0 \tau = 21.2776829509186, \qquad \mathrm{Var}_0(\tau) = 87.5301360067934. \quad (65)$$

The minimum is seven updates. No exponential clock or arbitrary history length is substituted. The experiment retains the **full marked stopped history**. The information of a terminal record that discards intermediate marks is a different quantity and requires the physical record pushforward.

14.2 Exact preservation under the static history law

Proposition 13 (closed cover weighting of a static source). Let the reference finite chain be irreducible, and let the regular source scores be row-centred and time independent. Use the fixed initial law and parameter-independent stopping rule (64). If G is the stationary per-update score Gram, the full stopped-history information is

$$G_{\mathrm{stop}} = \overline{\tau} G. \quad (66)$$

Proof. For any fixed anchor, let v_x be the expected number of departures from state x before stopping. Every path begins and ends at that anchor, so expected arrivals equal expected departures: $vK = v$. Irreducibility gives $v = (\mathbb{E}\tau)\pi$. Row-centred score increments are martingale differences; their different-time cross moments vanish under the stopping indicators. Summing their conditional second moments against v proves (66). Averaging over anchors gives the stated result. ■

For the same initial law, common positive support and full stopped paths, the relative-entropy chain rule also gives the finite-deformation identity

$$D_{\mathrm{KL}}\big(\mathbb{P}_0^{\tau}\|\mathbb{P}_{\eta}^{\tau}\big) = \overline{\tau}\sum_x \pi_x\, D_{\mathrm{KL}}\Big(K_0(\cdot|\,x)\|K_{\eta}(\cdot|\,x)\Big). \quad (67)$$

The kernels in (67) include the conditional event marks. The calculation checks all entries of the sixty-coordinate Gram, five nonlinear deformations and the reduction of all fifty-four hidden coordinates to the six D41 profiles, including the eliminated determinant. Equation (66) scales the baseline and subtraction together. Thus the bath-only clamped deficits remain 6.19444%, 4.47376% and 8.08718%; the other reductions in Table 8 also retain their fractional values. For the bath-only row, $d_{\mathrm{stop}} = 1.17303074317387$ and $\Delta_{\mathrm{stop}} = 0.0989019596872557$. This is a change of event grain inside the likelihood experiment, not a new action normalisation or a change to PCN.

14.3 Current propagation during completion

The source also supplies a conditional matter propagation law. EPM1 identifies one D36 pre-Fact update on the reconciled matter tangent with the source-even stationary traffic. On its no-reinjection single-excitation branch, an initial E_2 current amplitude is multiplied by μ^t before update t [8, Sections VII.24–25]. Reconstructing the additive reversibilisation and its mass-normalised E_2 eigenspace gives $\mu = -0.0993882275860840$ and $\mu^2 = 0.00987801978270324$. EPM1 and no reinjection remain premises of this continuation. This is the endpoint autocorrelation p of Section 4.1, by the remark there: on the rim, $\mu = p_{\mathrm{self}} - (p_{\mathrm{forward}} + p_{\mathrm{backward}})/2$.

For anchor a, let Q_a be the transient matrix of the augmented chain, e_a its initial unit vector and $x(i)$ the vertex of transient state i. The discounted vertex occupation and its total are

$$v_x(z) = \sum_a \pi_a \sum_{i:x(i)=x} [e_a^{\mathsf{T}}(I - zQ_a)^{-1}]_i\,, \qquad \mathcal{H}_{\tau}(z) = \sum_x v_x\,(z). \quad (68)$$

This keeps the completion clock correlated with the evolving trajectory. The evaluated totals are $\mathcal{H}_{\tau}(1) = 21.2776829509186$, $\mathcal{H}_{\tau}(\mu) = 0.909596787943724$ and $\mathcal{H}_{\tau}(\mu^2) = 1.00997656852395$. Together with the inherited traffic coefficient $\beta_{E_2} = 0.00564998284848651$, they reproduce the source-stopped occupation $\beta_{E_2}\mathcal{H}_{\tau}(\mu^2) = 0.00570635028953356$. This occupation is not an action stiffness and does not select its physical amplitude factor.

Use the thirty-coordinate chart containing twelve old scores, six D41 current coordinates and twelve bath scores. In the shared-parameter test, each old or bath tilt is one constant parameter over the full history, while the current score is multiplied by μ^t. If $\mathcal{R}_{x,ij}$ is the conditional row score Gram and $a_i = \mu$ on current coordinates and one otherwise, the complete joint information is

$$(G_{\mathrm{time}})_{ij} = \sum_x v_x\,(a_i a_j)\mathcal{R}_{x,ij}. \quad (69)$$

The current/current, current/nuisance and nuisance/nuisance blocks must therefore be weighted together before elimination. The exact vertex-resolved matrix agrees with independent time propagation.

Its scalar block factorisation has relative residual 2.67×10^{-15} on the supplied arrays. At that precision, the fractional subtraction relative to the propagated current baseline is attenuated by

$$\chi_\tau = \frac{\mathcal{H}_\tau(\mu)^2}{\mathcal{H}_\tau(1)\mathcal{H}_\tau(\mu^2)} = 0.0385001307559613. \quad (70)$$

The numerical calculation uses (69), not the scalar approximation. Table 9 gives its current deficits. The thirty unretained current directions are fixed throughout this table; only the named old and bath scores respond.

Table 9. Current deficits relative to each model's unscreened six-profile baseline. Shared parameters persist across the history; time-local parameters are independently adjustable at each update. Neither temporal model is selected here as the complete physical bath.

History and nuisance response	Colour %	Weak %	Hypercharge %
Static completed history; bath only	6.19444	4.47376	8.08718
Propagating current; shared bath only	0.23849	0.17224	0.31136
Propagating current; shared old scores and bath	2.10151	1.51776	2.74364
Propagating current; time-local bath only	6.19444	4.47376	8.08718

The total deficits retain 36: 26: 47 within numerical precision. With shared parameters, adding the bath after the old scores already respond gives incremental deficits 0.01928384%, 0.01384542% and 0.02534081%, using that already-relaxed baseline. These are distinct from the total fractions in Table 9 and from the all-current marginalisation of Table 8.

The time-local control gives each update its own nuisance parameters and eliminates them before summing. It returns $\mathcal{H}_\tau(\mu^2)$ times the original per-update reduced current matrix within the recorded numerical tolerance. This changes the temporal parameter space; it is not an alternative elimination order in the same parent. A shared statistical tilt also does not assert that a physical bath field is frozen.

14.4 Existing gauge map and physical interpretation

The archived 6-by-72 gauge-to-current Jacobian A_g of Section 10.3 is retained. Every form in Table 9 is transmitted as $A_g^{\mathsf{T}} G A_g$, without choosing another attachment. These information pullbacks have rank six. Their complete matrices are archived [25]; they are not the complete twelve-generator gauge-action Hessian.

The calculation establishes static completion-weight preservation and evaluates a conditional time-dependent continuation. It does not derive which temporal response the complete physical source produces. The required physical operation remains the joint transported-increment weighting of current, record, completion and matter through the existing source maps, followed by the physical quotient and spatial coarse graining [5, Section 56A.5]. Its temporal cross blocks must come from that same law. Selecting a response in Table 9 because it gives a preferred magnitude would be a fit. The native statistical scores and conditional EPM1 propagation do not by themselves supply that physical selection.

Part II Native recording, field motion and event energy

15 Native recording and temporal response

15.1 The existing operation and the completed event

The source supplies an explicit current-dependent recording operation [26], rather than only a statistical score model. The Born-conditioned closed-cover construction [27] applies it on the seven-site wheel, retaining the internal state from one opportunity to the next. This section evaluates that operation on its archived fixed-endpoint experiment. It is distinct from the scalar score models in Sections 10–14.

For the current $j_{xy} = \psi_y - U_{xy}\psi_x$, let p_j be its normalised ray projector. The native Hermitian matrices are $C_a = i[T_a, p_j]/\sqrt{s}$ and $C_0 = (I - \sum_a C_a^2)^{1/2}$, with the source's maximal-strength normalisation s. The marked amplitudes are $L_{r,a} = P_r C_a U_{xy}$, where P_r are the central sector projectors. The source's normalisation, square-root complement and current dependence are differentiated together. Reverse-edge amplitudes are evaluated from their own native formula, without replacing individual marked amplitudes by forward adjoints.

We use the archived prime-chirp endpoints and initial internal density $(I - |\Omega\rangle\langle\Omega|)/49$ on the fifty-coordinate diagnostic carrier, with Ω the equal neutral-sector superposition. Central pinching and the native channel act on non-self opportunities; self-loops retain the state. The event stops at the first visit to all seven sites followed by return to the starting site. Its mean duration is 21.2776829509186 opportunities. The probe is the unit-norm triangle $0 \to 1 \to 2 \to 0$, applied separately in colour generator 1, weak generator 1 and conventional hypercharge Y. These three probes are not sector averages or a complete twelve-generator gauge Hessian.

The inherited one-operation conjugate-momentum identities distinguish mean impulse from disturbance [8, XII.8–XII.12]. The completed-history calculation [28] retains the products of marked amplitudes before summing over histories. Its ordered cross-step contribution is about one third of the within-step disturbance in each probe. The calculation below resolves that contribution by separation and separately evaluates the derivative of the mean impulse [29]. It therefore tests memory without identifying its size with a force correction.

15.2 Two distinct temporal kernels

For an edge channel and its prescribed gauge derivative, define

$$\mathcal{E}(X) = \sum L X L^\dagger, \qquad \mathcal{D}(X) = \sum L' X L^\dagger, \qquad v(X) = -i\,\mathrm{tr}\mathcal{D}(X). \quad (71)$$

On Hermitian inputs, the trace in (71) is imaginary by completeness. Separate the Hermitian and anti-Hermitian parts of the insertion:

$$\mathcal{H}(X) = \frac{\mathcal{D}(X)+\mathcal{D}(X)^\dagger}{2}, \qquad \mathcal{A}(X) = \frac{\mathcal{D}(X)-\mathcal{D}(X)^\dagger}{2i}. \quad (72)$$

The same-field density derivative is $2\mathcal{H}(X)$. The component $\mathcal{A}(X)$ instead contributes to the real overlap between amplitude derivatives at different times. Let $\mathcal{T}$ be the native transient channel on the augmented cover states, and X_{occ} the sum of their incoming occupations. The past insertion enters only transient destinations; the later observation includes both continuing and completing transitions. With address probabilities included, put $Z_H = \mathcal{H}_{\mathrm{trans}} X_{\mathrm{occ}}$ and $Z_A = \mathcal{A}_{\mathrm{trans}} X_{\mathrm{occ}}$. Then

$$C_\ell = 2v\mathcal{T}^{\ell-1} Z_A, \quad R_\ell = 2v\mathcal{T}^{\ell-1} Z_H \quad (\ell \geq 1). \quad (73)$$

Here C_ℓ is the ordered disturbance contribution at lag ℓ, whereas R_ℓ is the delayed derivative of the mean later impulse. Differentiating the mean-impulse operator at the same opportunity supplies a contact term R_0. The derivative of the accumulated mean impulse is

$$\chi_{\mathrm{imp}} = R_0 + \sum_{\ell \geq 1} R_\ell. \quad (74)$$

Neither (73) nor (74) is the energetic gauge-action Hessian. The event is not assumed stationary or thermal, and no fluctuation-dissipation relation is used to convert disturbance into mean response or stiffness.

Table 10. Completed-history disturbance and mean-impulse derivative in the three fixed-endpoint probes. The last column is not a force coefficient.

Probe	Within-step disturbance	Ordered disturbance	χ_{imp}
Colour 1	0.165848618	0.055237553	6.48492×10^{-7}
Weak 1	0.178972450	0.059524749	-2.45233×10^{-7}
Y	0.283313516	0.094530256	-1.03199×10^{-6}

The ordered-to-within-step ratios are 33.3060%, 33.2592% and 33.3660%. Their absolute-weighted mean separations are 6.53, 6.45 and 6.32 opportunities, and approximately 95% of each ordered contribution is accumulated by lag twenty. The mean-response kernel has absolute-weighted mean separations of 8.84, 8.40 and 9.68 opportunities. Its contact terms are $(-1.70231, 6.01348, -2.84687) \times 10^{-7}$; the delayed sums are $(8.18724, -8.46581, -7.47308) \times 10^{-7}$, in the same probe order. The three ratios lie within 0.07 percentage points of one third. No identity is claimed for this: it is a numerical observation about the three archived probes under the D36 cover law, and a derivation, if one exists, would have to come from the lag kernel (73).

The recurrence retains 1,479 transient cover states and the complexification of 544 Hermitian matrix coordinates, without resetting the internal state. Summing C_ℓ reproduces the completed-history calculation [28]. Lags 251–300 contribute below 2×10^{-19} to disturbance and below 6×10^{-24} to delayed response. These are observed numerical tails; the absorbing-chain bound in [28] separately controls the stopped amplitude-response truncation. Independent nonlinear finite differences on a shortest completed path verify the contact-plus-delayed response to below 1.6×10^{-12} absolute error. Full lag, contact, chronological and finite-frequency arrays are supplied [29].

15.3 An exact uniform-state control

Lemma 14 (uniform-state mean response). For the native Hermitian recording matrices with $\sum_a C_a^2 = I$, central pinching and a fixed one-generator link family, the derivative of the completed mean impulse vanishes for the uniform internal preparation $I/50$. The disturbance need not vanish.

Proof. The channel is unital because

$$\mathcal{E}_\theta(I) = \sum_r P_r \left(\sum_a C_a^2\right) P_r = I, \qquad \partial_\theta \mathcal{E}_\theta(I/50) = 0. \quad (75)$$

Every past same-field density insertion therefore vanishes, eliminating the delayed response. For the mean-impulse operator $\mathcal{I} = -i\sum L^\dagger L'$, completeness and $\mathrm{tr} \sum_a C_a\, C_a{}' = 0$ give $\mathrm{tr}\mathcal{I} = -i\mathrm{tr}\left(U^\dagger U'\right)$. On a fixed generator family $U(\theta) = \exp(i w_e \theta T)$ this equals $w_e \mathrm{tr} T$, independent of θ. The contact derivative also vanishes. The stopping rule and address law are unchanged, so the conclusion holds across completed histories. The impulse itself can be nonzero, particularly in hypercharge; the statement concerns its derivative.

The archived rank-forty-nine preparation differs from the uniform state, and that difference is retained in Table 10. The exact control explains why a substantial disturbance can coexist with a small mean response in this experiment. It does not exclude a response from a different physical preparation, moving fields or the remaining source variables. The kernels are also not identified with the Euclidean angle-history coefficient of CLSN-1 Section 17.105, which the source already distinguishes from electric-flux curvature [3].

16 Field motion under compact evolution

16.1 Source ingredients and declared attachment

To test whether the native recording operation can affect field motion, we compose it with the source's positive compact Wilson transfer and spectral-log evolution [8, VIII.2–VIII.5]. This is a declared single-cycle construction. It uses a different probe from the unit-norm triangle chart in Section 15, so its numerical outputs are not a continuation or rescaling of Table 10.

Isolate one primitive triangle cycle, with compact coordinate ϕ and integer flux k. The three edge-flux contributions give

$$Q_k = \left[\frac{I_{|k|}(\beta_t)}{I_0(\beta_t)}\right]^3, \qquad 2\log\frac{I_0(\beta_t)}{I_1(\beta_t)} = 1, \qquad \beta_t = 1.54277472222737. \quad (76)$$

The coefficient and one-opportunity grain are inherited from the finite unit-flux matching on the PCN compact-Wilson branch [3, Sections 17.95 and 17.104–17.108]. Equation (76) retains the exact Bessel spectrum; it does not replace that spectrum by a quadratic flux law. With the isolated face potential $V(\phi) = 1 - \cos\phi$, whose unit coefficient is an input of this branch, define

$$T_W = e^{-V/2} Q e^{-V/2}, \qquad H_W = -\log(T_W/\lambda_0), \qquad U_W = e^{-iH_W}, \quad (77)$$

where λ_0 is the largest eigenvalue of T_W. The full spectral logarithm of the sandwich is used. It is not replaced by the sum of a free kinetic logarithm and V at finite spacing. The initial field is the positive ground state of this isolated transfer, with no adjustable packet width. This preparation is not asserted to be the vacuum of the complete interacting source.

Use primitive hypercharge $q = 6Y$ with integer eigenvalues and put

$$U_{12}(\phi) = e^{i\phi q}, \qquad U_{21}(\phi) = U_{12}(\phi)^{-1}, \qquad j_{xy}(\phi) = \psi_y - U_{xy}(\phi)\psi_x. \quad (78)$$

All other links are identity, and all native edge recording channels remain present. At each opportunity the address transition is followed by the native marked operation, one U_W field step and the cover-stop test. This order, the isolation of one cycle and the bare-field preparation are stated attachment conditions. PCN and clock equality alone do not derive this composition as the complete master-action evolution. Endpoint amplitudes are fixed; the current changes through (78), without an independently evolved current field. The fifty-coordinate internal state is retained throughout.

16.2 The completed moving-field calculation

Quantum trajectories sample the source's native marked amplitudes with their Born weights, retaining the joint field and internal state until the event completes. No independent classical noise is added. A tangent corresponding to a shift of the initial field is propagated through the same marked sequence with its likelihood contribution retained. Each reported run contains 8,192 completed histories. The field circle is represented by 49, 65 and 97 points; these are numerical regulators, not proposed primitive phase alphabets.

Table 11. Completed-event observables with and without field propagation. Uncertainties are Monte Carlo standard errors; they do not measure uncertainty in the physical attachment. The moving run uses 97 field points and the frozen control uses 65.

Observable	Propagation off	Propagation on
$\langle 1-\cos\phi\rangle$	0.415254 ± 0.000503	0.838526 ± 0.003388
$\langle \sin\phi\rangle$	-0.000034 ± 0.000653	0.021172 ± 0.003007
$\langle H_W\rangle$ above the ground value	10.060339 ± 0.170108	9.339775 ± 0.167015
Initial-shift derivative of final $\langle \sin\phi\rangle$	0.584400 ± 0.000505	-0.000351 ± 0.002742

The initial magnetic-cost expectation is 0.415350841. Turning off propagation leaves the angle marginal unchanged by the recording channel, although its coherences and flux can change. The exact frozen shift-response value is 0.584649159. Both controls are reproduced within sampling error. With propagation but no recording, the unshifted ground state remains unchanged. Recording followed by field evolution changes the mean magnetic-cost observable by 0.423273 ± 0.003425 relative to the frozen recording control.

The mean sine enters the declared potential's force, $-\sin\phi$, and its nonzero final value gives a signed displacement test. Neither this mean nor the change in $\langle 1-\cos\phi\rangle$ measures a new potential coefficient. The unit coefficient in (77) remains an input. The bare-field energy increase records work into that subsystem under the stated composition; balancing it against current, record and matter energy requires the complete source accounting.

The no-record moving control has final initial-shift response 0.000693064 under the same stopping clock. Table 11 does not resolve an additional change of this small response. The distribution of completion times already suppresses this particular terminal susceptibility, so its near-zero value cannot be read as a vanishing force or a new stiffness.

16.3 Numerical controls and physical scope

Table 12. Field-grid refinement of the moving calculation with matched random numbers.

Field points	$\langle 1-\cos\phi\rangle$	Outer flux-band probability
49	0.838497 ± 0.003387	1.09×10^{-3}
65	0.838527 ± 0.003388	1.26×10^{-4}
97	0.838526 ± 0.003388	6.02×10^{-12}

The paired 97-minus-65 difference in magnetic cost is $(-4.01 \pm 4.15) \times 10^{-7}$. High-precision diagonalisation retains the transfer's very small positive eigenvalues. Native completeness and field unitarity residuals are below 1.1×10^{-14}. Twenty-one final controls pass, including the derivative of total probability, tangent norm identity, completion clock, frozen marginal, paired-grid comparison and resolved magnetic-cost change [29]. These verify the stated finite model; they do not establish a spatial continuum limit.

The construction demonstrates transmission from the native recording operation to moving field observables without refitting PCN, the clock or a fluctuation amplitude. It does not evaluate the complete six-defect parent, independent current evolution, responding endpoint matter and completion, allowed cross blocks, or local Gauss and Fock-space admission. It returns neither the D41 force reductions nor

three measured force strengths. The source operation exists and the record-to-field route is executable; its complete physical composition and the resulting coarse-grained gauge-action Hessian remain the calculation to evaluate.

16.4 Response to a calibrated drive

The compact construction also permits an explicit energetic probe [30]. Keep the preparation, native operation, clock and bare field Hamiltonian of Section 16.1, and apply the same small source throughout each event:

$$H(h) = H_W - hO, \qquad O = \sin\phi, \qquad \chi_{\text{event}} = \frac{\partial\langle O_{\text{final}}\rangle}{\partial h}\Big|_{h=0}. \quad (79)$$

The coefficient of the source term is specified in the existing Hamiltonian energy units. The observable is periodic on the compact cycle; it is not replaced globally by the angle. The unitary derivative is evaluated by its exact spectral divided difference and independently checked by a Fréchet derivative and finite differences. Each selected marked path carries both the state and its source derivative, with the same base-probability normalisation. The derivative therefore retains changes in path probabilities, not only changes in normalised conditional states.

Table 13. Calibrated compact-cycle response to the source in (79).

Experiment	Susceptibility
Bare ground-state static response	0.473928270
No recording with the same completed-cover clock	0.473367291
Native recording with 65 field points	0.106214 ± 0.003706
Native recording with 97 field points	0.106214 ± 0.003706

Each recording run contains 8,192 histories. The recorded response is 0.224380 ± 0.007829 of the no-record value, a reduction of 77.56 ± 0.78 percentage points. The paired 97-minus-65 difference is $(-2.29 \pm 1.88) \times 10^{-8}$. Twenty-six checks pass, including native completeness, the derivative of total probability, the exact clock, independent matrix derivatives and full-path finite differences. The errors are Monte Carlo errors for this finite construction.

This is a calibrated finite-event susceptibility, not the inverse gauge stiffness. Even without recording, the bare static susceptibility is approximately 0.474 while the supplied coefficient of $1 - \cos\phi$ is one. The compact observable, quantum state and spectrum enter its response. On any finite field grid, the joint maximally mixed state supplies an exact control: the native channel is unital and Hamiltonian propagation preserves that state, so its drive response vanishes without making the Hamiltonian coefficients vanish. The preparation used for Table 13 is the bare ground state, not that control state.

The work-calibrated route in RCHS-35 [8, VII.28] requires the same physical carrier and complete responding source. PCN is retained; this probe supplies no second common normalisation [3, Section 17.108]. Section 17 applies an energetic drive to a different, explicitly quadratic three-direction construction with the inherited gauge coefficients as its starting point. The percentage in Table 13 is not carried into that calculation as an input.

17 Coupled gauge response on the quadratic branch

17.1 Inherited coefficients and the field restriction

The coupled calculation retains one colour Cartan direction, one weak Cartan direction and conventional hypercharge on the archived fifty-coordinate carrier [31]. Their generator matrices are the source's T^3, t^3 and Y. Direct traces reproduce the inherited baseline:

$$Z_A = \mathrm{Tr}(T_A^2), \qquad (Z_C, Z_W, Z_Y) = \left(6, \frac{13}{2}, \frac{21}{2}\right). \quad (80)$$

The neutral padding contributes zero. Equation (80) is a replay of the existing census, not a new derivation of particle content. The primitive convention $q = 6Y$ gives $Z_q = 378$ and $\theta_Y = 6\theta_q$; both the phase and quadratic cost are unchanged. This conversion is checked directly, without choosing a new normalisation.

On the isolated triangle, the three edge-flux contributions supply the factor three in the quadratic electric energy. Combining that restriction with the inherited sector coefficients gives the tested Hamiltonian and energetic source:

$$H_0 = \sum_A \left(\frac{3p_A^2}{2Z_A} + \frac{Z_A\theta_A^2}{2}\right), \qquad H(h) = H_0 - \sum_A h_A\,\theta_A. \quad (81)$$

This is a stated quadratic restriction of the electric and magnetic construction [8, VIII.2–VIII.6; 3, Sections 17.104–17.108]. It does not supply the omitted nonlinear gauge terms or the complete physical parent. The computational coordinates $x_A = \sqrt{Z_A}\theta_A$ make the three oscillator frequencies equal to $\sqrt{3}$. Returning the probe and observable to θ_A preserves the coefficients in (80); the coordinate transformation is not a fitted conversion.

The bare product ground state, isolated triangle and order of native recording followed by field propagation are attachment conditions. The endpoint matter is held fixed. The current follows its link-dependent source map but has no independent evolution. The restriction includes neither all non-Abelian field directions nor all six spatial cycles, and it does not establish the full matter Gauss-law and energetic admission of the source.

17.2 One shared current and recording operation

The three moving coordinates enter the same chord link:

$$U_{12}(\theta) = \exp[i(\theta_C T^3 + \theta_W t^3 + \theta_Y Y)]. \quad (82)$$

The current is $j_{12}(\theta) = \psi_2 - U_{12}(\theta)\psi_1$; the reverse link is the inverse and the other links are identity. The three displayed generators commute because they act in distinct factors. This is a restriction of the full carrier, not a claim that colour or weak gauge theory is Abelian.

Every native recording opportunity remains present. The jointly varying current feeds all twelve pointer operators and the seven central terminal projectors, so the current normalisation and marked outcomes depend on all three fields. The internal preparation remains $(I - |\Omega\rangle\langle\Omega|)/49$. The three field coordinates and internal state are propagated together until the first closed cover, using the inherited address probabilities and completion rule. No common response multiplier or zero cross-response condition is imposed.

The derivative of the field unitary is inserted at every opportunity. All three source tangents follow the same sampled marked sequence, with its probability derivative retained. The resulting matrix is

$$\chi_{AB} = \left.\frac{\partial\langle\theta_{A,\mathrm{final}}\rangle}{\partial h_B}\right|_{h=0}. \quad (83)$$

17.3 Exact calibration and coupled response

For the unrecorded quadratic field, the static and finite-duration responses are exact:

$$\chi_{AA,\mathrm{static}} = \frac{1}{z_A}, \qquad \chi_{AA}(n) = \frac{1-\cos(\sqrt{3}\,n)}{z_A}, \qquad \chi_{AB} = 0 \quad (A \neq B). \quad (84)$$

With the closed-cover probability p_n of Section 14, define

$$\mathcal{C}_{\mathrm{stop}} = \sum_n p_n\left[1-\cos\left(\sqrt{3}\,n\right)\right] = 0.999299358040212, \qquad \chi^{(0)}_{AA,\mathrm{event}} = \frac{\mathcal{C}_{\mathrm{stop}}}{z_A}. \quad (85)$$

Equations (84)–(85) calibrate the starting response without a new scale. They also give an exact variance-reduction control. For each sampled duration, subtract the known no-record response in (84) from the diagonal estimator and add its exact stopped mean in (85). The subtraction coefficient is fixed to one. This changes numerical variance, not the physical history weights or the expectation of the response.

Table 14. Coupled quadratic response in canonical generator coordinates.

Direction	No-record response	Coupled response	Response ratio
Colour Cartan	0.166550	0.166469 ± 0.000240	0.99952 ± 0.00144
Weak Cartan	0.153738	0.153361 ± 0.000232	0.99755 ± 0.00151
Hypercharge	0.095171	0.095094 ± 0.000043	0.99919 ± 0.00046

The calculation uses 512 completed histories in each of two oscillator bases, with nine and thirteen levels per coordinate and matched history seeds. Table 14 gives the thirteen-level result. The largest paired basis change among the nine responses is 4.03×10^{-10}. The largest state weight in the upper three levels of the finer basis is 7.38×10^{-12}; the corresponding maximum drive-tangent weight is 1.08×10^{-10}. These are finite-basis checks, not a spatial continuum limit.

Table 15. Complete finite-event Jacobian in the retained three-direction chart.

Response coordinate	Colour source	Weak source	Hypercharge source
Colour	0.166469 ± 0.000240	0.000411 ± 0.000212	-0.000069 ± 0.000052
Weak	0.000109 ± 0.000101	0.153361 ± 0.000232	-0.000007 ± 0.000020
Hypercharge	0.000154 ± 0.000111	-0.000136 ± 0.000134	0.095094 ± 0.000043

The off-diagonal entries are retained. A finite-event Jacobian on a fixed background is not automatically a static, symmetric gauge-action Hessian; Table 15 is not inverted and issued as a physical kinetic matrix. The reported standard errors describe the sampling of this construction. The responses are close to their calibrated baselines, with no statistically decisive diagonal change at approximately two standard errors. This is numerical preservation in the stated coupled model, not a theorem for the complete physical source.

17.4 The local D41 action comparison

The D41 numbers supply a definite comparison without measured-force input. Let $n_A = (36,26,47)$, $d = 0.0551296278772322$ and $\Delta = 0.004648154590676$. If a time-local effective action multiplies both electric and magnetic quadratic coefficients by the corresponding D41 factor, the oscillator frequency remains $\sqrt{3}$ and

$$r_A = 1 - \frac{\Delta n_A}{49d}, \qquad \chi^{\mathrm{D41}}_{AA,\mathrm{event}} = \frac{\mathcal{C}_{\mathrm{stop}}}{Z_A r_A}. \quad (86)$$

Equation (86) predicts responses (0.177548,0.160938,0.103545), compared with the coupled values (0.166469,0.153361,0.095094) in Table 14. The numerical return therefore does not reproduce that local quadratic D41 surrogate. The comparison makes no adjustment to the source, uses no measured coupling and selects no interpolation.

The discrepancy is large for the specified surrogates that change the static susceptibility. Equation (86) lies about 46, 33 and 197 reported Monte Carlo standard errors above the coupled colour, weak and hypercharge values. A magnetic-only surrogate, which multiplies the magnetic potential coefficient by r_A, has frequency $\sqrt{3r_A}$ and static response $\frac{1}{Z_A r_A}$. It predicts (0.177392, 0.160837, 0.103426), approximately 45.5, 32.2 and 193.8 reported standard errors above the coupled values. These componentwise distances measure disagreement within this finite protocol and its stated numerical error model; they are not experimental exclusions of D41 or uncertainties in the complete physical theory.

An electric-only surrogate replaces Z_A by $Z_A r_A$ in the kinetic denominator, leaving the magnetic potential unchanged. Its frequency is $\sqrt{\frac{3}{r_A}}$, while its static response remains $\frac{1}{Z_A}$. It predicts (0.166692, 0.153833, 0.095277), within 0.11 per cent of the no-record baseline but approximately 0.9, 2.0 and 4.3 reported standard errors above the coupled values. The hypercharge discrepancy is therefore resolved relative to the reported sampling error; the tested electric-only surrogate cannot be described as indistinguishable. These figures do not constitute a joint three-sector significance test, which would require the covariance of the estimates. An independent sampling and estimator check would test the robustness of the smaller discrepancy.

The stopped factor $C_{stop}(\omega) = \sum_n p_n[1 - cos(\omega n)]$ stays within 0.4 per cent of one over frequencies 1.5–3, and within 0.3 per cent over the surrogate frequencies 1.66–1.81. Completion-time averaging therefore suppresses frequency sensitivity in these harmonic controls. Their finite-event responses closely approximate their static susceptibilities, but the remaining frequency dependence can still exceed the sampling error. This calibration does not identify the recorded response with a long-distance gauge-action Hessian. It strongly separates the tested static-susceptibility rescalings and leaves a smaller, nonzero discrepancy for the electric-only case. The coupled values lie approximately 0.3, 1.6 and 1.8 reported standard errors below the no-record baseline.

This conclusion is restricted to the surrogate in (86), the retained carrier and the event protocol. Additional responding fields or a frequency-dependent effective action can change the relation between this finite-duration response and a long-distance gauge coefficient. The result does not exclude the D41 pattern after complete physical coarse graining. It shows that the native recording composition on this quadratic branch approximately preserves the baseline response instead of generating those additional reductions.

The compact sine-response suppression in Table 13 is not universal. The compact and quadratic experiments differ in action, observable, preparation and retained directions; the comparison does not isolate a single cause of their different returns. The coupled calculation starts from (80) and evaluates all nine derivatives. Neither its response ratios nor the earlier 78 per cent suppression is installed as a

measured force correction. The full non-Abelian field space, responding endpoint matter and independent current/completion variables, admitted energetic accounting and long-distance response remain to be evaluated.

18 Completed event energy and recording dynamics

18.1 Field energy gained during recording

The quadratic construction of Section 17 permits a direct energy calculation over the same native completed histories [32]. The Hamiltonian, generator traces, initial ground state, fixed endpoint matter, current map and recording/propagation order are unchanged. Energy is evaluated before and after each operation. The calculation retains all first source derivatives and, in a separate run, the six symmetric second derivatives. Path probabilities are differentiated together with the state.

Table 16. Bare field energy gained per completed event.

Field direction	Mean energy gain	Sampling standard error
Colour Cartan	0.060325	0.006178
Weak Cartan	0.056500	0.005646
Hypercharge	0.052188	0.005560
Total	0.169012	0.011330

The calculation in Table 16 uses 256 histories in each of the nine- and thirteen-level bases and reports the finer result. The total error includes correlations between directions. Each mean gain is resolved; the largest paired basis change is 9.88×10^{-11}. The common zero-point energy cancels. These are dimensionless model-energy increments, not percentages, gauge coefficients or an independently identified PCN event cost.

18.2 Recording exchange and probe work

At zero probe, field propagation conserves H_0 in (81), with maximum step residual 1.55×10^{-15}. A constant source instead obeys the exact unitary work identity. Summing all steps gives the ensemble balance

$$\langle \Delta H_0 \rangle = Q_{\mathrm{rec}} + W_h, \qquad W_h = \sum_A h_A \left(\langle \theta_{A,\mathrm{final}} \rangle - \langle \theta_{A,\mathrm{initial}} \rangle \right). \quad (87)$$

Here Q_{rec} is the sum of changes in bare field energy at recording stages. It is not an independently evaluated record Hamiltonian. The native channel acts pointwise in the field coordinates and preserves functions of those coordinates after its outcomes are summed. It therefore preserves the magnetic and probe potentials nonselectively. Its mean recording-stage energy transfer is kinetic; individual conditioned potential jumps are not measured reservoir-energy transfers. The field-independent closed-cover rule preserves this ensemble statement.

For the source-independent initial preparation, differentiating (87) twice at zero probe yields

$$\partial_{h_B} \partial_{h_C} \langle \Delta H_0 \rangle = \partial_{h_B} \partial_{h_C} Q_{\mathrm{rec}} + \chi_{BC} + \chi_{CB}. \quad (88)$$

The susceptibility is the event response defined in (83). Equation (88) is an energetic consistency relation for this protocol. Its derivatives are taken with respect to the applied source, not the retained physical curvature; it does not identify an energy curvature with the gauge-action Hessian.

18.3 Executed energy derivatives

The second-derivative calculation uses 128 histories in each basis, with three first state tangents and six second tangents. Its exact no-record diagonal is $2\mathcal{C}_{\mathrm{stop}}/Z_A$, with zero cross terms. The duration-dependent bare value supplies a control variate with coefficient one, as in Section 17.3. This changes sampling variance without changing the history law.

Table 17. Diagonal second derivatives of total field energy and recording-stage exchange.

Energy probe	No recording	With recording	Recording exchange
Colour	0.333100	0.33275 ± 0.00141	-0.00234 ± 0.00172
Weak	0.307477	0.30784 ± 0.00175	-0.00060 ± 0.00143
Hypercharge	0.190343	0.19005 ± 0.00036	-0.00016 ± 0.00017

Each total energy curvature is within one sampling standard error of its no-record value. Thus the calculation resolves energy deposition but not a change in these diagonal curvatures. It does not prove that the correction is zero. The last column is the derivative of Q_{rec}, not a force correction; the complete matrices and raw estimates are archived.

The largest paired basis change in any sector energy derivative through second order is 7.23×10^{-8}. The per-step second-order work identity holds to 5.72×10^{-15}. An independent seven-hop completed path checks all eighteen sector-resolved Hessian entries by finite differences of raw probability-weighted energy, with maximum error 8.48×10^{-11} at step 0.0005. The ensemble work relation has a largest entrywise residual of 2.09 correlated sampling standard errors. Its exact algebraic form and its finite-sample check are distinct. These tests do not extend the retained Cartan directions to all twelve generators.

18.4 Simultaneous field and recording dynamics

The source's dimensionless implementation of the recording isometry permits a direct test of energy exchange [8, XIV.11–XIV.15; 33]. Let $V(\theta)$ denote the native forward-chord operation on edge $1 \to 2$, including link transport, thirteen pointer outcomes and seven terminal supports. It satisfies $V^\dagger V = I$. The terminal supports are compressed isometrically into their matching internal subspaces; the field Hamiltonian preserves this compression. On the direct sum of input and output implementation spaces, use the inherited block construction

$$H_{\mathrm{dil}} = \begin{pmatrix} 0 & -iV^\dagger \\ iV & 0 \end{pmatrix}, \qquad H_{\mathrm{tot}} = H_{\mathrm{free}} + gH_{\mathrm{dil}}, \qquad H_{\mathrm{free}} = \mathrm{diag}(H_0, H_0). \quad (89)$$

Here H_0 is the three-direction field operator (81), with the identity on internal and pointer factors understood. Only field self-energy and this explicit recording interaction are retained. Omitting independent current, record, completion and matter Hamiltonians is a restriction of the test, not a derivation that their energies vanish. The endpoint amplitudes and link-derived current remain those of Section 17. This is one recording opportunity, not the first closed-cover event of Sections 18.1–18.3.

The initial state occupies the input stage and combines the field ground state with the exact rank-49 internal density. Both initial energy expectations are zero after subtracting the common field zero-point constant. The state evolves under $\exp(-i\tau H_{\mathrm{tot}})$. The two energy contributions are then evaluated independently:

$$E_{\mathrm{field}} = \mathrm{Tr}(\rho_\tau H_{\mathrm{free}}), \qquad E_{\mathrm{int}} = g\mathrm{Tr}(\rho_\tau H_{\mathrm{dil}}), \qquad E_{\mathrm{field}} + E_{\mathrm{int}} = 0. \quad (90)$$

The sum follows from the time-independent Hamiltonian during this interval; the separate values require the evolution. The negative interaction value is not installed by subtracting the field gain. The choice $g\tau = \pi/2$ implements V exactly when H_{free} is absent. Setting $\tau = 1$ and $g = \pi/2$ is a dimensionless implementation control, not a source-selected physical interaction strength or an additional PCN normalisation.

Table 18. Independently evaluated energies for one duration-one recording opportunity, with seven oscillator levels per field direction.

Joint quantity	Calculated value
Colour field gain	0.033294659
Weak field gain	0.033349154
Hypercharge field gain	0.032754393
Total field gain	0.099398206
Recording interaction change	−0.099398206
Total-energy residual	2.83×10^{-15}

All 49 occupied input states are propagated, so these results have no Monte Carlo sampling error. Refining all three field coordinates gives the convergence check below. The output-stage probability is 0.986062251, less than one: the simultaneous evolution does not reproduce the ideal recording pulse exactly at this duration. That stage probability is not a completed-Fact probability.

Table 19. Joint field-basis refinement of the duration-one implementation test.

Levels per field	Total field gain	Output-stage probability
3	0.099385173	0.986062437
5	0.099398199	0.986062251
7	0.099398206	0.986062251

The five-to-seven-level change in the field gain is 7.09×10^{-9}. This is finite-basis convergence, not a physical spatial limit. At three levels per field, durations 1, 1/2 and 1/4, each with $g\tau = \pi/2$, give field gains 0.099385, 0.094213 and 0.092694 and output probabilities 0.986062, 0.996032 and 0.998975. These duration controls are not selected physical alternatives. Their values must not be compared directly with the completed-event gain in Table 16.

18.5 Ending the recording interaction

The interval in (90) is closed under its fixed Hamiltonian. Ending the interaction is a separate operation. An instantaneous change from g to zero leaves the state unchanged and requires work

$$W_{\mathrm{off}} = -g\mathrm{Tr}(\rho_\tau H_{\mathrm{dil}}) = E_{\mathrm{field}}. \quad (91)$$

For Table 18 this is 0.099398206 model units. An independent control projects the final density onto the input and output stages and recomputes its energy. That dephasing removes the off-diagonal interaction expectation and increases the specified energy by the same amount. The control is not identified with the physical Fact-Lock operation. Keeping the interaction instead retains its negative energy and continuing backreaction; it does not recover the preceding prescription of instantaneous recording followed by free field propagation.

Thus the computed compensation during the pulse does not close a complete physical event. A physical completion must account for its energy while retaining the record, either through continuing interactions or through an explicitly evaluated transfer. The present construction supplies neither independent subsystem energies nor that completion dynamics.

18.6 A condition on the additional source dynamics

The earlier energy-covariance audit derives the condition for an energy-covariant implementation of the exact isometry with prescribed block-diagonal free energies [34]:

$$H_{\mathrm{out}}V = VH_{\mathrm{in}}. \quad (92)$$

This criterion is inherited. Its finite-carrier evaluation here uses the actual native field matrices rather than the earlier four-flux diagnostic.

Proposition 15 (pointwise auxiliary obstruction). On the field grid, let the isometry act as V_i at node i, and let the free field matrix H_0 act identically on the input and output stages. If $H_{0,ij}(V_j - V_i) \neq 0$ for some $i \neq j$, no additions to H_{in} and H_{out} that are pointwise in that field coordinate can satisfy (92) as an operator identity.

Proof. The off-diagonal field block of the intertwining residual is

$$(H_{\mathrm{out}}V - VH_{\mathrm{in}})_{ij} = H_{0,ij}(V_j - V_i), \qquad i \neq j. \quad (93)$$

Pointwise additions contribute only to diagonal field blocks. They cannot change a nonzero block in (93), even when their internal or record matrices depend on the field coordinate. ■

The norm of this uncancellable part is 3.945220167 on the three-level colour slice, with the other field coordinates fixed at zero. It is a basis-dependent nonzero certificate, not a physical discrepancy or a force coefficient. Mixed kinetic terms, field-changing auxiliary operations, other preparations and a modified recording map are outside the proposition. The complete source already admits mixed temporal response and cross-defect terms [8, XIII.5–XIII.7]; they are candidates to evaluate, not terms excluded by this test.

The low-rank operation agrees with explicit native matrices to 7.11×10^{-15}. An independent adaptive Schrödinger solver on a one-coordinate slice agrees with the matrix-exponential evolution to 2.18×10^{-12}. The largest energy-balance residual among the reported runs is 8.69×10^{-15}. These checks verify the restricted implementation. They do not identify its pulse coupling or omitted Hamiltonians with the complete physical source.

18.7 Kinetic completion of the native recording map

The pointwise obstruction can be removed by an explicit field-changing term built from the same native isometry and incoming field operator [35]. This is a construction satisfying the inherited intertwining requirement, not a return of the complete six-defect Hamiltonian. Keep $H_{\mathrm{in}} = H_0$, put $P_V = VV^{\dagger}$ and $Q_V = I - P_V$, and denote the repeated bare field operator on the output by H_b.

Proposition 16 (Hermitian kinetic completion). Every Hermitian output operator satisfying (92) has the form

$$H_{\mathrm{out}} = VH_0V^{\dagger} + Q_V L Q_V. \quad (94)$$

Here the complement $Q_V L Q_V$ is arbitrary and Hermitian. If H_0 and the complement are positive semidefinite, so is H_{out}.

Proof. Equation (92) fixes $H_{\mathrm{out}}P_V = VH_0V^\dagger$. Hermiticity fixes its adjoint, so both cross blocks between the image and complement vanish. The image block is fixed and the complementary block remains free. The converse and positivity follow directly. ■

Choose $Q_V L Q_V = Q_V H_b Q_V$. For the field-node matrices V_i and $Q_i = I - V_i V_i^\dagger$, the correction to the bare output operator is

$$(\Delta H)_{ij} = H_{0,ij}\big(V_i V_j^\dagger + Q_i Q_j - I\big), \qquad \Delta H = H_{\mathrm{out}} - H_b. \quad (95)$$

The diagonal field blocks vanish because $V_i V_i^\dagger + Q_i^2 = I$. Scalar multiplication potentials cancel as well. This is a kinetic correction outside Proposition 15's pointwise class. All Hermitian complements in (94) give the same action on a coherently recorded input, although they need not agree after another operation moves the state out of that image.

The block free operator $\overline{H} = \mathrm{diag}(H_0, H_{\mathrm{out}})$ commutes with the source dilation in (89). Consequently free motion and the exact recording transfer coexist:

$$e^{-i\tau(\overline{H}+gH_{\mathrm{dil}})}(\psi \oplus 0) = 0 \oplus Ve^{-i\tau H_0}\psi, \qquad g\tau = \pi/2. \quad (96)$$

For the ground-state preparation of Section 18.4, the bare field gains 0.0921921484462 model units and the correction contributes -0.0921921484462. Both expectations are evaluated directly. The joint output energy is zero to 1.10×10^{-15}, and the largest intertwining residual in the three-coordinate runs is 3.87×10^{-15}. This field gain differs from Table 18 because (96) reproduces the exact native map, whereas the earlier finite-duration implementation does not.

Table 20. Field-basis refinement of the kinetic completion and its terminal-dephasing control.

Field levels	Bare field gain	Terminal cost with $Q_V H_b Q_V$	Minimum terminal cost
3	0.092172543	0.008733128	0.002547013
5	0.092192136	0.008740688	0.002548390
7	0.092192148	0.008740701	0.002548391

All 49 occupied input states are retained. The five-to-seven-level changes in the last three columns are 1.21×10^{-8}, 1.26×10^{-8} and 1.06×10^{-9}. The terminal columns are defined in Section 18.8. These are finite-basis checks in the declared energy convention, not a spatial limit or force-strength determination.

The transfer interaction has zero expectation along this trajectory. Turning off g at the exact transfer time therefore has zero mean work in this construction; the kinetic correction remains in H_{out}. Turning off that correction would restore the bare-field cost. The timing is prescribed, not an autonomous source-derived gate, and keeping the transfer interaction on produces continuing stage oscillation. Endpoint amplitudes and link-derived current remain fixed as in Section 17. Equation (96) concerns one opportunity, not a completed first-cover event or independent physical current, matter and completion dynamics.

18.8 Terminal record energy and stability

Let Π_r project onto one of the seven neutral terminal labels, and consider $\mathcal{D}(\rho) = \sum_r \Pi_r \rho \Pi_r$. This explicitly removes coherence between terminal labels on the joint output. It is a control operation, not an identification of physical Fact-Lock. Taking a partial trace to describe observations does not perform this operation or inject energy into the full system. The terminal-label compression used above is isometric on the matching internal supports, and the constructed operators stay within that encoded output space.

Proposition 17 (terminal energy and stability criterion). Let ρ_0 be supported in the zero-energy space of the positive semidefinite H_0, and put $E_r = V^\dagger \Pi_r V$. For (94), terminal dephasing has energy cost

$$\Delta E_{\mathcal{D}} = \sum_r \mathrm{Tr}\,(H_0 E_r \rho_0 E_r) + \sum_r \mathrm{Tr}\left(Q_V L Q_V \Pi_r V \rho_0 V^\dagger \Pi_r\right). \quad (97)$$

If $Q_V L Q_V$ is positive semidefinite, the first sum is the minimum over that class, attained at $Q_V L Q_V = 0$. If the output Hamiltonian also preserves every terminal projector, then for every r it is necessary that

$$[H_0, E_r] = V^\dagger [H_{\mathrm{out}}, \Pi_r] V = 0. \quad (98)$$

Proof. Substitute (94) into the dephased energy expectation and use cyclicity of the trace. The initial output energy vanishes because $H_0 \rho_0 = 0$. Each term involving a positive complementary block is nonnegative. Pulling back the output commutator by V gives (98). ■

On the seven-level basis the first sum is 0.002548391111. For the chosen $Q_V H_b Q_V$ complement, the second is 0.006192309912 and the total is 0.008740701023. Thus the exact coherent transfer fixes neither the complementary response nor the energy of this subsequent operation. The lower bound is conditional on the stated ground preparation, nonnegative complement and unchanged native map; it is not a universal energy cost of recording.

Table 21. Coordinate-resolved energies for the kinetic completion at seven levels per field.

Field coordinate	Bare gain at transfer	Terminal cost with $Q_V H_b Q_V$	Minimum terminal cost
Colour Cartan	0.030969699	0.003251121	0.000812082
Weak Cartan	0.030873312	0.002846747	0.000819411
Hypercharge	0.030349137	0.002642833	0.000916897

These are energies in the selected field coordinates, not sector stiffnesses or screening fractions. The seven effects fail (98) on every tested basis. Their nonzero commutators exclude simultaneously retaining the unchanged V, the bare incoming H_0 and an output Hamiltonian commuting with all terminal projectors. This restricted result does not exclude an enlarged current/matter/completion system, a different joint preparation, a source-modified recording map, approximate record stability or a physical commitment operation other than $\mathcal{D}$.

Independent dense field blocks on the three-level colour slice agree with the low-rank operator to 8.84×10^{-16}. Direct terminal projection and the split formula (97) agree to 1.12×10^{-16}. Simultaneous evolution of a random excited input reproduces (96) to 1.05×10^{-15}. Five separately generated nonnegative complements satisfy the lower bound. The thirteen-pointer dephasing control gives a cost of 0.008426237 and minimum 0.002058946 on the seven-level basis; its individual pointer labels require the fixed reference basis and are distinct from the neutral terminal records [35].

18.9 Energy-resolved transfer with a retained record

An enlarged implementation can retain a terminal label while explicitly supplying the field's energy [36]. This construction uses the inherited native operators and finite field Hamiltonian, not a returned Hamiltonian for independently moving current, matter and completion variables. Write the native terminal Kraus operators as $K_{a,r} = P_r C_a$, including the inherited link transport, with thirteen pointer channels and seven terminal supports. Let Q_n be the spectral projectors of $H_0 = \sum_n n\,\omega Q_n$, where $\omega = \sqrt{3}$ in the declared oscillator convention. Resolve each operator by its field-energy transfer:

$$K_{a,r,k} = \sum_{m-n=k} Q_m K_{a,r} Q_n, \qquad \left[H_0, K_{a,r,k}\right] = k\omega K_{a,r,k}. \quad (99)$$

The refined operators satisfy $\sum_{a,r,k} K_{a,r,k}^{\dagger} K_{a,r,k} = I$. Add a store with levels $b\omega$ and shifts S_{-k} that lower its energy by $k\omega$. If the field excitation ranges from zero to $N_{\max}$, a store input supported on $N_{\max}, \dots, N_{\max} + L - 1$ has sufficient reserve; output levels lie between zero and $L + 2N_{\max} - 1$. There is no negative store energy or cyclic wrap-around.

Proposition 18 (energy-resolved recording on a finite reserve). On this safe input space, the joint map

$$\mathcal{V} = \sum_{a,r,k} K_{a,r,k} \otimes |a, r\rangle \otimes S_{-k}, \qquad (H_0 + H_B)\mathcal{V} = \mathcal{V}(H_0 + H_B) \quad (100)$$

is an isometry and conserves field-plus-store energy. After transfer, evolution generated by $H_0 + H_B$ preserves every terminal label projector R_r on the neutral output register. Dephasing that register then has zero energy cost.

Proof. Decompose native completeness into its energy bands. The cross terms with a fixed nonzero transfer difference sum to zero, while the zero-difference terms sum to identity. Safe shifts have the same shift overlaps for each such difference, establishing $\mathcal{V}^{\dagger}\mathcal{V} = I$. Equation (99) and $[H_B, S_{-k}] = -k\omega S_{-k}$ establish (100). Finally $[H_0 + H_B, R_r] = 0$, so both label probabilities and total energy are unchanged by register dephasing. ■

The inherited block dilation of (89), with V replaced by $\mathcal{V}$, commutes with the corresponding free Hamiltonian. A prescribed $\pi/2$ pulse therefore performs the transfer during free evolution and has zero mean switch-off work at exact transfer. Dense propagation verifies the pulse to 7.55×10^{-16} and its energy balance to 8.88×10^{-16}. This is an application of the inherited energy-covariant construction [34], not a source-derived autonomous gate. Record retention follows from the declared label-preserving continuation. Its physical selection remains a separate requirement [8, XIV.15].

For a store initially in a sharp energy state, tracing it out resolves the energy transfers rather than retaining their interference:

$$\mathcal{J}_r^{\mathrm{res}}(\rho) = \sum_{a,k} K_{a,r,k}\, \rho K_{a,r,k}^{\dagger}, \qquad E_r^{\mathrm{res}} = \sum_n Q_n\, E_r Q_n. \quad (101)$$

Thus terminal probabilities agree with the native operation on every energy-stationary input. The complete output state need not agree. On the exact 49-state ground ensemble at seven levels per field coordinate, the field gains 0.0921921484462 and the store loses that amount. The coordinate gains are those in Table 21. Terminal probability error is below 5.56×10^{-16}, yet the reduced field trace distance from the native output is 0.0230184283. Five-to-seven-level changes in the energy and trace distance are 1.21×10^{-8} and 2.39×10^{-8}. These are finite-basis controls.

The distinction also has an operator test. A product-prepared auxiliary state commuting with its Hamiltonian, an energy-conserving joint unitary and an energy-compatible pointer can only induce effects commuting with the incoming field Hamiltonian. Moving free evolution through the unitary and tracing the stationary auxiliary proves this covariance statement. The native effects fail it: on the dense three-level colour slice their largest commutator norm is 0.367783. An optimised input gives terminal probabilities 0.777073 and 0.700184 for the native and energy-resolved operations. This is a mathematical witness, not a physical preparation or force discrepancy. The criterion excludes the specified stationary-auxiliary implementation, not nonstationary or correlated sources, interacting energy assignments or approximate recording. Proposition 18 does not contradict Proposition 17: it enlarges the energy carrier and changes the reduced instrument.

18.10 Source coherence and completed histories

A coherent store can retain interference between different energy transfers. For a uniform superposition of L consecutive safe store levels, the shift overlap is $\chi_L(j) = \max(1 - |j|/L, 0)$ and the reduced operation is

$$\mathcal{J}_{r,L}(\rho) = \sum_{a,k,k'} \chi_L\,(k - k') K_{a,r,k} \rho K_{a,r,k'}^{\dagger}. \quad (102)$$

At fixed field cutoff, $L \to \infty$ recovers the native instrument. Every finite construction conserves joint energy and retains the record under the declared continuation. The initial store mean is $\omega[N_{\max} + (L-1)/2]$ and its variance is $\omega^2(L^2 - 1)/12$. This growing resource limit is neither spatial coarse graining nor exact restoration with a finite source budget. No value of L is fitted or source-selected.

Table 22. One-opportunity restoration controls for two explicitly different fixtures.

Store packet levels	Reduced field trace distance	Maximum single-terminal probability error
1	0.02301843	0.07688827
4	0.01096279	0.02006554
16	0.00274070	0.00501639
64	0.00068517	0.00125410

The middle column uses the ground ensemble and all three field coordinates at seven levels each. The last column maximises over input states on the three-level colour slice, with one level in each other coordinate. It is an operator-norm effect error, not the trace distance or a force-strength accuracy. The ground-ensemble energy gain remains 0.0921921484462 for every packet width. Independent dense assembly verifies the overlap formula and energy balance [36].

The sharp-energy-store construction is also evaluated through completed histories. Each run uses 512 histories, the inherited D36 transition law and stationary start, and stops at the first visit to all seven vertices followed by return to the initial vertex. Every nonself opportunity applies the native instrument resolved into the energy transfers (99), with the opposite store change. No new completion rate or fitted waiting time is introduced. Starting from the ground shell, successive transfers telescope exactly:

$$\sum_j k_j\,\omega = E_{\text{final}} - E_{\text{initial}} = -\Delta E_B. \quad (103)$$

Table 23. Completed-cover energy transfer at seven levels per coordinate, 512 histories.

Quantity	Mean	Monte Carlo standard error
Recording opportunities	21.8984	0.4236
Colour field gain	0.05720	0.01088
Weak field gain	0.04868	0.01105
Hypercharge field gain	0.03959	0.00943
Total field gain	0.14547	0.02380
Store energy change	−0.14547	0.02380

The largest pathwise balance error is 7.11×10^{-15} and the integer transfer identity is exact. The store remains nonnegative on every path. The initial reserve 18ω is a finite-cutoff provision, not PCN's unit or a

derived physical energy budget. Three-, five- and seven-level runs share random numbers and give the same sampled total work; this is not proof of exact basis convergence. Their declared stopped, append-only continuation retains the labels. Coherent-store reuse through a completed event has not been evaluated: Table 22 and Table 23 are distinct tests and cannot be combined into a completed coherent physical event. In particular, Table 23 is not a correction to the unchanged native protocol of Table 16.

Within the factorised spectral implementation class, the physical matching object is the source's transfer-overlap matrix,

$$\eta_{kk'} = \mathrm{Tr}\big(B_k \sigma_{\mathrm{aux}} B_{k'}^{\dagger}\big), \qquad [H_{\mathrm{aux}}, B_k] = -k\omega B_k. \quad (104)$$

It determines which transfer amplitudes still interfere after unresolved variables are integrated. The complete source may require channel and record indices, field-source correlations and interacting energies beyond this class. Neither a uniform packet nor an equally spaced auxiliary spectrum is imposed on it. The later physical channel must also preserve the identified record, $\Phi^*(R_r) = R_r$, or return its leakage. Conservation alone determines neither this continuation nor (104). These are explicit source-matching requirements for the joint interaction and recording calculation, rather than another common normalisation constant.

18.11 Joint current field and record response

The aggregation construction [43, Section 9] connects the current mismatch to the polar record phase. The post-commitment source identifies that phase as the tangent of $\mathrm{Pol}(\Phi)$ [39, Section 46R]. Their joint restriction can be evaluated on the unchanged six-defect parent [7], rather than inferred from a record-only block. On the common-zero unit-metric branch, each orthonormal cycle of eigenvalue $\ell \in \{1,2,2,4,4,5\}$ has field, current and record coordinates (q, j, y) and potential

$$V_\ell = 1/2\,[\ell q^2 + (j+q)^2 + \ell y^2 + (q-y)^2], \qquad K_\ell = \begin{pmatrix} \ell+2 & 1 & -1 \\ 1 & 1 & 0 \\ -1 & 0 & \ell+1 \end{pmatrix}. \quad (105)$$

This is an invariant subspace of the full Hessian, not merely a selected principal block. Direct elimination on the 187-dimensional quotient of the 226-coordinate parent reproduces the cycle reductions [37]. Its three scalar slots remain distinct from the twelve gauge-generator directions.

On the uniform cycle, $\ell = 1$, holding the current fixed leaves the field–record block $\begin{pmatrix} 3 & -1 \\ -1 & 2 \end{pmatrix}$ and relaxed field coefficient $5/2$. Allowing the current to respond gives $j = -q$ and coefficient $3/2$. Fixing the record phase while allowing that same current response instead gives 2. Thus the record constraint adds $1/2$ relative to the jointly relaxed reference. Current relaxation removes the current-mismatch cost; it does not remove the difference between a free and a fixed record phase.

Proposition 19 (record contribution after current relaxation). For positive diagonal residual weights a, c, r, b and current coupling κ, take

$$V_\ell = 1/2\,[a\ell q^2 + c(j+\kappa q)^2 + r\ell y^2 + b(q-y)^2]. \quad (106)$$

With both auxiliaries free, and with the record phase fixed at zero respectively, the retained coefficients satisfy

$$K_{\mathrm{free}} = a\ell + b - \frac{b^2}{b+r\ell}, \qquad K_{\mathrm{phase\ fixed}} = a\ell + b, \qquad \Delta K = \frac{b^2}{b+r\ell}. \quad (107)$$

Proof. Minimising in j gives $j = -\kappa q$ in either experiment. In the free experiment, minimising in y gives $y = bq/(b + r\ell)$. Substitution proves (107). The comparison uses the same weights and retained coordinate in both cases.

Table 24. Current and record reduction on the unit scalar parent. Repeated eigenvalues have the same response.

Cycle eigenvalue	Current and record free	Current free, phase fixed	Difference
1	1.500000	2.000000	0.500000
2	2.666667	3.000000	0.333333
4	4.800000	5.000000	0.200000
5	5.833333	6.000000	0.166667

One hundred positive diagonal metrics, with six cycle blocks each, reproduce (106)–(107) from the full parent to 2.42×10^{-14}. This verifies a family of restrictions, not the physical metric: arbitrary cross blocks, field-dependent weights, responding matter and a displaced background lie outside Proposition 19. The archived continuity-only temporal incidence vanishes on these cycle blocks. Explicit harmonic temporal completions therefore remain controls; their independently propagated energy is conserved to 3.63×10^{-13}, but neither their inertial coefficients nor a permanent recording operation is selected by that check [37].

18.12 Commitment constraints and the retained response

The physical question is which changes the realised Fact prevents. CLSN-1 expresses the post-commitment tangent as the kernel of the identified record differential [3, Sections 17.83–17.85]. Its readout is indexed by the event, after commitment and before renewal; this static comparison requires no arbitrary locking duration. The post-commitment construction leaves the availability of the old polar phase to be identified [39, Section 46R]. Preserving a terminal label is not automatically the constraint $y = 0$ used in Table 24.

The archived terminal arrays make that distinction concrete. Their seven projectors on the 50-dimensional carrier have ranks (3,3,6,2,9,9,18). For every one of the twelve generator matrices, direct evaluation gives

$$[P_r, T_a] = 0, \qquad \sum_r P_r\, T_a P_r = T_a. \quad (108)$$

Finite gauge rotations also preserve every terminal subspace. Thus terminal-label pinching alone leaves these generator operators unchanged. This tests the terminal projectors, not the complete current-dependent recording channel. The master-action phase of $\mathrm{Pol}(\Phi)$ is a separate carrier, so (108) neither identifies its availability projector nor proves that the old phase physically survives unchanged [38].

Proposition 20 (response under a specified record constraint). Let q be retained coordinates and η auxiliary coordinates of a positive quadratic form, with D positive definite. Impose the linearised record constraint before eliminating the auxiliaries:

$$H = \begin{pmatrix} A & B \\ B^{\mathsf{T}} & D \end{pmatrix}, \qquad L_q q + L_\eta \eta = 0. \quad (109)$$

For independent auxiliary constraints, define

$$K_{\mathrm{pre}} = A - BD^{-1}B^{\mathsf{T}}, \quad F = L_q - L_\eta D^{-1}B^{\mathsf{T}}, \quad S = L_\eta D^{-1} L_\eta^{\mathsf{T}}. \quad (110)$$

The constrained retained response is

$$K_{\mathrm{post}} = K_{\mathrm{pre}} + F^{\mathsf{T}} S^{-1} F. \quad (111)$$

Proof. Write $\eta = -D^{-1}B^{\mathsf{T}}q + \zeta$. The unconstrained minimum contributes $q^{\mathsf{T}}K_{\mathrm{pre}}q/2$, while the constraint becomes $L_\eta\zeta = -Fq$. Minimising $\zeta^{\mathsf{T}}D\zeta/2$ subject to this equation adds $q^{\mathsf{T}}F^{\mathsf{T}}S^{-1}Fq/2$. Positivity and the rank bound follow directly.

Equation (111) separates the supplied parent from the record map to be read from the source. Its nonnegative correction is relative to the same relaxed reference. It is a constant-metric quadratic result on the stated quotient, not a selection theorem for the physical record map or a complete nonlinear event calculation. Forty independent positive-matrix tests agree with direct constrained minimisation to 6.83×10^{-13} [38].

An explicit gauge-invariant candidate fixes the phase around one triangular loop: $(Cy)_s = 0$, where C is the six-by-twelve triangle-incidence matrix and y contains all twelve record-edge phases. This constraint annihilates the parent's 39 null directions. Applying it to the full quotient gives Table 25. Identifying this loop phase as the committed Fact is an additional premise; the calculation does not insert it as an inherited source result.

Table 25. Uniform-cycle response under different record constraints on the unit parent. Except where stated, other retained field modes are held at zero.

Record constraint and carrier	Retained coefficient
No added phase constraint	$3/2 = 1.500000$
One full triangular-loop phase fixed	$399/256 = 1.558594$
Same loop fixed; other field modes also respond	$591/380 = 1.555263$
All six loop phases fixed	2.000000
Private-rim cut on the six-rim-only carrier	$19/12 = 1.583333$

The one-loop increase is $15/256$, or 3.90625 per cent of the free reference. When other field modes respond, it is $21/380$, or 3.68421 per cent. The full quotient and independent constrained equations agree, and the single scalar constraint produces a rank-one update. All 64 subsets of the six loop constraints have been evaluated; intermediate responses depend on which loops are fixed, not only how many [38].

The private-rim construction in the numerical-confrontation source [40, Section 8.2A] gives squared overlap $5/6$ and record increment $1/12$ in its reduced attachment. Including current relaxation in that attachment gives $19/12$, reproduced by restricting record phases to the six rims with spoke phases fixed. It is not the same map as a full loop-phase constraint. The distinct values in Table 25 therefore do not correct the source's reduced formula; they show why its carrier restriction and the physical record map must be retained. A Euclidean overlap alone does not determine the compliance-weighted expression (111).

If the same spatial parent and record constraint are attached independently to every generator, their contribution factorises and preserves the baseline ratio $6: 13/2: 21/2$. These scalar controls consequently do not derive the unequal collective D41 force reductions. They do establish an executable response once the record differential is supplied, and show that a record contribution survives simultaneous current relaxation. The next physical input is the actual Fact-bearing map on the joint carrier, together with its source weighting; no extra conversion constant is required.

18.13 Recorded outcome and phase dynamics

The post-commitment source supplies a natural realisation in which a phase rotates a two-state record and the outcome is read in the same axial basis [39, Section 46S.5]. The phase-cut census already shows that the published discrete commitment, no-overwrite and effect constraints do not impose a hard cut on the uniform old polar phase [42, Sections 28BF–28BG, Corollaries 6.105–6.111]. That is an inherited result, not a consequence first established by this calculation. It does not prove that the complete physical event has no additional constraint. The aggregation construction likewise retains the identification of the physical record map [43, Sections 7 and 9].

The operation can be evaluated explicitly without replacing an outcome label by a fixed phase. Let the incoming two-state record be $\varrho_0 = (I + \alpha\sigma_x)/2$, with $|\alpha| \le 1$, and let

$$U(\phi) = e^{-i\phi\sigma_z/2}, \qquad P_s = \tfrac{I+s\sigma_z}{2}, \qquad s = \pm 1. \quad (112)$$

Both outcomes have probability $1/2$ for every phase. To attach this operation to the scalar parent, take a product preparation $\rho_{\mathrm{conf}} \otimes \varrho_0$ and promote ϕ to a configuration observable. On the uniform rim mode its source angle is $\phi = Y/\sqrt{6}$, where Y is the normalised record coordinate of Section 18.11. The off-uniform extension $\phi(z) = \frac{1}{6}\sum_{e\ \mathrm{on\ rim}} y_e = lz$ is a declared collective lift. It annihilates the scalar gauge directions, but the full source has not selected this extension or the product preparation [41].

Proposition 21 (phase readout without a configuration constraint). Under this preparation and lift, the outcome maps on the configuration carrier have Kraus operators

$$M_s = \tfrac{1}{\sqrt{2}} e^{-is\phi/2}, \qquad \rho_s(z,z') = e^{-is[\phi(z)-\phi(z')]/2}\rho_{\mathrm{conf}}(z,z'). \quad (113)$$

Each M_s is a nonzero scalar times a unitary operator and has no kernel. Conditioning on either outcome leaves the configuration probability density unchanged. Ignoring the outcome multiplies the configuration kernel by $\cos\big[\big(\phi(z) - \phi(z')\big)/2\big]$. For an immediate configuration integral with retained field q, the corresponding unnormalised branch weight therefore satisfies

$$Z_s(q) = 1/2\, Z(q), \qquad \Gamma_s(q) = \Gamma(q) + \ln 2, \qquad \Gamma_s''(q) = \Gamma''(q), \qquad \Gamma = -\ln Z. \quad (114)$$

Proof. In the σ_z basis, both diagonal entries of ϱ_0 are $1/2$. The controlled unitary and projection onto outcome s consequently give $M_s\rho_{\mathrm{conf}}M_s^{\dagger}$. Its trace is $1/2$ independently of the configuration state. Normalising gives (113); summing the two unnormalised kernels gives the cosine. On the diagonal $z = z'$ the phase cancels. Integrating the unchanged configuration density, including its auxiliary determinant, gives (114).

This result concerns the declared joint operation. A retained discrete label and a hard constraint on the continuous polar phase are different source objects. The outcome operation does not impose the loop constraints of Table 25, and assigning their coefficients to it would change the model. The full 187-dimensional positive quotient returns the free coefficient $3/2$ in the uniform direction and the six free coefficients of Table 24. Equation (114) also holds for a non-Gaussian configuration weight under the same preparation and operation; it is not a claim about its subsequent evolution or about a general correlated incoming state.

The operation changes conjugate momentum. In canonical units with $\hbar = 1$, a linear phase $\phi = lz$ gives

$$p \mapsto p - \tfrac{s}{2} l^{\mathsf{T}}, \qquad \Delta E_{\mathrm{kin}} = \tfrac{1}{8} l M^{-1} l^{\mathsf{T}} \quad \text{for zero initial mean momentum.} \quad (115)$$

Here M is the declared kinetic metric. With unit metric on the positive quotient, the uniform record momentum shifts by $\mp 1/\big(2\sqrt{6}\big)$ and its energy increases by $1/48$. These are dimensionless control values,

not a new primitive normalisation or a derived physical energy supply. Exact harmonic propagation on all 187 modes moves the conditional means but leaves the centred covariance and linear probe response unchanged. Combining the two outcome branches adds the covariance of their different means; that extra spread is not a change in the restoring Hessian. The energy supplied by the recording apparatus has not been evaluated in this control.

18.14 Nonlinear response and available directions

The nonlinear test retains the unchanged six-defect scalar potential and its endpoint and Higgs potentials, with all 226 configuration coordinates available. It starts at the common-zero configuration, gives the record the momentum translation of (115), and adds a declared unit kinetic term. This is deterministic classical evolution, not quantum propagation of the nonlinear Gaussian state and not a return of the source's physical time law. With a small initial momentum probe in the uniform link direction, the measured quantity is

$$\ddot{z} = -\nabla V(z), \qquad \chi(t) = \left.\frac{\partial q(t)}{\partial p_q(0)}\right|_{p_q(0)=0}, \qquad \Delta\chi(t) = \chi_{\mathrm{kick}}(t) - \chi_0(t). \quad (116)$$

The derivative is taken about each kicked or un-kicked trajectory. It is a finite-time impulse response, not the static gauge-action Hessian. Table 26 gives the paired results; the kicked and un-kicked responses agree immediately but acquire a nonzero response difference during nonlinear evolution [41].

Table 26. Uniform link impulse response under the full nonlinear scalar evolution. Time and impulse use the declared kinetic units.

Control time	No record kick	Full record kick	Difference
1	0.58376444	0.58383625	0.00007181
2	0.06604234	0.06625706	0.00021472
4	0.41711790	0.41875958	0.00164167
8	−0.28207776	−0.26755510	0.01452266

Halving the kick reduces these differences by factors 3.99985, 3.99948, 4.00225 and 3.92576, respectively. The early response is consistent with a leading quadratic dependence on the kick. Motion also enters endpoint-amplitude and conservation terms outside the three-mode harmonic restriction. The closed post-kick trajectory conserves its energy to 4.52×10^{-13}; this check does not calculate the recording apparatus's compensating energy. Independent probe and integration refinements change the evaluated responses or trajectories by at most 5.05×10^{-10} and 1.35×10^{-12}, respectively.

The available directions materially affect the result. A separate control constrains the motion to the fixed 187-dimensional positive slice of the common-zero Hessian, rather than allowing all 226 coordinates to evolve. This is an additional nonlinear restriction, not an equivalent gauge fixing. The full trajectory satisfies the scalar Noether charge constraints to 4.49×10^{-16}, but that fact does not identify the fixed slice with the complete physical reduced dynamics. Table 27 compares the two evolutions.

Table 27. Change in the impulse response when different directions are available. The fixed linear slice is a separate control.

Control time	Full 226 coordinates	Fixed 187-dimensional slice
1	0.00007181	0.00007178
2	0.00021472	0.00018675
4	0.00164167	−0.00004357
8	0.01452266	0.00278733

At time 4 even the sign differs. The calculation therefore establishes a route from a recorded outcome to later nonlinear field response without a hard phase constraint, but does not select its physical magnitude or sign. The source must supply the kinetic law, the preparation and collective lift, the available nonlinear directions and the apparatus's energy exchange on the same joint carrier. These are explicit objects in the remaining calculation. The repeated scalar slots do not constitute the faithful twelve-generator gauge model, and no value in Tables 26–27 is identified with an unequal D41 reduction or a measured force strength.

18.15 Record patterns and the restoring response

The aggregation construction obtains a restoring cost by preserving a record at its previously relaxed value [43, Proposition 5]. The corresponding operation can be executed on the existing current–record parent: its bond and composition terms already supply the cost. We construct the map from the field to a polar loop pattern and evaluate its compliance on the full scalar quotient [44]. The unit response $3/2 \to 2$ is the benchmark of Section 18.11. The additional result is its explicit pattern map, together with magnitude, background and unsigned-history controls. Identifying this pattern with the spatial density of committed events is a separate source obligation.

Let C be the six-by-twelve triangle-incidence matrix, E an orthonormal basis of its six edge cycles, and $\theta = Eq$ the retained link phase on one scalar slot. Write the record transports as $\Phi_e = \exp(s_e + iy_e)$. Once the conserved current has relaxed, the quadratic potential is

$$V(\theta, y) = 1/2\,[\theta^{\mathsf{T}} L\theta + y^{\mathsf{T}} S y + (\theta - y)^{\mathsf{T}}(\theta - y)], \qquad L = C^{\mathsf{T}} C. \quad (117)$$

The reduction retains all positive auxiliary directions of the 226-coordinate parent. At the unit common zero, $S = L$. An exact positive composition background has spoke transports $\Phi_{0i} = a_i$ and rim transports $\Phi_{i,i+1} = a_{i+1}/a_i$, with $a_i > 0$ and cyclic rim indexing. All phases and currents vanish, the endpoint fields are constant, and all six defects vanish. Holding the unit residual metric fixed gives

$$S = C^{\mathsf{T}} \mathrm{diag}\big(a_{i+1}^2\big) C, \qquad D = I + S, \qquad y_*(q) = D^{-1} E q. \quad (118)$$

The polar transports have gauge-invariant triangle holonomies $\exp\big(i(Cy)_f\big)$. On a local phase branch, their pattern is $r = Cy$. The relaxed pattern, its field derivative and its compliance are therefore explicit:

$$r_*(q) = CD^{-1}Eq, \quad J_{\mathrm{rec}} = CD^{-1}E, \quad S_{\mathrm{rec}} = CD^{-1}C^{\mathsf{T}}, \quad M = J_{\mathrm{rec}}^{\mathsf{T}} S_{\mathrm{rec}}^{-1} J_{\mathrm{rec}} = E^{\mathsf{T}} D^{-1} E. \quad (119)$$

Proposition 22 (restoring response of the polar record pattern). On the quadratic parent (117), preserve the relaxed pattern at a reference field q_L. With the same current and remaining auxiliary coordinates free, the difference between the constrained and relaxed energies is

$$V_{\mathrm{lock}}(q; q_L) - V_{\mathrm{free}}(q) = 1/2\,(q - q_L)^{\mathsf{T}} M (q - q_L). \quad (120)$$

Its value and first derivative vanish at q_L, while its Hessian is the positive matrix M on the six-dimensional cycle carrier.

Proof. Completing the square leaves $(y - D^{-1}Eq)^{\mathsf{T}} D (y - D^{-1}Eq)/2$ above the relaxed energy. Fixing y at $D^{-1}Eq_L$ gives (120). Fixing only its six loop phases gives the same result: D preserves the cycle and gradient subspaces, the optimal record lies in the cycle subspace, and the unconstrained gradient contributes zero. Applying Proposition 20 with record differential C gives the middle expression in (119). Since C is invertible between the cycle carrier and its image, that expression equals $E^{\mathsf{T}} D^{-1} E$.

This is the aggregation paper's pinning structure evaluated with the source bond and composition action. It establishes no identity between the two papers' record carriers. Adding (120) as a second potential to an action whose record is already constrained would count the same restoring effect twice. The formula and direct full-parent reduction agree to 2.90×10^{-16} relative error; an independent constrained solve agrees below 4.01×10^{-16} [44].

Magnitude and background controls. The transport intensity $m_e = |\Phi_e|^2 = \exp(2s_e)$ has differential $dm_e = 2|\Phi_e|^2 ds_e$ at these real backgrounds. It has no phase component. The complete Hessian separates the magnitude and gauge-phase variations, so preserving all 36 intensities leaves all eighteen retained cycle-field coefficients unchanged. This zero is local to the stated quadratic backgrounds and constant metric.

For uniform spoke modulus $a_i = t$, the response of each cycle with eigenvalue ℓ is

$$K_{\text{free}}(\ell, t) = \ell + 1 - \frac{1}{1+t^2\ell}, \qquad K_{\text{polar fixed}}(\ell, t) = \ell + 1, \qquad \Delta K = \frac{1}{1+t^2\ell}. \quad (121)$$

Table 28. Uniform-cycle response on exact zero-defect backgrounds with the unit residual metric held fixed. Fixing transport intensities gives the free value in every row.

Spoke modulus	Free response	Polar pattern fixed	Increase
0.5	1.200000	2.000000	0.800000
1.0	1.500000	2.000000	0.500000
2.0	1.800000	2.000000	0.200000

These are backgrounds of the declared parent, not certified physical alternatives. A compensating composition metric $\mathrm{diag}\left(a_{i+1}^{-2}\right)$ restores the unit-background result in every case. The test therefore preserves metric covariance and requires the physical background and metric to be supplied together. The nonuniform control $a = (0.7, 0.9, 1.1, 1.3, 1.0, 0.8)$ gives uniform-mode diagonal 1.46693752 and off-diagonal Frobenius norm 0.19729434. This mixes spatial modes. Attached identically to every generator, it still preserves the representation-trace ratio 6: 13/2: 21/2 and supplies no unequal sector screening.

An exact nonlinear restriction is available in the source phase action [39, Section 46S.5]. With record moduli and spoke phases fixed, its energy per rim edge and its extra curvature when the previously relaxed record is preserved are

$$\frac{\mathcal{E}}{6} = (1 - \cos y) + \big(1 - \cos(\theta - y)\big), \qquad y_*(\theta) = \frac{\theta}{2}, \qquad \Delta K(\theta_L) = 1/2 \cos\frac{\theta_L}{2} \quad (|\theta| < \pi). \quad (122)$$

The extra curvatures at $\theta_L = 0, \pi/6, \pi/3$ are 0.50000000, 0.48296291 and 0.43301270 per edge. This is a fixed-modulus, fixed-spoke restriction of the nonlinear source, not elimination of the complete nonlinear parent or a calculation of recording energy.

Unsigned event addresses. The scalar committed density is a sum of weighted events at spacetime locations [45]. It is not defined as transport intensity or polar phase; the source distinguishes that density

from internal edge ordering and phase information [39, Section 46S.4; 42, Section 9.1]. A direct control uses the archived D36 transition law and the first closed cover of all seven vertices. Starting from its stationary distribution, the mean duration is 21.277682950919 primitive opportunities. The resulting address statistics are shown in Table 29. They use the archived transition matrix, not the different stationary weights of the canonical wheel.

Table 29. Exact unsigned address statistics for the stopped native history. Opportunity counts are not counts of completed Facts.

Address statistic	Hub	Each rim vertex
Completed return-address probability	0.189423731	0.135096045
Mean incoming opportunity count	4.030498090	2.874530810

After all pointer and terminal outcomes are summed, the native instrument is trace preserving. Each address-path probability therefore remains the product of its prescribed transition probabilities. With that law, the stopping rule, weights and address-to-position map fixed, an unsigned density depending only on those addresses has zero field derivative. A link-dependent current witness changes individual mark probabilities by as much as 0.00355829 while their sum remains one, verifying that this marginal zero does not require the marked instrument itself to be constant [44].

A fixed marginal does not fix the joint response: field–record correlations, conditional energies, momentum translations and later backreaction can remain nonzero. Field-dependent transition rates, geometry, completion rules and joint propagation are outside this address control. For a general history density, both the weights and the spatial embedding can respond. On common support, differentiating the mean gives

$$\partial_a \overline{\rho}(x;q) = \sum_h P\,(h \mid q)[\partial_a \rho_h(x;q) + \rho_h(x;q)\ \partial_a \log P(h \mid q)]. \quad (123)$$

Even this mean derivative is insufficient for the energetic response: the joint fluctuations, action and measure derivatives must also be retained. The missing physical identification is the Fact-bearing record map on the joint source, including its spacetime embedding. If it preserves the polar pattern, (119)–(120) give its static transfer on the declared parent. A label or an unsigned count marginal does not establish that constraint. The completed calculation supplies this explicit map and its controls without selecting the full physical metric, temporal evolution or force coefficients.

18.16 Combined physical response and source matching

The complete physical response has not been evaluated. RCHS-35 supplies the six-defect parent architecture, metric cross blocks, explicit bath, shared-link fermions, temporal reductions and interaction work [8, XIII.3–XIII.17]. It also supplies a current-retaining isometry and a dimensionless unitary implementation [8, XIV.11–XIV.15]. The remaining identification is that the complete source action generates the joint evolution and recording operation on one physical carrier. A closed implementation must evaluate

$$\Delta\langle H_0 + H_{\mathrm{rest}} + H_{\mathrm{int}}\rangle = W_{\mathrm{external}}. \quad (124)$$

The remaining energies include independently responding current, record, completion and matter variables, with interaction energy counted once. At zero applied probe, they must together offset Table 16 if the same reduced field protocol survives. Assigning their sum as the negative of the field gain would enforce accounting without calculating their dynamics. Their restored evolution may also change the protocol and its gain. The number 0.169012 is therefore a matching target for this restriction, not an immutable complete-source prediction.

The executable constructions do not yet supply that common evolution. The quadratic field event keeps endpoint matter fixed and gives the current its link dependence without independent current propagation. The nonlinear 226-coordinate scalar model permits field, current, record and completion coordinates to respond, but adds a unit kinetic metric and does not propagate the full fermion carrier. The kinetic completion and energy-store implementations provide independently checked balances under their stated Hamiltonians and preparations. Neither is identified with the complete source action. Their energies and response corrections therefore cannot be combined by addition into a physical event result.

The governing source states the required matching explicitly [8, XIV.15]. Once the joint propagator moves the current, its evolution must be included before the current is traced out. The Born probabilities must then be evaluated on the resulting joint state at each recording opportunity, with the actual completion condition. Fixed-current history weights cannot simply be retained during a different coupled motion. HMGBC specifies a route through the operational transfer and the transported increments of the physical defects [5, 56A.1–56A.5]; its canonical wheel score metric is a benchmark, not a substitute for the full physical construction.

The combined response requires one calculation retaining the responding current, record, completion and matter, all admitted interaction terms, and the incoming correlations. It must calculate their energy changes and the event probabilities from that evolution, identify the permanently retained record, and differentiate the reduced response under the same field probe. Energy balance in (124) is a consistency check. It does not determine the field response: a conserved total can coexist with nonzero field stiffness and nonzero transfers between its parts. Comparison with force strengths additionally requires the stated gauge and spatial coarse-graining identification.

This assembly audit adds no numerical combined response or survival fraction. It does not show that the restoring effect vanishes, and it leaves the D41 history result and the conditional polar-pattern kernel intact. Those results provide inputs and checks for the physical construction. The joint evolution, its source-derived probabilities and the resulting retained gauge response remain unevaluated together. PCN supplies the unchanged primitive normalisation.

18.17 Interaction realisation of the current recording rule

The native current rule has an explicit interaction realisation [46]. The later field-dependent instrument supplies the link and current dependence used here [47, Sections 65–73]; the calculation is not an extension by the identity on the field carrier. Its maximal-positivity prescription remains a declared constitutive choice. This section derives the generator that realises the prescribed current stage and tests it on the archived carrier. It does not identify that generator with the complete master action.

On an archived edge at identity link, let $j = \psi_t - \psi_s$ and $p_j = jj^\dagger/(j^\dagger j)$. With the twelve faithful generators on the 50-dimensional internal carrier, define

$$K_a = i[T_a, p_j], \qquad \mathcal{K}_J = \mathrm{stack}(K_1, \dots, K_{12}), \qquad S_J = \mathcal{K}_J^\dagger \mathcal{K}_J. \quad (125)$$

The amplitude stack $\mathcal{K}_J$ is distinct from the gauge-to-cycle-current Jacobian. The inherited thirteen-channel operation is

$$C_0 = (I - \eta S_J)^{1/2}, \qquad C_a = \sqrt{\eta} K_a, \qquad \eta = \lambda_{\max}(S_J)^{-1}. \quad (126)$$

Complete positivity and completeness also hold at smaller nonnegative η; saturation does not follow from these properties alone [47, Section 66]. The run inherits the archived endpoint preparation and the saturation prescription. A current direction is required: the normalised ray is not defined at $j = 0$.

Proposition 23 (principal interaction realisation). On the positive spectral support of S_J, put

$$B_J = \mathcal{K}_J S_J^{-1/2} \arcsin\sqrt{\eta S_J}. \quad (127)$$

The product has its continuous extension on the null space. The dimensionless Hermitian generator on the ready and twelve-output carrier is

$$G_{\mathrm{rec}} = \begin{pmatrix} 0 & -iB_J^{\dagger} \\ iB_J & 0 \end{pmatrix}. \quad (128)$$

Its unit-parameter evolution gives the exact current isometry:

$$e^{-iG_{\mathrm{rec}}} \begin{pmatrix} \psi \\ 0 \end{pmatrix} = \begin{pmatrix} C_0\psi \\ \sqrt{\eta}\,\mathcal{K}_J\psi \end{pmatrix}. \quad (129)$$

Proof. Let $\mathcal{K}_J = W\mathrm{diag}(\sigma_i)V^{\dagger}$. Equation (127) has the same singular vectors and singular values $\vartheta_i = \arcsin\left(\sqrt{\eta}\,\sigma_i\right)$. The exponential in (129) rotates each ready–output pair by ϑ_i. Its ready amplitude is $\cos\vartheta_i = \sqrt{1-\eta\sigma_i^2}$ and its output amplitude is $\sin\vartheta_i = \sqrt{\eta}\,\sigma_i$. Null directions stay ready. ■

This is the principal off-diagonal realisation, with angles in $[0, \pi/2]$ and no diagonal or output-to-output interaction. Other logarithms, pulse schedules, environment bases and complementary dynamics can realise the same operation. A physical duration or energy scale is not selected by (129). In particular, the construction is an inverse realisation of an inherited rule, not a forward derivation of that rule from the full source.

Replacing B_J by one scalar multiple $t\mathcal{K}_J$ instead gives output amplitudes $\mathcal{K}_J S_J^{-1/2}\sin\left(t\sqrt{S_J}\right)$. Equality with (129) would require

$$\frac{\sin(t\sqrt{\lambda})}{\sqrt{\lambda}} = \sqrt{\eta} \quad \text{for every positive eigenvalue } \lambda \text{ of } S_J. \quad (130)$$

For $t > 0$ on the principal interval $t\sqrt{\lambda} \le \pi/2$, the left-hand side is strictly decreasing in λ. A multi-eigenvalue support therefore cannot satisfy (130) with one bare multiplier. This is a restriction on that implementation class, not on the complete source with its other interactions. The spectral factor $\arcsin x/x$ ranges from 1 to $\pi/2$; it is an interaction-angle correction, not a force-screening fraction.

All twelve archived edges have thirteen positive eigenvalues of S_J. On the 650-dimensional current-pointer carrier, direct exponentiation reproduces (129) to a Frobenius discrepancy below 1.26×10^{-14} on every edge. The 125 checks include completeness, covariance and terminal Born probabilities after the inherited projector readout. The bare control at $t = \pi/\left(2\sqrt{\lambda_{\max}}\right)$ saturates the largest direction but has relative isometry error between 0.07704 and 0.07799, normalised by $\sqrt{50}$. This is neither an optimised fit nor a physical force discrepancy. For the inherited rank-49 neutral-complement prior, edge 0–1 gives accepted-current probability 0.040730 under the native rule and 0.066285 under this bare control. These are not the endpoint-prepared hazards quoted in [47].

The endpoint background is frozen and the links are the identity in this execution. The terminal projector readout is supplied after the current stage; its physical generation and permanent retention are not generated by G_{rec}. Conservation of this constructed generator does not evaluate the physical energies of field, current, record, completion and matter. The result supplies a precise operation to match if the native rule survives complete coarse graining.

18.18 Directed history and common source matching

The source already distinguishes directed history transport from a symmetric relaxation generator [47, Section 47]. Reconstructing its frozen row-stochastic kernel K_{hist} gives stationary weights 0.189423730906 at the hub and 0.135096044849 at each rim vertex. With $\Pi = \mathrm{diag}(\pi)$, its inherited weighted polar decomposition is

$$A_\pi = \Pi^{1/2} K_{\mathrm{hist}} \Pi^{-1/2} = U_{\mathrm{hist}} P_{\mathrm{hist}}, \qquad H_{\mathrm{orientation}} = i \log U_{\mathrm{hist}}. \quad (131)$$

The reconstruction residual is 1.24×10^{-15} and the exponential of the Hermitian orientation generator agrees with U_{hist} to 7.87×10^{-15}. This reproduces an inherited result; the seven-state logarithm is not the complete physical Hamiltonian. The stationary-flow antisymmetry has Frobenius norm 0.208648721690. The twelve oriented minimal cycles give forward/reverse odds 14618.031753:1 in the preferred orientation. Symmetrising stationary flow preserves the stationary distribution but changes those odds to 1:1.

The distinction also follows without numerical approximation. The Perron–Doob normalisation of a real symmetric cone-positive transfer is reversible, and any deterministic stationary record pushforward preserves symmetric two-time flow. Such a pushforward cannot directly return the frozen directed kernel under the same identification. This does not exclude directed conditioning, nonstationary preparation, time-reversal-odd variables or a full refinement carrying the polar orientation. HMGBC's positive operational transfer and the native directed kernel cannot simply be equated; the source already prescribes retaining the relevant orientation information [5, Section 56A.2; 46, Section 47].

HMGBC constructs the core, unresolved and mixed response blocks by compressing one full-carrier generator [5, Sections 56A.1–5]. That prescription retains all six defects, their magnitudes, the physical quotient and the CAR/Fock matter carrier. Its Euclidean generator requires the source's continuation and physical admission before it is interpreted as real-time energy evolution [8, XIII.7]. In a finite-regulator expansion, its symmetric heat transfer gives $H_E = L_{\mathrm{op}} + V_{\mathrm{ref}} + O(a^2)$. If ready and outcome projectors are configuration-label projectors and V_{ref} is multiplication, the leading cross block between distinct labels comes from L_{op}. This conditional statement identifies where a transition must be read from the source; it does not construct the full operator.

Once an admitted joint propagator $U_{\mathrm{src}}(\tau)$ and a ready record preparation $|0\rangle$ are specified, its outcome blocks determine the recording operation and its probabilities together:

$$M_{r\beta}(\tau) = \langle r, \beta | U_{\mathrm{src}}(\tau) | 0 \rangle, \qquad \mathcal{J}_r(\rho) = \sum_\beta M_{r\beta}\, \rho M_{r\beta}^\dagger. \quad (132)$$

The outcome probability is $\mathrm{Tr}\mathcal{J}_r(\rho)$. Here the untraced carrier includes the responding field, current, completion and matter. For correlated incoming record and source states, the full joint state and outcome projectors must be used instead of assuming a preparation-independent channel on a smaller carrier. The actual source completion condition must also be retained. Equation (132) is not permission to replace a coarse-grained event by a fixed externally chosen pulse.

Matching the native operation requires equality of these full propagator blocks, up to an unresolved-environment isometry preserving the physical outcome labels. Equality of one instantaneous cross block is insufficient at finite duration when the source variables also move. The record continuation must separately preserve the identified record observables, as in Section 18.10, or return their leakage. Proposition 23 makes the current-stage target explicit; it supplies neither the other Hamiltonian blocks nor an autonomous permanent-record mechanism. No joint physical event, survival fraction or measured force coefficient follows from this matching formulation alone.

Part III Fermion carriers and the physical source calculation

19 The physical source calculation

The later source fixes the exact endpoint Fold weighting and supplies the positive edge realisation evaluated in Section 4. It also derives a nonlinear current-squared response into record stretch, with coefficient $2/(2809\sqrt{3}) = 0.000411071747376$ on the unit EPMD/CFB1 branch [2, Section 16; 15]. That coefficient is an inherited source result, not a freely chosen interaction. Its record-stretch carrier differs from the history-eligibility carrier. The existing source therefore cannot be completed by relabelling it as the missing gauge coefficient.

The complete source response must contain the current-conservation coupling, all allowed cross blocks, the record and completion dependencies, the measure and the gauge derivatives before taking the common-zero background. Physical Applicability [16, Sections 40–42] gives the current-conservation reduction and shows why a static zero does not imply a zero higher derivative. It also distinguishes the canonical wheel metric entries from the authoritative physical path-law metric. These results prevent the scalar current-square cancellation, the endpoint Hodge zero or Table 1 from being used as a no-go theorem for the complete coarse-grained response.

PCN fixes the common primitive unit and its specified gauge image [3, Sections 17.106–17.108]. The remaining object is the representation-resolved response on that fixed carrier. Earlier work-normalisation proposals do not reopen a free overall multiplier after PCN. The primitive semidirect law must specify the joint link/current/record increments and their background dependence, or the source must prove that the retained physical response is independent of any unreturned part. The endpoint covariance identity alone is not such a result: it fixes the covariance required by a supplied energetic branch and gives no derivatives of that branch under the complete physical gauge perturbation.

The coupled harmonic history in RCHS-35 [8, Section IV.17] retains 36 evolving and 151 algebraic coordinates, including the continuity derivative. Its metric is a candidate, and its direct operational kinetic sector is omitted by construction. That calculation therefore cannot be substituted for the complete physical fluctuation law without the stated source attachment. Section 11 supplies an explicit current insertion and covariance for two stated finite parents; Section 12 evaluates the published coupled factor-blind weighting, including its conditional mean. It also shows why a projection into the old score coordinates is insufficient: a residual remains and old/current correlations are nonzero. A full physical readout must retain those contributions and obtain its covariance from the same physical branch, including nonlinear terms and history dependence where required. Alternatively, the complete gauge response can be differentiated directly without passing through the finite score coordinates.

19.1 The single hypercharge source calculation

Restricting the external probe to hypercharge reduces the number of requested gauge derivatives, but does not remove the other responding variables. Choose a non-gradient cycle perturbation on the seven-point cell and insert its link phases in the inherited hypercharge representation. All current, record, completion, matter and unresolved field variables required by the physical source remain in the joint law. The conventional generator Y and primitive generator $q = 6Y$ are related by the fixed conversion of Section 17.1; this is not an adjustable source weight.

HMGBC specifies the raw master transfer on the complete finite-regulator carrier as the symmetric operational heat transfer [5, Sections 56A.1–5]. With a hypercharge probe parameter θ, its required family is

$$\widehat{\mathbb{T}}_n(\theta) = M_{\exp[-a_t V_n^{\mathrm{ref}}(\theta)/2]} \exp\left[-a_t L_n^{\mathrm{op}}(\theta)\right] M_{\exp[-a_t V_n^{\mathrm{ref}}(\theta)/2]}. \quad (133)$$

Here M denotes multiplication on the common operational measure. Equation (133) is the inherited construction applied to the probe, not a newly evaluated physical operator. Its generator acts on the resolved MASD configuration, the fermionic state space and unresolved records. The source requires the relevant positivity conditions and physical quotient. It explicitly distinguishes this operator from the seven-state wheel kernel and distinguishes the physical defect increments from a wheel/internal tensor-product benchmark [5, Sections 56A.2–5].

The finite-cell calculation would differentiate the reduced raw action in this fixed curvature direction, retaining the joint measure, eliminated determinants and actual recording condition. Equation (18) separates direct curvature from the connected fluctuation contribution, and (28) retains the off-zero derivatives of the complete residual metric. These terms must be evaluated with one common physical weighting. The stationary Schur expression (29) is sufficient only on its stated quadratic branch. Normalising event probabilities first, or holding the other source variables fixed, does not supply the same response. A source-derived effective action can perform this task without reconstructing every real-time trajectory, provided its reduction and recording condition are established.

The inspected source specifications and executable archives supply the wheel law, the conditional parent models and the reduction procedures, but do not supply an evaluated full-carrier family (133), or an equivalent complete physical response, for this probe. In particular, the required joint transition rule and its field derivatives cannot be recovered by assigning the wheel probabilities to the three scalar slots of the archived parent. The audit does not establish that no further VERSF premise can select the rule; it identifies the unevaluated source input in this execution [2, Sections 3–8 and 16; 5, Sections 56A.3–5 and 56A.11; 6].

Consequently no numerical physical hypercharge coefficient is returned. This is a source-specification audit, not a zero-response theorem, a new simulation or an exclusion of the collective D41 response. PCN's primitive unit remains fixed. The inherited value $21/2$ is the unscreened benchmark; multiplying it by the D41 history fraction would still require the physical transfer calculation. Neither that multiplication nor a fitted conversion is performed. Even a completed finite-cell curvature would require the appropriate spatial coarse-graining and matching before it could be compared with a measured coupling.

19.2 Composition and the fermionic gauge response

The chiral-fermion construction derives a temporal precision from exact composition and specifies its placement in the fermion seed [12, Sections 8.4–8.5]. Its static extension has been tested on free and non-Abelian backgrounds, but that execution did not insert the coefficient's new link vertices into the gauge-response fit. The running calculation retains the unit temporal coefficient [11, Appendix A]. We evaluate the missing magnetic response here, retaining the derivatives of the composition coefficient and the full fermion determinant [48]. This returns a finite contribution from an already specified source construction without introducing a new fluctuation weight.

Let S be the spatial Wilson seed, $K = \gamma_4 S$, and $\phi(z) = \sqrt{z}/\sinh\sqrt{z}$, with $\phi(0) = 1$. The symmetric static extension specified in [12] is

$$C = \tfrac{1}{2}\left[\phi\left(S^\dagger S\right) + \phi\left(SS^\dagger\right)\right]. \quad (134)$$

For static spatial links and identity temporal links, in dimensionless step units, the seed and overlap completion are

$$X = \gamma_4 \sinh K - I + C(1 - \cos\theta) + i\gamma_4 \sin\theta, \quad (135)$$

$$D = I + \gamma_5 \operatorname{sign}(\gamma_5 X). \quad (136)$$

The reference has $C = I$. On the free branch, the composition coefficient is $C = (E/\sinh E)I$, where $E^2 = W^2 + \sum_i \sin^2 q_i$ and $W = \sum_i (1 - \cos q_i)$. The placement in the Grassmann seed and the symmetric static lift are the inherited specified construction; neither is proved uniquely selected here. The ordered electric continuation is evaluated in Section 19.3; general time-dependent source backgrounds retain their own ordering obligation. The calculation concerns the parity-even magnitude of the massless fermion determinant on this branch, not the complete joint weighting in Section 19.1.

The parity-even determinant magnitude used here is sufficient to define the stated response experiment. It does not by itself fix the phase of a chiral fermion measure or establish its gauge-consistent integrability. Those requirements belong to the full quantum theory and must be supplied independently when this contribution is embedded in that theory [54].

The probe is $U_1(x) = \exp[it\cos(kx_3)]$, with $k = 2\pi n/L$, on a periodic spatial torus and antiperiodic temporal boundary conditions. We differentiate both matrix functions in (134), including their second derivatives, as well as $\sinh K$ and the overlap sign function. At the free background, $S^\dagger S = SS^\dagger = E^2 I$ at each momentum, so spectral divided differences give the vertices coupling momenta separated by k. Direct curvature and the two-vertex term both enter

$$H(k) = \frac{1}{2}\mathrm{ReTr}[D^{-1}D'' - D^{-1}D'D^{-1}D']. \quad (137)$$

Here H differentiates $\frac{1}{2}\log|\det D|$, and primes denote probe derivatives at $t = 0$. The effective fermion action has the opposite sign. To retain the convention of [12, Section 6.3], define $P = -24\pi^2 H/(Vk^2)$, with $V = L^3 N_t$. Its unit-charge Dirac logarithmic slope is compared with one. For the Weyl magnetic action convention $\Delta\Gamma_W = (\Delta C_M/2)\int \sum_{i<j} F_{ij}^2$, the conversion is instead

$$\Delta C_M(k) = -\frac{2\Delta H}{Vk^2} = \frac{\Delta P(k)}{12\pi^2}. \quad (138)$$

The factor of two distinguishes the Weyl census coefficient from the Dirac-normalised plotted response. The difference is composition rule minus unit temporal rule in the same regulator convention. It is not a PCN conversion or a fitted common multiplier.

Table 30. Full determinant response on $128^3 \times 256$ *sites.*

Momentum mode	Unit rule P	Composition rule P	Difference ΔP
1	1.742555936	1.520898198	−0.221657739
2	1.320939537	1.099449688	−0.221489849
4	0.658186806	0.437370677	−0.220816129
8	0.018129183	−0.199961548	−0.218090731

At modes 2, 4 and 8, the fit $P(k) = c + s\ln(1/k) + dk^2$ gives $s = 0.967064119$ for the reference and $s = 0.967078795$ for the composition rule, a change of 1.47×10^{-5}. The corresponding d values are 0.261631 and 0.285283. Thus the specified temporal correction leaves the fitted running nearly unchanged. Three parameters and three momenta leave no residual degrees of freedom, and this comparison does not prove either fitted value to be the continuum coefficient.

The finite difference has substantially less volume dependence than either response. At fixed $k = \pi/32, \pi/16, \pi/8$, doubling the lattice from $64^3 \times 128$ to $128^3 \times 256$ changes the reference P by 0.269523, 0.017046 and 0.001244. The corresponding changes in ΔP are -9.58×10^{-13}, -2.18×10^{-11} and -1.03×10^{-10}. These are matched-volume numerical results, not bounds on all finite-volume effects.

Table 31. Low-momentum extrapolation of the difference on $128^3 \times 256$ *sites.*

Modes	Fit in k	Intercept $\Delta P(0)$	Maximum residual
1, 2	Constant plus k^2	−0.2217137017	5.55×10^{-17}
1, 2, 4	Constant plus k^2 and k^4	−0.2217136536	1.67×10^{-16}
1, 2, 4, 8	Constant plus k^2 and k^4	−0.2217136990	2.96×10^{-8}
2, 4, 8	Constant plus k^2 and k^4	−0.2217137443	1.11×10^{-16}

Using the three lowest momenta with the quartic term gives $\Delta C_M \simeq -0.00187202415$. The four-point fit tests that ansatz with a nonzero residual. The fit variation is an extrapolation diagnostic, not a statistical uncertainty or a rigorous error bound on the limiting coefficient. The finite estimate $\Delta C_M \simeq -0.001872$ is supported by the displayed momentum and volume controls.

The common-operator factorisation of [12, Proposition 7; 16, Section 35] applies to both operators and their difference. On the inherited three-generation massless Weyl census, the colour, weak and conventional-hypercharge indices are (6,6,10), so

$$\Delta(A_3, A_2, A_Y) = \Delta C_M(6,6,10), \qquad A_F = g_F^{-2}. \quad (139)$$

With the contrast rows $j = (-2, -3, 3)$ and $t = (466, -687, 159)$, their contractions with the matter indices are zero and 264 exactly. Hence

$$\Delta J = 0, \qquad \Delta T = 264 \Delta C_M \simeq -0.494214. \quad (140)$$

Table 32. Magnetic matching increments relative to the unit temporal rule.

Gauge quantity	Calculated increment
A_3	−0.011232145
A_2	−0.011232145
A_Y	−0.018720242
J	Zero under the common-operator premises
T	−0.494214

These increments are not the full physical J and T. They belong to the magnetic part of the specified massless fermion candidate; the Higgs determinant and the remaining source terms are separate. The result does not reproduce the D41 participation fractions or determine measured couplings. It supplies a finite gauge contribution that was absent from the unit-temporal calculation. It is to be counted once when that reference candidate is replaced by (134), not added again after the complete new determinant has already been included.

All 28 recorded validation checks pass [48]. Independent dense-chain finite differences agree with the analytic response within 9.9×10^{-9} in P on $4^3 \times 8$ and 2.2×10^{-7} on $8^3 \times 16$. The checks also cover the first and second coefficient derivatives, high-precision scalar divided differences, finite gauge covariance, the archived baseline and full versus reflection-reduced momentum sums. These validate the finite calculation rather than its physical selection. Every fermion mode is retained. Exact blocking with $\det D = \det F \det D^c$ preserves this total response when both factors and their derivatives are kept; no new numerical seven-site split is claimed. The completed step here is the composition-dependent magnetic

contribution. Section 19.3 supplies its ordered electric counterpart; the complete physical source response and common electric–magnetic matching remain to be evaluated.

19.3 Ordered electric response and the coupled derivatives

The electric counterpart must retain the ordering of the sequential defect before differentiating its temporal links. Sections 8.1 and 8.4 of the chiral paper [12] supply that defect and its exact-composition precision. Continuing the subtracted half-defect with the same gamma-five projection gives an explicit electric calculation [49]. The continuation agrees with Section 19.2 on commuting backgrounds, but includes a transported-precision term that contributes to the electric response. Its positive total increment relative to the local unit temporal rule contains two opposing terms: restoring the full ordering raises the coefficient, and changing the precision partly offsets that increase.

Ordered continuation. Write T_4 for the temporal transport operator, to distinguish it from the gauge contrast T in (140). At dimensionless step one, with Hermitian $K = \gamma_4 S$ and unit innovation density, define

$$A_0 = e^{-K}, \qquad W = e^{K}\frac{K}{\sinh K}, \qquad M(T_4) = (T_4 - A_0)^{\dagger} W (T_4 - A_0). \quad (141)$$

Matrix functions use their continuous values at zero. For $\mathcal{E}_5(Z) = (Z + \gamma_5 Z \gamma_5)/2$, put $C = \mathcal{E}_5(K/\sinh K)$ and $W_+ = \mathcal{E}_5(W)$. Since $W A_0 = A_0 W = K/\sinh K$ and temporal transport commutes with γ_5, the continued temporal term is exactly

$$\begin{aligned} Q(T_4) &= \mathcal{E}_5\left(\tfrac{M(T_4) - M(I)}{2}\right), \\ Q(T_4) &= 1/2\left[T_4^{\dagger} W_+ T_4 - W_+ + 2C - T_4^{\dagger} C - C T_4\right]. \end{aligned} \quad (142)$$

For $T_4 = e^{i\theta} I$, the first difference vanishes and $Q = C(1 - \cos\theta)$, with precisely the coefficient (134). For a spatially varying temporal link, neither $[T_4, W_+]$ nor $[T_4, C]$ need vanish. The candidate and its local-unit reference are

$$\begin{aligned} X &= \gamma_4 \sinh K - I + Q(T_4) + 1/2\,\gamma_4\left(T_4 - T_4^{\dagger}\right), \\ D &= I + \gamma_5 \operatorname{sign}(\gamma_5 X), \qquad Q_{\text{unit}} = I - 1/2\left(T_4 + T_4^{\dagger}\right). \end{aligned} \quad (143)$$

The projection makes Q Hermitian and gamma-five even, retaining the seed's gamma-five Hermiticity. The half-defect placement, subtraction, symmetrisation and overlap completion are specified premises. Exact Gaussian composition fixes W conditional on the unit innovation density; it does not by itself select the complete physical fermion action. Equation (142) resolves the ordering within this continuation, not all possible time-dependent source dynamics.

Electric vertices. Take identity spatial links and $T_4 = e^{i\theta}\exp[i\alpha\cos(k x_3)]$, with $k = 2\pi n/L$ and antiperiodic fermion frequencies $\theta = 2\pi(j + 1/2)/N_t$. The scalar α is the probe amplitude. At the free background,

$$\begin{aligned} E^2(p) &= W_s^2 + \textstyle\sum_i \sin^2 p_i, \qquad W_s = \textstyle\sum_i (1 - \cos p_i), \\ C(p) &= \frac{E}{\sinh E}, \qquad W_+(p) = E\coth E\, I + i\gamma_4 \textstyle\sum_i \gamma_i \sin p_i. \end{aligned} \quad (144)$$

Here $C(p)$ denotes the scalar coefficient. Primes denote α derivatives at zero. For $r = p \pm k e_3$, the first vertex and diagonal second vertex are

$$\begin{aligned} Q'_{pr} &= 1/4\,\sin\theta\left(C_p + C_r\right) I \\ &\quad + i/4\left[W_{+p} - W_{+r} + \cos\theta\left(C_r - C_p\right) I\right], \\ Q''_{pp} &= 1/2\,\cos\theta\, C_p I + 1/4 \textstyle\sum_{r = p \pm k e_3} \left(W_{+r} - W_{+p}\right). \end{aligned} \quad (145)$$

The other temporal term in (143) contributes $i\gamma_4 \cos\theta/2$ to the first vertex and $-i\gamma_4 \sin\theta/2$ to the diagonal second vertex. Spectral divided differences differentiate the overlap sign. Both terms of the determinant Hessian (137) are retained. With the same $P = -24\pi^2 H/(L^3 N_t k^2)$ convention, the electric Weyl increment satisfies

$$\Delta\Gamma_W = \frac{\Delta C_E}{2} \int \sum_i F_{4i}'^2, \qquad \Delta C_E(k) = \frac{\Delta P(k)}{12\pi^2}. \quad (146)$$

The comparison is ordered composition minus local unit rule at the same regulator and probe. It does not alter PCN and is not the candidate-minus-Wilson comparison of [16].

Table 33. Electric determinant response on $128^3 \times 256$ *sites.*

Electric mode	Unit rule P	Ordered rule P	Difference ΔP
1	2.556549287	2.872468074	0.315918787
2	1.530321397	1.843073826	0.312752429
4	0.823014150	1.123246932	0.300232781
8	0.177126031	0.429528020	0.252401989

At modes 2, 4 and 8, the fit $P = c + s\ln(1/k) + dk^2$ gives $s = 1.049965$ for the unit rule and $s = 1.051046$ for the ordered rule, with $d = 0.708046$ and 0.300975. Three parameters on three points leave no residual degrees of freedom. These finite-volume fits are not a determination of the continuum logarithmic coefficient.

Table 34. Electric low-momentum extrapolations on $128^3 \times 256$ *sites.*

Electric fit modes	Fit in k	Intercept $\Delta P(0)$	Maximum residual
1, 2	Constant plus k^2	0.3169742393	Zero to displayed precision
1, 2, 4	Constant plus k^2 and k^4	0.3169774790	5.55×10^{-17}
1, 2, 4, 8	Constant plus k^2 and k^4	0.3169765376	6.14×10^{-7}
2, 4, 8	Constant plus k^2 and k^4	0.3169755963	1.67×10^{-16}

The three-lowest-momentum quartic extrapolation gives $\Delta C_E \simeq +0.002676378$ per Weyl index. The corresponding $64^3 \times 128$ estimate is $+0.002676346$. At fixed $k = \pi/32, \pi/16, \pi/8$, doubling both extents changes ΔP by 1.84×10^{-6}, 1.82×10^{-6} and 1.72×10^{-6}, whereas the reference P changes by -0.336697, -0.025848 and -0.001441. These are matched-volume and extrapolation diagnostics, not statistical errors or rigorous bounds on the limit.

Ordering and precision separately. The full trial defect of [12, Section 8.1] uses $W_{\mathrm{trial}} = e^K$. It reduces to the local unit term only when temporal transport commutes with K. Differentiating its full ordered form gives the intermediate comparison in Table 35. In that control, $C = I$ and $W_+ = \cosh E\, I + (\sinh E/E) i\gamma_4 \sum_i \gamma_i \sin p_i$.

Table 35. Decomposition of the electric increment at $64^3 \times 128$, using modes 1, 2 and 4 with the quartic extrapolation. All rows use the same Weyl normalisation.

Electric comparison	Increment per Weyl index
Ordered trial minus local unit rule	+0.004887099
Ordered composition minus ordered trial	−0.002210752
Ordered composition minus local unit rule	+0.002676346

The rows form a telescoping difference in one regulator convention. Thus the positive combined increment must not be attributed entirely to changing the precision. At fixed ordering that change is negative. At $k = \pi/32$, the precision-only difference changes by approximately 1.02×10^{-12} in P when both extents are doubled. The trial precision is not exactly compositional and is used only as a control. The shortcut $Q = \{C, Q_{\mathrm{unit}}\}/2$, which agrees on the commuting background, instead gives approximately $+0.000425174$ per Weyl index on the same 64-site extrapolation. Its different answer confirms that the electric calculation tests information absent from the commuting magnetic probe; it does not establish a family of admitted physical alternatives.

The common massless Weyl census gives

$$\begin{gathered} \Delta(A_3, A_2, A_Y) = \Delta C_E(6{,}6{,}10) \\ \simeq (0.016058267,\ 0.016058267,\ 0.026763778), \\ \Delta J = 0, \qquad \Delta T = 264\Delta C_E \simeq +0.706564. \end{gathered} \tag{147}$$

These are relative electric increments, whereas (140) is a relative magnetic increment. Their opposite signs do not determine the full electric or magnetic stiffness, and they must not be averaged into a physical coupling. The reference, the remaining source contributions and common space-time matching must be assembled consistently. Each determinant is counted once, including its eliminated-mode factor under exact blocking.

Derivatives for the responding source. The accompanying matrix Taylor calculation retains dependence on K, T_4 and the innovation covariance density $\mathcal{C}_{\mathrm{in}}$. It differentiates the covariance integral, inverse precision, ordered defect, overlap sign and fermion action together:

$$Q_{\mathrm{cov}} = \int_0^1 e^{-sK}\, \mathcal{C}_{\mathrm{in}} e^{-sK^\dagger}\, ds, \qquad W = Q_{\mathrm{cov}}^{-1}, \qquad \Gamma_1 = -1/2 \log|\det D|. \tag{148}$$

The stored two-parameter arrays include D_α, $D_{\alpha\alpha}$, D_η, $D_{\alpha\eta}$, $D_{\eta\eta}$, $D_{\alpha\alpha\eta}$, $D_{\alpha\eta\eta}$ and $D_{\alpha\alpha\eta\eta}$, their action derivatives, and corresponding reference and difference arrays. Taylor coefficients are converted to derivatives with their multi-index factorials. The method accepts additional directions or their polarised contractions.

For verification, a spatially varying Hermitian scalar is inserted into S on a three-site chain. Its action derivatives $\Gamma_{1,\alpha\eta} = 0.5242196917$, $\Gamma_{1,\alpha\alpha\eta} = 0.1099950594$ and $\Gamma_{1,\alpha\alpha\eta\eta} = 0.4734962238$ agree with independent dense differences within 5.50×10^{-8}, 5.60×10^{-8} and 1.32×10^{-7}. This insertion is a differentiation test, not a selected current, record or completion mode. A separate test varies the actual spatial link $U_1(x_3)$ alongside the electric probe, including both link derivatives. Its eight independent checks pass for the new and reference operators. This supplies a shared-link test without assigning physical co-motion or fluctuation sizes.

For a stationary reduction, let $\eta_0(a)$ be the source-selected auxiliary response to gauge coordinates a, and let S_0 be the leading source action on its physical quotient. At first order in the fermion correction, [16, Section 38, Proposition 49] gives

$$V_a = \big(e_a, \eta_{0,a}\big), \qquad \eta_{0,a} = -S_{0,\eta\eta}^{-1} S_{0,\eta a}, \quad (149)$$

$$\delta K_{ab} = V_a^T \Gamma_1'' V_b + \Gamma_{1,\eta} \cdot \eta_{0,ab}. \quad (150)$$

Here e_a is a gauge-coordinate basis vector, not an event increment. The derivatives in (148) provide the fermion side of (150) once the actual source maps are inserted. The full auxiliary Hessian, its mixed and third derivatives, the recording condition and joint weighting must come from the same source. The stored diagnostic arrays do not substitute for those inputs. For a nonstationary event, the corresponding history reduction must be differentiated under its own probabilities rather than assumed to equal (150).

All 25 primary checks in [49] pass, separately from the eight shared-link checks. Independent dense position-space evaluation of the unexpanded defect agrees with the analytic electric response within 5.2×10^{-9} in P on $4^3 \times 8$ and 9.3×10^{-8} on $8^3 \times 16$. The checks cover gamma-five Hermiticity, the chiral identity, finite gauge covariance, pure-gauge invariance, the commuting limit, full versus reduced momentum sums and mixed derivatives through fourth total order. They validate the specified continuation and retained derivatives. The numerical advance is an evaluated electric fermion contribution and its coupling derivatives, ready for insertion into the complete source reduction; no measured force strength has selected an input.

19.4 Coupled fluctuations and fermion feedback

The derivatives of Section 19.3 can be contracted with an explicit joint fluctuation law. The calculation [50] uses the inherited electric probe and spatial hypercharge fluctuations on the same fermion links. Its bosonic input is the scalar current–record block continued to cubic transverse modes, with constant unit defect weights and the conventional hypercharge trace $Z_Y = 21/2$. Eliminating the current and record gives mode stiffness $k(\lambda) = \lambda + \lambda/(1+\lambda)$. A real mode of squared norm N_p therefore has variance $v_p = \big[Z_Y N_p k(\lambda_p)\big]^{-1}$. This cubic continuation and weighting are specified model inputs; fixing a record in a control is not an identification of Fact-Lock.

All fourteen nonconstant real modes depending on one spatial coordinate, in both transverse polarisations, are included on the $8^3 \times 16$ box. The constant holonomy is fixed at zero. Electric derivatives are analytic; the two internal-link derivatives use refined symmetric differences. At leading order in the internal variances, the inherited Weyl census gives

$$\Delta(A_3, A_2, A_Y) = b_{\mathrm{E}}(11/12, 1/2, 95/18), \quad \Delta J = 25/2\, b_{\mathrm{E}}, \quad \Delta T = 5537/6\, b_{\mathrm{E}}. \quad (151)$$

Here $b_{\mathrm{E}} = \sum_p v_p\ \Gamma_{1,\alpha\alpha\eta_p\eta_p}/(Vk^2)$, with the probe normalisation of Section 19.3. This is a particular fluctuation contribution, not the complete two-loop coefficient. Its sector direction is rank one at this order; it need not remain so when higher charge powers enter.

The determinant also changes the probability of the internal fluctuations. For a base measure μ_B independent of the external probe, the normalised weighting and its free-energy Hessian are

$$d\mu_F = \frac{e^{-\Gamma_F} d\mu_B}{\int e^{-\Gamma_F} d\mu_B}, \qquad \mathcal{F} = -\log \int e^{-\Gamma_F} d\mu_B, \qquad \mathcal{F}_{,ab} = \langle \Gamma_{F,ab} \rangle_F - \mathrm{Cov}_F\big(\Gamma_{F,a}, \Gamma_{F,b}\big). \quad (152)$$

The complete 45-state Weyl magnitude is included once. Its internal hypercharge trace is 10. Keeping its quadratic internal-link curvature Π_p resums the variance to

$$v_{F,p} = \left(v_{B,p}^{-1} + 10\Pi_p\right)^{-1}. \quad (153)$$

The tested total precisions remain positive. Internal variances rise by 0.60–0.71 per cent. The resulting change in the small electric correction is shown in Table 36; the percentage is not a percentage change in a force strength. If the physical base measure also depends on the probe, its derivatives must be included in (152).

Table 36. Electric fluctuation contraction on the same fourteen-mode slice. The reference is the local unit temporal rule; the ordered column uses Section 19.3's composition rule.

Fluctuation weighting	**Ordered b_{E}**	**Reference b_{E}**
Gaussian current and record	$3.27265045 \times 10^{-6}$	$3.03738293 \times 10^{-6}$
Including quadratic fermion feedback	$3.29258340 \times 10^{-6}$	$3.05256679 \times 10^{-6}$
Relative increase of this correction	0.6091%	0.4999%

With feedback, the ordered result is $\Delta J = 4.11573 \times 10^{-5}$ and $\Delta T = 0.00303851$. This resummation retains the original four-point response and is not a complete higher-loop calculation. A separate $4^3 \times 8$ test integrates the unexpanded census determinant over one sine/cosine pair in one polarisation [51]. Five- and seven-node product quadratures agree in the sector increments within 1.9×10^{-14} and in the covariance within 3.8×10^{-13}. Feedback raises that pair's correction by about 0.989 per cent. Its exact sector direction differs slightly from (151), as higher-order charge traces allow. The normalised probability's second derivative is retained and checked against finite probe changes. This two-coordinate test verifies the weighting operation without representing an integration over every space-time mode.

19.5 A common spatial carrier and seven site coarse graining

The next calculation [52] constructs the bosonic phase parent and the fermion response on one cubic lattice. It derives the transverse stiffness from the incidence matrices of that complex, replacing the spectral substitution used in Section 19.4 by an explicit spatial construction. It does not establish that this finite complex is the physical embedding of the history wheel.

Let θ, u, y be the spatial link phase, current and polar-record phase, ϕ the matter phase and h a scalar completion coordinate. With $d_i = 2\sin(p_i/2)$, $C = i[d\times]$ and $\lambda = d^\dagger d$, the declared static phase action is

$$\begin{aligned} 2S = a \parallel C\theta \parallel^2 + w_J \parallel u + \theta - d\phi \parallel^2 + w_T \parallel d^\dagger u \parallel^2 \\ + b \parallel Cy \parallel^2 + c \parallel \theta - y \parallel^2 + (w_H + m)|h|^2. \end{aligned} \quad (154)$$

All weights are positive. The gauge direction is $(d, 0, d, 1, 0)$. Fixing $\phi = 0$ leaves two transverse links and eight auxiliary coordinates per momentum: the longitudinal link, three currents, three record phases and completion. The constant diagonal metric and plaquette composition extension are declared. Completion decouples on this branch; radial modes, field-dependent cross blocks and their coupling to completion are outside this restriction.

Eliminating the auxiliaries gives $u = -\theta$ and $y = c\theta/(b\lambda + c)$ for a transverse link. Conservation is satisfied and the retained scalar stiffness is

$$k(p) = a\lambda + \frac{bc\lambda}{b\lambda + c}. \quad (155)$$

The unit case reproduces Section 19.4's mode function on this complex. The coarse sites form the index-seven sublattice $x_1 + 2x_2 + 3x_3 = 0 \pmod 7$. Its disjoint stars have offsets $0, \pm e_1, \pm e_2, \pm e_3$. The uniform scalar block Q_0 is a coisometry. A linear Abelian link block Q_1 averages the seven translated fine paths for each coarse bond and obeys

$$Q_0 Q_0^\dagger = I, \qquad Q_1 D_f = D_c Q_0. \quad (156)$$

The rows of the coarse basis matrix B are $(1,1,-1)$, $(2,-1,0)$ and $(0,2,1)$, so $|\det B| = 7$. Paths use the declared x, y, z order. For a coarse momentum represented by p, the aliases and scalar coefficients are

$$p_m = p + 2\pi m/7\ (1,2,3), \qquad z_m = \frac{1+2\sum_i \cos p_{m,i}}{7}, \qquad m = 0, \dots, 6. \quad (157)$$

If $P_{j\mu}(p_m)$ is the oriented midpoint path sum along coarse bond b_j, its link block is

$$[Q_m]_{j\mu} = z_m e^{-ip\cdot b_j/2} P_{j\mu}(p_m), \qquad Q_m = E_c^\dagger Q_m E_m. \quad (158)$$

Here E_m and E_c are orthonormal transverse frames at p_m and Bp. Midpoint signs are converted when aliases wrap around the momentum torus. Equation (156) is verified in both position and Fourier space. It is a linear Abelian commuting block, not a selection of nonlinear non-Abelian transport.

The fermion calculation uses the inherited static composition coefficient, its gamma-five-compatible placement and the admitted overlap completion [12]. The parity-even Weyl action is $-1/2 \log|\det D|$. Write $\Pi_F(p_m)$ for its transverse two-point matrix per unit squared charge, normalised by $2/V$ for a real cosine probe. The joint coarse covariance and stiffness are

$$\mathcal{C}_c(p) = \sum_{m=0}^{6} Q_m \left[Z_Y k(p_m) I_2 + 10\Pi_F(p_m)\right]^{-1} Q_m^\dagger, \qquad K_c = \mathcal{C}_c^{-1}. \quad (159)$$

The factor 10 is the fermion hypercharge trace; $Z_Y = 10.5$ is the inherited benchmark attachment of the bosonic parent, not a returned physical metric. The Higgs determinant is not included. Seven aliases form a 70-coordinate gauge-fixed source parent. Its direct reduction agrees with (159) within 1.72×10^{-16} in covariance, and the Gaussian determinant factorisation has residual below 1.78×10^{-14}.

Table 37. Common-carrier hypercharge response on $7^3 \times 14$, at $p = (0,0,2\pi/7)$ and unit diagonal reference weights. Ratios are generalised eigenvalues relative to the bosonic coarse stiffness.

Spatial response	Stiffness ratio	Fractional change
First transverse polarisation	0.9931664202	−0.68335798%
Second transverse polarisation	0.9931713686	−0.68286314%

These are two spatial polarisations of one hypercharge field. They are not a colour–weak–hypercharge triple or D41 screening fractions. Fine-alias variances rise by 0.585–0.706 per cent and all total precisions remain positive. The pure-gauge fermion response is below 3.16×10^{-11}; halving the amplitude steps changes the transverse matrices by at most 2.18×10^{-10}. The minimum sampled seed gap is 0.999568. An independent position-space fermion calculation on $3^3 \times 6$ checks the momentum-chain implementation. This static magnetic response and Section 19.4's electric fluctuation contraction are different probes and are not added together.

The long-wavelength normalisation of the reference construction is explicit. Since $k(p) = (a+b)|p|^2 + O(|p|^4)$, its bosonic coarse covariance satisfies

$$\mathcal{C}_{c,B}(p) \sim \frac{E_c^\dagger B P_T(p) B^T E_c}{Z_Y (a+b)|p|^2}, \qquad P_T(p) = I - \frac{pp^T}{|p|^2}. \quad (160)$$

The basis matrix must be retained: it is not an extra physical conversion constant. Along the tested ray, relative errors against (160) fall from 0.0171 at $|p| = 0.1$ to 0.00211 at $|p| = 0.0125$, consistently with the path block's leading correction. This is a bosonic infrared check, not a continuum extrapolation of the finite fermion percentage in Table 37. The determinant contribution must be counted once when this result is assembled with matching and running.

19.6 Source sensitivities and retained derivatives

The common carrier permits a direct test of how source weights affect the retained response. Table 38 gives the generalised eigenvalues of $\partial K_{c,B}/\partial a$, $\partial K_{c,B}/\partial b$ and $\partial K_{c,B}/\partial c$ relative to $K_{c,B}$ at unit weights. They are logarithmic sensitivities there. These derivatives concern the bosonic reference, with the fermion determinant omitted.

Table 38. Sensitivity of the bosonic coarse stiffness at the momentum of Table 37.

Source weight	Lower eigenvalue	Upper eigenvalue
Closure a	0.639996	0.643208
Record composition b	0.202138	0.204667
Bond c	0.154652	0.155339

Independent differences agree within 1.13×10^{-10} relatively. At the matrix level the three derivatives sum to $K_{c,B}$, with residual 3.47×10^{-16}, as common rescaling requires. Eigenvalues in different rows need not add pairwise. Substituting the wheel-coefficient benchmark (12/31,12/31,21/124) gives stiffness ratios 0.33739 and 0.33770 relative to the unit reference. This is a sensitivity control, not a second certified physical weighting or a refit of PCN.

For a supplied positive parent precision $\mathcal{H}$ on its physical quotient, put $\Sigma = \mathcal{H}^{-1}$. Its first and mixed derivatives are

$$\Sigma_{,a} = -\Sigma\mathcal{H}_{,a}\Sigma,$$
$$\Sigma_{,ab} = \Sigma\mathcal{H}_{,a}\Sigma\mathcal{H}_{,b}\Sigma + \Sigma\mathcal{H}_{,b}\Sigma\mathcal{H}_{,a}\Sigma - \Sigma\mathcal{H}_{,ab}\Sigma. \quad (161)$$

A moving source-to-coarse map Q must be differentiated as well. With $\mathcal{C} = Q\Sigma Q^{\dagger}$ and $K = \mathcal{C}^{-1}$,

$$\mathcal{C}_{,a} = Q_{,a}\Sigma Q^{\dagger} + Q\Sigma_{,a}Q^{\dagger} + Q\Sigma Q^{\dagger}_{,a}, \qquad K_{,a} = -K\mathcal{C}_{,a}K. \quad (162)$$

The implementation retains all nine product-rule terms in $\mathcal{C}_{,ab}$, including derivatives of both copies of Q, and returns

$$K_{,ab} = K\mathcal{C}_{,a}K\mathcal{C}_{,b}K + K\mathcal{C}_{,b}K\mathcal{C}_{,a}K - K\mathcal{C}_{,ab}K. \quad (163)$$

Independent moving-map differences agree at 5.63×10^{-10} for a first derivative and 4.06×10^{-8} for a mixed derivative. The parent and map derivatives are retained inputs to this interface; they are not inferred from the unit benchmark. The Gaussian determinant identity is also verified at the reference, without evaluating the full nonlinear bosonic determinant's gauge derivatives.

The calculation therefore closes a finite common-carrier operation: current and record relaxation, the fermion two-point correction, seven-site covariance blocking and the required derivative propagation are evaluated consistently. The remaining source identification concerns the physical spatial attachment, joint history weighting, metric and background derivatives, and the evolving recording condition. HMGBC's physical metric construction [5, Section 56A] and the full configuration derivatives [8, Part XIII]

specify why those inputs belong to the joint source. The phase restriction does not evaluate them, or certify that the 0.68 per cent in Table 37 survives their inclusion.

19.7 Joint history transfer and temporal memory

The common spatial parent permits an explicit joint-history test [53]. Its field, current and polar-record coordinates evolve together before spatial reduction. The construction retains 70 complex Fourier coordinates, or 140 real sine and cosine coordinates, across the seven aliases of Section 19.5. It remains a phase restriction: the matter phase is gauge-fixed, radial matter is absent, and completion is independent on this branch. The inherited static, parity-even fermion curvature is included once as a time-local quadratic term; its complete frequency dependence is not evaluated.

Declared transfer. Let $\mathcal{H} > 0$ be the supplied real parent matrix and $D_{\mathrm{op}} > 0$ a constant diffusion matrix. The symmetric transfer is

$$\begin{gathered} L_D = -1/2\,\nabla \cdot D_{\mathrm{op}} \nabla, \qquad V_{\mathcal{H}}(z) = 1/2\, z^{\mathsf{T}} \mathcal{H} z, \\ \mathbb{T}_h = e^{-hV_{\mathcal{H}}/2} e^{-hL_D} e^{-hV_{\mathcal{H}}/2}. \end{gathered} \tag{164}$$

Equation (164) uses the mathematical form prescribed by HMGBC [5, Section 56A.2]. The reference takes $D_{\mathrm{op}} = I$ in the declared gauge-fixed coordinates and imports the quadratic parent of Section 19.5 as $V_{\mathcal{H}}$. Neither identification is derived as the complete physical source. In particular, HMGBC's upstream V_{ref} excludes an independently chosen W_{prim}; inserting the benchmark parent does not construct that upstream potential. The histories here are stationary and unconditioned, with no selected completed-Fact boundary.

Put $B_D = D_{\mathrm{op}}^{1/2}$, $\Omega = B_D \mathcal{H} B_D$, $R_h = (\Omega + h^2\Omega^2/4)^{1/2}$ and $\tilde{F}_h = (I + hR_h + h^2\Omega/2)^{-1}$. Direct Gaussian integration gives a joint conditional update $z' = F_h z + \xi$, whose innovation and stationary covariances are

$$\begin{gathered} F_h = B_D \tilde{F}_h B_D^{-1}, \qquad \mathrm{Cov}(\xi) = h B_D \tilde{F}_h B_D, \\ \Sigma_h = \mathrm{Cov}(z) = 1/2\, B_D R_h^{-1} B_D. \end{gathered} \tag{165}$$

The raw Perron factor is retained: $\log\lambda_0 = -1/2\,\mathrm{logdet}(I + hR_h + h^2\Omega/2)$. Direct quadrature checks that factor as well as the conditional mean and covariance. First and mixed derivatives propagate through the parent, diffusion and coarse map; the actual closure and record-composition derivatives on this parent are archived. This supplies a tested derivative interface without selecting missing physical derivatives.

Static response and instantaneous fluctuations. For the existing spatial block Q and discrete temporal angle ω, the full two-sided covariance spectrum, including the step factor h, is

$$\begin{gathered} \mathcal{C}_h(\omega) = \left[\mathcal{H} + \tfrac{4\sin^2(\omega/2)}{h^2} D_{\mathrm{op}}^{-1}\right]^{-1}, \\ K_c(\omega) = [Q \mathcal{C}_h(\omega) Q^{\mathsf{T}}]^{-1}. \end{gathered} \tag{166}$$

At zero frequency the diffusion cancels exactly:

$$\begin{gathered} h \sum_{n\in\mathbb{Z}} \mathrm{Cov}\,(z_n, z_0) = \mathcal{H}^{-1}, \\ K_c(0) = [Q \mathcal{H}^{-1} Q^{\mathsf{T}}]^{-1}. \end{gathered} \tag{167}$$

Consequently the static correction of Section 19.5 is preserved. This is an exact identity of the constant quadratic construction, also consistent with the history controls of Section 7. Its verification is an implementation check, not independent evidence that the physical source selects the starting weighting. The equal-time covariance $Q\Sigma_h Q^{\mathsf{T}}$ is a different object. Table 39 compares each response with its own bosonic reference at $h = 1$.

Table 39. Joint-history response ratios in the two spatial hypercharge polarisations.

History observable	Lower ratio	Upper ratio
Zero-frequency coarse stiffness	0.99316642	0.99317137
Inverse equal-time coarse covariance	0.99451910	0.99453417

The approximately 0.55 per cent equal-time change is not a second prediction of a force correction. Time-step controls and changes to the declared diffusion alter the instantaneous fluctuations and finite-frequency response while preserving (167) at fixed $\mathcal{H}$. These controls are not a certified family of physical VERSF alternatives.

Memory after coarse graining. With $C_j = QF_h^j \Sigma_h Q^{\mathsf{T}}$, a stationary Gaussian one-step coarse process would require $C_2 = C_1 C_0^{-1} C_1$. The reference instead gives

$$\frac{\|C_2 - C_1 C_0^{-1} C_1\|_F}{\|C_2\|_F} = 0.237769 \qquad (h = 1). \quad (168)$$

The hidden coordinates therefore leave memory in this reduced process. This percentage is a two-step covariance discrepancy, not an error bar on a force strength. Equation (166) retains the temporal response that a single coarse update would discard.

The native PFDMI readout is checked separately on all twelve archived edges, varying the transported endpoint and induced current together. Its normalised outcome probabilities can be appended to a supplied configuration transition, but summing all outcomes then returns that same transition. This factorised assembly cannot select the configuration law; the test does not exclude outcome-dependent field changes, feedback, record conditioning or stopping. The terminal labels are not identified with the separate polar-record phase by this calculation.

The result is a consistency and memory test with reusable derivatives. It does not determine the complete physical weighting, derive the full completion and matter dynamics, or issue measured force strengths. Progress beyond this branch requires the actual joint generator, reference weighting and recording operation, or an equivalent source-derived effective action retaining their effects.

19.8 Derivation status

Table 40. Derivation status of calculations and source identification.

Item	Established result	Remaining physical identification
Conserved current lift	Inherited result independently checked in 36 directions	Faithful full-carrier attachment
Exact Fold law	Source covariance and stationary balance reproduced	EPM1 and energetic branch identification
Endpoint autocorrelation and EPM1 attenuation	One number: the E_2 eigenvalue of the symmetrised D36 rim law, $\mu = p_{self} - (p_{forward} + p_{backward})/2 = -0.0993882276$	Whether the exact-Fold update P_+ is defined as that reversibilisation
Full edge covariance	Six cycle variances and gradient correlations evaluated	Physical joint increment map

Item	Established result	Remaining physical identification
Cycle reduction	Both marginal and conditional responses computed with determinants	Which conditioning the physical observable requires
D41 restriction	Native KL-rate Hessian retains the current fractions	Same-source gauge contraction
Correlated joint response	Conditional formula and cancellation condition derived	Physical joint covariance and mean response
Nonlinear history response	Mixed third and fourth tensors computed; parity zeros resolved	Full physical event-law identification
Averaging and relaxation	Nonzero variance-response coefficients survive current relaxation	Source-selected mean and covariance
Stationary event population	Preserved exactly by the complete state-function bath	Physical identification of this profiled family
Event-score fluctuations	Full covariance and exact stationary history scaling computed	Physical interpretation of the event readout
Field to event map	All 36 scalar cycle currents mapped; residual quantified	Full physical current insertion
Enlarged current carrier	Rank-48 family contains D41 exactly	Other physical field and measure dependencies
Coarse field sizes	Full scalar-parent covariance and link conditioning evaluated	Source-selected joint weighting and spatial limit
Coupled source weighting	Published FB lift gives variance factor 1.080285 and mean map	Internal structure suppressed by FB and full physical history
Current pair identification	Current restriction differs; full FB readout has rank bound 32 against native rank 12	Physical relation outside the excluded Gaussian identification
Native participation reduction	Common spatial reduction preserves the participation form; coefficients evaluated	Physical selection of readout and mark dependence
Incremental bath effect	Matched old-score relaxation distinguishes incremental from total reductions	Which physical variables respond and which remain fixed
Closed-cover completion	Exact common multiplier for the static stopped-history information	Physical record pushforward and full source identification
Propagating current	Conditional EPM1 clock and joint temporal cross weights evaluated	Actual joint bath, record, completion and matter dynamics
Temporal response	Shared-history and time-local controls give different magnitudes	Source selection of temporal correlations

Item	Established result	Remaining physical identification
Native record memory	Completed amplitudes give a resolved lag kernel and about 33% ordered disturbance	Full moving-source preparation and joint composition
Mean impulse response	Causal derivative computed separately; uniform-state zero proved	Energetic gauge response on the full physical carrier
Moving compact field	Native recording changes field observables with the PCN-matched spectral-log step	Complete coupled evolution and physical gauge-action Hessian
Calibrated compact drive	Finite-event susceptibility changes from 0.473367 to 0.106214	Complete source attachment and stiffness identification
Coupled quadratic response	All nine derivatives evaluated with baseline coefficients 6, 6.5 and 10.5	Other gauge directions, responding matter and full energetic admission
Local D41 action surrogate	Both-coefficient and magnetic-only predictions differ by about 32–197 reported standard errors; the less sensitive electric-only comparison retains a 4.3-standard-error hypercharge discrepancy.	Independent statistical check of the smaller discrepancy; complete source reduction and possible frequency dependence.
Completed-event field energy	Gain of 0.169 ± 0.011 model units; recording and probe-work contributions evaluated	Independently evaluated energies of the rest of the joint source
Energy response derivatives	First and second source derivatives verified; no resolved diagonal curvature change	Complete energetic implementation and physical curvature response
Recording interaction	Independently evaluated field gain and interaction loss of 0.099398 model units in one opportunity	Physical interaction and independent subsystem Hamiltonians
Ending the interaction	Switch-off work and stage-dephasing energy cost evaluated	Physical completion that retains the record and accounts for its energy
Pointwise auxiliary energies	Cannot cancel the nonzero off-diagonal intertwining residual	Physical source selection outside that class
Kinetic completion	Exact native transfer during free evolution; calculated field and correction energies of ±0.092192	Complete source Hamiltonian and autonomous completion gate
Terminal energy and stability	Dephasing cost 0.008741 and conditional minimum 0.002548; native effects fail the stable-projector criterion	Actual physical commitment operation and enlarged joint dynamics
Energy-resolved recording	Field-plus-store energy conserved; labels stable under stated continuation	Source Hamiltonian, store preparation and record protection

Item	Established result	Remaining physical identification
Source coherence	One-opportunity transfer-overlap family tends to the native instrument	Physical overlap matrix and coherent reuse across the event
Completed energy-resolved event	512 sharp-store histories balance pathwise; mean field gain 0.1455 ± 0.0238	Complete source selection of this altered instrument and stopping dynamics
Joint current and polar record	Full-parent reduction gives free coefficient 3/2 and phase-fixed coefficient 2; positive diagonal family verified	Physical joint metric, background and temporal terms
Terminal-label compatibility	Seven terminal projectors preserve all twelve generator operators	Identification with the separate polar-phase availability map
Constrained record response	General formula (111); one-loop unit-parent coefficient 399/256, or 591/380 with other field modes free	Source-selected Fact-bearing record differential
Phase and outcome operation	Exact conditional map (113); immediate response unchanged; momentum translation evaluated	Physical joint lift, incoming state and commitment gate
Harmonic propagation after readout	Full positive quotient moves the means but preserves centred covariance and linear response	Physical kinetic law and recording energy supply
Nonlinear propagation after readout	Nonzero later impulse-response correction on the full scalar parent	Quantum event dynamics and faithful gauge carrier
Available nonlinear directions	Fixed positive slice changes the correction and can reverse its sign	Source-selected evolving carrier and temporal terms
Polar record pattern	Field Jacobian, compliance and restoring kernel computed on the full scalar quotient	Identification with the physical Fact-bearing record
Magnitude and background controls	Intensity constraints give no quadratic change; exact backgrounds and compensating metric evaluated	Joint physical background and metric
Unsigned history density	Stopped-address statistics computed; fixed-address marginal has zero field derivative	Physical spatial embedding and joint field-dependent event law
Nonlinear pattern restriction	Exact preserved-record curvature on the fixed-modulus phase branch	Complete nonlinear elimination and recording dynamics
Current-stage interaction	Principal realisation verified on twelve archived edges; one bare multiplier fails on the tested multi-eigenvalue support	Selection by the complete source, responding background and event duration

Item	Established result	Remaining physical identification
Directed history transport	Inherited polar split and closure odds reproduced; stationary reversible identification excluded	Full-carrier transport and record pushforward with the appropriate orientation
Combined physical event	Source-matching operation (132) specified; separate finite implementations retained	Joint source evolution, event probabilities, permanent recording and surviving restoring response
Single hypercharge source	Required raw transfer and derivative scope specified; no numerical physical coefficient returned	Full joint weighting or an equivalent source-derived reduced action
Composition coefficient in the fermion response	Magnetic and ordered electric determinant Hessians evaluated	Full physical selection and common space-time matching
Magnetic matching increment	$\Delta C_M \simeq -0.001872$ and $\Delta T \simeq -0.494214$ relative to the local unit rule	Other source contributions; counted once
Electric matching increment	$\Delta C_E \simeq +0.002676$ and $\Delta T \simeq +0.706564$; $\Delta J = 0$ in both probes	Ordered half-defect continuation and complete physical matching
Electric ordering and precision	Approximately $+0.004887$ from ordering and -0.002211 from precision per Weyl index	Source selection of the complete temporal construction
Coupled fermion derivatives	Mixed derivatives through fourth total order retained; shared-link insertion independently checked	Actual current, record and completion maps and their joint weighting
Coupled electric fluctuations	Fourteen internal modes contracted with the electric four-point response; $b_{\mathrm{E}} = 3.27265 \times 10^{-6}$	Full space-time fluctuation law and physical metric
Fermion feedback on weighting	Quadratic feedback increases that correction by 0.609 per cent; unexpanded pair integral verifies normalised weighting	Complete bosonic measure and remaining modes
Common spatial carrier	Explicit phase parent and linear Abelian seven-site block; incidence identity verified	Physical spatial attachment and full non-Abelian event
Coarse hypercharge stiffness	Two spatial ratios 0.993166 and 0.993171 on the stated $7^3 \times 14$ model	Physical weighting, full completion and continuum matching
Source-weight response	Three stiffness derivatives evaluated; common-rescaling identity verified	Source-selected weights and cross blocks
Moving coarse map	First and mixed derivatives propagated through parent inversion and blocking	Actual physical parent and map derivatives

Item	Established result	Remaining physical identification
Joint Gaussian history	Full phase-parent transition, raw Perron weight and first/mixed derivatives evaluated	Physical operational generator, upstream potential and event boundary
Static history preservation	Equation (167) reproduces the 0.68 per cent correction as an exact quadratic identity	Source selection of the starting weighting
Coarse temporal memory	One-step coarse closure has 23.78 per cent two-step covariance error on the reference	Physical history and recording correlations
Force coefficients	Finite common-carrier contribution checked through a conditional history extension; no physical triple issued	Complete source response and physical spatial limit

Sections 10–14 supply the nonlinear response tensor, an explicit scalar current insertion, conditional means and covariances, native participation preservation and the closed-cover history weighting. Proposition 13 fixes the static completion multiplier within the full marked-history experiment. The propagating-current tests evaluate two stated temporal parameter spaces without identifying either as the physical source response. Proposition 12 extends the paired-rank test through common linear Gaussian reduction of the complete FB parent. Proposition 11 states a sufficient structure for preserving participation; it does not assume that physical record, completion and matter scores are independent of the participation mark. Sections 15–17 execute native recording on completed histories, compact field evolution and a coupled quadratic branch. The calibrated probes return both diagonal and cross-responses, with the inherited gauge coefficients retained as the quadratic starting point. Section 18 also evaluates field-energy deposition and its first and second source derivatives. Its single-opportunity implementation independently returns compensating interaction energy and an energy cost for ending that interaction. The kinetic completion reproduces the exact native transfer with a calculated compensating term; terminal dephasing probes its unfixed complementary dynamics. The energy-store construction evaluates a further joint implementation and completed sharp-store histories. Its coherence controls determine how an added source preparation changes the instrument; they do not select that preparation or record protection. The full-parent restriction in Section 18.11 closes the question of whether free current relaxation removes the tested record contribution: it does not. Section 18.12 supplies the constrained reduction for an identified record map and evaluates distinct candidate maps without conflating them. Proposition 21 evaluates one source readout in a specified joint lift and distinguishes its momentum effect from the hard constraints. The full nonlinear scalar test demonstrates a later response correction and its dependence on the available modes. Proposition 22 constructs the polar-pattern restoring response from the same parent, while the magnitude and unsigned-address controls distinguish it from other candidate records. Identifying the actual Fact-bearing map and its commitment operation, and evaluating its complete interacting Hamiltonians and full event evolution, remain necessary. These calculations do not close the full physical composition or identify a finite-event susceptibility with the long-distance gauge-action Hessian. The complete calculation must evaluate the joint source on the actual changing-field carrier and differentiate its full reduced response. It need not factor through the twelve-edge benchmark of Section 4. In the Gaussian description of Section 9, the unevaluated return includes the joint covariance blocks and the mean-response map on one physical branch. Section 14 shows why their temporal correlations matter: a constant history parameter and independently responding time slices are different models, even when they reproduce the same static per-update Gram. The complete physical calculation has not been performed by comparing them. The inspected joint-update source explicitly retains its continuous increment distribution as a source-

selection obligation [3, Section 17.79; 6]. This is a scoped source conclusion, not a theorem that all VERSF premises leave the response nonunique. A current-carrying background, changing covariance and nonlinear terms must be evaluated where the source requires them.

19.9 Conditions for a physical force prediction

The finite results in Table 40 become a physical force prediction only after the same source fixes their inputs and their relation to the observable. The following requirements make that distinction testable. They may be met by the admitted joint evolution or by an equivalent source-derived effective action that retains its weighting and record condition; they do not require a particular numerical method.

Source selection. Specify the physical carrier, background, operational measure, generator and reference potential for the chosen gauge probe. Derive the metric, mixed blocks and their field derivatives from that construction, or prove that the requested response is independent of any unresolved input. A successful fit to measured couplings is not a substitute. In Section 19.6 the alternative benchmark weights give bosonic stiffness ratios about 0.337 relative to the unit reference. This is a change of the reference model, not an error bar on the 0.68 per cent fermion correction, but it demonstrates why the weighting must be selected.

Joint recording and response. Identify the record observable actually retained after commitment, together with its incoming correlations, completion rule and subsequent stability or leakage. Evaluate the field, current, record and matter response under that same law, including changes in event probabilities and any required energy exchange. Preserving a terminal label does not by itself impose a polar-phase constraint. A factorised readout whose summed probabilities equal one cannot select an otherwise supplied configuration transition.

Complete reduction. Differentiate the reduced action with the relevant measure, determinant and mixed-response terms included once, on the physical gauge quotient. Equations (18), (28) and (29) describe the appropriate operations in their respective regimes. Check direct and sequential reductions, gauge identities and the chosen conditioning. Reproducing equation (167) verifies the constant quadratic history extension; because its zero-frequency covariance is fixed by the supplied parent, that identity does not select the parent physically.

Spatial and temporal matching. Evaluate the retained response on a sequence of spatial regulators and lower physical momenta under a fixed prescription, and establish the common electric–magnetic normalisation and matching scale. Table 37 is a result at one momentum on a $7^3 \times 14$ carrier; equation (160) separately checks the bosonic infrared behaviour. Neither establishes convergence of the finite fermionic percentage. Bare and renormalised temporal and spatial coefficients must be related consistently, as in anisotropic lattice matching [55]. Any conversion to a measured coupling also requires the stated representation normalisation, running and threshold treatment.

Fermion scope and uncertainty. The determinant computations in Sections 19.2–19.7 concern the parity-even magnitude on the specified overlap branch. They do not by themselves establish the phase and measure of the full chiral quantum theory, whose gauge-consistent definition is a separate requirement [54]. If that requirement is supplied upstream, its precise result and applicability to this carrier must be identified. Report sampling, numerical discretisation, finite-volume and extrapolation errors separately from unresolved physical premises. A numerical residual is a calculation check, not an accuracy claim for a Standard Model prediction.

The immediate target can remain one hypercharge probe. Success would be a source-selected retained action curvature with its recording condition and controlled matching, or a proof that the unresolved inputs cancel from that observable. It would then be meaningful to extend the result to all gauge factors.

Another conditional Gaussian continuation can test the method, but does not by itself meet this selection requirement.

20 Conclusion

The paper establishes conditional routes from history statistics and recording operations to retained field response. Its finite calculations show which proposed identifications succeed and which fail under explicit assumptions. They also identify the source inputs needed for a physical force prediction. No measured coupling selects an input, and PCN remains the common primitive action normalisation.

The current-history results survive their stated reductions. Common spatial coarse graining preserves the D41 participation form under Proposition 11, and static closed-cover weighting multiplies the complete marked-history information without changing its fractional reductions under Proposition 13. Those statements do not determine the gauge action: Sections 6–8 give parents with identical current restrictions and different retained link responses, while the factor-blind and native Gaussian response pairs fail the common-readout identification.

The coupled quadratic event gives diagonal response ratios 0.99952 ± 0.00144, 0.99755 ± 0.00151 and 0.99919 ± 0.00046 relative to its no-record prediction. The specified both-coefficient and magnetic-only D41 surrogates differ by about 32–197 reported Monte Carlo standard errors. The electric-only comparison is much less sensitive, but its hypercharge prediction remains about 4.3 reported standard errors above the coupled result. These are comparisons within the tested protocol. The recorded response is not identified with the long-distance gauge-action Hessian, and the result does not exclude a D41 pattern after a different, physically established full reduction.

Recording deposits 0.169 ± 0.011 model energy units in the quadratic field experiment without a resolved diagonal energy-curvature change. Separate kinetic and energy-store constructions supply explicit compensating dynamics under their stated assumptions. They establish possible implementations and their limitations, rather than a single complete physical event. On the scalar parent, joint current and record relaxation gives uniform-mode stiffness 3/2; fixing its polar record phase gives 2. The discrete outcome operation need not fix that phase, although it changes momentum and can affect later nonlinear response. The physical record map, source preparation and dynamics therefore remain consequential.

The fermion calculations return magnetic and ordered electric increments of approximately −0.001872 and +0.002676 per Weyl index, with the ordering and precision contributions separated. Quadratic fermion feedback raises the small electric fluctuation correction by 0.609 per cent on the stated fourteen-mode slice. On the common spatial carrier, current and record relaxation, the fermion two-point matrix and seven-site blocking give hypercharge stiffness ratios 0.993166 and 0.993171. These are two polarisations of one field at specified inputs, not a physical gauge-coupling triple.

The joint Gaussian history preserves the static correction by equation (167) and exposes memory after spatial blocking. The preservation is an exact quadratic consistency result; the temporal response contains information absent from a static calculation. Neither result selects the physical generator, reference weighting or completed-record condition. Section 19.9 specifies the remaining acceptance conditions: source selection, consistent joint recording and differentiation, complete reduction, controlled spatial and temporal matching, and an explicit account of the fermion measure and uncertainties. The calculations and retained derivatives provide concrete inputs and checks for that task.

Appendix A Reproduction and verification

Every numerical statement in this paper is produced by a reproduction package in Python, NumPy and SciPy, with the archived source functions included unchanged, a results file, a source register and SHA-

256 hashes. Table 41 lists the packages by section. Check counts are executions of named checks within each package; repeated checks across extensions, time steps, modes and history lengths are counted as executions, not independent theorems, and the counts of different packages are not added into a validation total. Numerical residuals measure these finite computations, not the accuracy of a Standard Model prediction. No experimental coupling or mass enters any script.

The independent comparisons that carry the most weight are: the Moore–Penrose lift against the direct conserved-current injection; weighted inversion against the specified metric restriction; complete 187-coordinate Schur elimination against the twelve-coordinate formula; cyclic history-block elimination against the closed transfer expression, with equation (16) evaluated for 45 extension, step and history combinations and all 181 auxiliary eigenvalues retained; the nonlinear profiled KL Hessian against D41; direct and sequential elimination of the sixty-coordinate score Gram with determinants; direct time propagation against the vertex-resolved stopped information; independent nonlinear finite differences of the completed-path response; dense Schrödinger evolution against the matrix-exponential and low-rank implementations; full-parent reductions against the closed formulas of Sections 18.11 to 18.15; and position-space fermion and parent constructions against the momentum-chain implementations of Section 19. Where a result depends on Monte Carlo sampling, the archives contain the raw and control-variate estimates, all cross-responses, the seeds and the reproduction commands; standard errors are sampling errors of the stated constructions.

Sections 18.16 and 19.1 are source audits and add no numerical execution; their evidence registers and governing extracts are preserved under joint_assembly_audit/ and hypercharge_source_audit/. Source consultation for the calculations used term screening of the archived public corpus (607 full texts, about 22,500 pages, with an inventory of 4,294 VERSF-named files and unchanged hashes for the governing PDFs) followed by close reading of the controlling passages, with live copies of the controlling PDFs checked against the archive. The registers accompanying each package preserve the URLs, hashes, extracts, queries and private-source reads. This is reproducible corpus search with focused reading, not a page-by-page audit of the entire corpus.

Table 41. Reproduction packages by section. Hashes are SHA-256 of the named calculation scripts.

Sections and package	Scripts and checks	SHA-256 of calculation scripts
3, 5 to 8: main calculation	calculate.py with the unchanged archived source_parent.py; 96 named checks; Jacobian reconstruction, analytic quotient, cycle injections, weighted lift, D41 whitening, full positive metrics and complete-parent reductions	in the package manifest
4: exact Fold	calculate_exact_fold.py, exact_fold_results.json, exact_fold_arrays.npz; 79 checks including the tilted stationary law, discrete Lyapunov balance, edge pushforward, Hodge decomposition, both Schur complements and determinant identities, exact finite histories	in the package manifest
5: D41 information rate	d41_rate/calculate_rate.py; 10 checks; joint score Gram, nonlinear profiled KL Hessian against D41, stationary per-Fold rate through 2401 steps, archived conditional gauge-current derivative	in the package manifest
9: joint response	joint_response/verify_joint_response.py; 11 exact SymPy checks of (23) to (26), both elimination orders, determinant identity and off-zero chain rule	20410babfcc40abe0a93011f9cf7334a7c5b55233fb9dd7866becfb867c9ef55

Sections and package	Scripts and checks	SHA-256 of calculation scripts
10.1 to 10.4: nonlinear response	native_mixed_response/calculate.py, results.json, arrays.npz; 101 checks; full 18^3 and 18^4 tensors	8c2fd3140a3d99fa3ba6edf0bff82f303e7036d28cd502932d3cb44ee0079e65
10.5 to 10.6: populations	fluctuation_population/calculate.py; 274 checks including all twelve stationary-population derivatives and full two-step path enumeration	47c05d198440ccc229785fd4b321bc3c6a7b852cb25e68b2b70654388820c63a
11: field fluctuations	physical_fluctuation_bridge/calculate.py; 69 checks; rank-48 extension, exact D41 embedding, full scalar-parent Schur and determinant identities, frequency covariance	9e007070106c06c7c3284273c7f5d661d56397bb12a77ed289171a581f48dfea
12: source-weighted fluctuations	source_weighted_bridge/calculate.py; 73 checks; six-mode coupling, full typed metric, both elimination orders, conditional variance and mean, paired current responses	605462bebbf6269c1549d1596e4b34ebac370f8a1fd8c478c4506f856806273c
13: participation reduction	participation_weighting/calculate.py; 102 checks; sixty raw scores, common-profile reduction, Gaussian rank bound, conditional field contractions; largest scaled residual 2.44×10^{-15}	b6bf59c63c7c98dcbcb93c1c8f326a81eb792076747d76a30d8dc4a27361cbd5
14: completion clock	closed_cover_weighting/calculate.py; 74 checks; first closed-cover distribution, conditional E2 propagation, all-entry stopped information, nonlinear relative entropy; largest scaled residual 1.94×10^{-14}	deeb98a6c8ee1cfce8c27e4a905e1f6993568ee612a428983c04b714ea92a32a
15.1: completed-record response	record_backreaction/calculate_event.py; 57 checks; full marked amplitudes, both orientations of every native edge, absorbing-chain tail bound	in the package manifest
15.2 to 16.3: lags and moving field	record_feedback/calculate_lags.py, verify_response.py, compact_field.py, moving_field.py (8,192 histories on 49, 65 and 97 points), analyse_controls.py; 21 final controls	f192831f22610266cd8204bef3dae2087bf94152ff7fb33f3cc6ffa9e646a02e (lags); 29add4fdc66855342ac823e25a5d40a75ad10ff848880d2e380111082b4a677e (moving field)
16.4: calibrated drive	force_response/calculate.py, analyse.py; 26 checks; 8,192 histories per grid	58b3f95d7159dd0ff58de86649efe3ee144adab292458df633acf1fe9562dd44
17: coupled quadratic response	sector_response/harmonic.py, joint.py, parallel_run.py (512 histories at nine and thirteen levels), verify.py 56 checks, verify_harmonic.py 11 checks, analyse_harmonic.py 45 checks	9326609ab9aaf7081081e422c7ca4a66f3466758b2458cbffea14a2ac7743a20 (coupled); 502adfd3c913f2b8c95c34e35ab6f15e12c8b435a13ca1bac537ea0d071198cd (harmonic)
18.1 to 18.3: event energy	joint_event_energy/calculate.py, parallel_run.py (256 histories per basis), calculate_twojet.py, parallel_twojet.py (128 per basis); verify.py 46 checks; verify_twojet.py all eighteen Hessian entries on one path	8a0aee2b9fb0ddcba4ed291b0ab8300ac98878c03e6486376cb75a80321c7fcb (first order); 3daca7646861300329aed466678682923bcbf03661c9df9ac580f3d39f469cb9 (second order)
18.4 to 18.6: recording interaction	joint_energy_dynamics/calculate.py (all 49 inputs at three, five and seven levels), verify.py (native matrices, adaptive Schrödinger evolution, pointwise obstruction); inherited criterion in sources/	in the package manifest

Sections and package	Scripts and checks	SHA-256 of calculation scripts
18.7 to 18.8: kinetic completion	recording_kinetic_completion/calculate.py, verify.py; dense field blocks, excited input, terminal projections, nonnegative complements	c4790e98780f685ad3e4c9b34c8fe937bc358eb8983ecbd9143e051ba25f1b13; 1cb0affab4d9f251245d250929943c9f9ab31d1d9e8e7f87a91eaa39674e8504
18.9 to 18.10: energy-resolved recording	source_record_joint_completion/calculate.py, verify.py, completed_event.py (512 histories per basis, seed 20261030)	03e84b465f55ea859f0357f7c57240b0d708b358c8e88d168462a406718fd5a2; 47a79ce5fce90df0fb86556c00fd92a844af08e8f34dd8c1bc4ead69eebecdda; 653cd79d27c55aff23195d56c3d9b1f4198dab7ebd2550075dfb018e5d99831d
18.11: joint current and record	joint_current_record_response/calculate.py 178 checks; verify.py five symbolic identities, 100 positive diagonal metrics, causal-memory test, quantum-ground control	3ce879c87aa93ca4d37d83ada5bd430ddaaafef191027f4e0077ba64852244ec
18.12: commitment constraints	commitment_record_response/calculate.py 89 checks (all 64 loop subsets); verify.py rational identities and 40 constrained-response tests	cf1408ea85fce1b530ee3af0b5f1d274bfb8d3da8d8a6ad5cc519d2243c7dfdc
18.13 to 18.14: readout and propagation	physical_record_selection/calculate.py 231 checks, nonlinear.py 26 checks, verify_dynamics.py 6 checks; run in that order	6786773a46a92455fdb6117be5fbf6d2f481234071a452acc777bb33da04ff74; e2ed6439c357558b33facc238bf167e1305d1aa70ab1a8683dde48ff3e7c8dec; f04b568cd24ae40fba7085d7d4b20e8847e54b0f271e6720bbb68e70ed07eccd
18.15: record pattern	record_pattern_transfer/calculate.py; 125 checks; full-parent residual 2.90×10^{-16}, constraint residual below 4.01×10^{-16}, nonlinear curvature within 3.68×10^{-7}	f3bd4f927bb6d3bee65518a5d7e5e5505dec29c184947913056029677 5a9ebb5
18.17 to 18.18: current-stage interaction	common_evolution_recording/calculate.py 125 checks on the 650-dimensional carrier; history.py 10 checks	9ccca34d08015a5709b6e5e47fa4151a623bd65cb06ef76ec471c116fda4e210; 4934562b80f605a0a6c69645fbf537592bb1af8eb20757627b2be19fc3ae15ac
19.2: magnetic determinant	composition_magnetic_response/src: composition.py, run_response.py, batch.py, direct_check.py, validate.py, analyse.py; 28 checks; largest volume $128^3 \times 256$	in the package manifest
19.3: electric determinant	composition_electric_response/src: run_response.py, batch.py, direct_check.py, analyse.py, mixed_jets.py, link_mixed.py; 25 primary and 8 shared-link checks	in the package manifest
19.4: coupled fluctuations and feedback	coupled_fermion_response/src (coupled.py, analyse.py, verify.py; 101 checks); source_weighting_feedback/src (weighting.py, verify.py; 91 checks)	in the package manifests
19.5 to 19.6: common spatial carrier	common_spatial_carrier/src: common.py, analyse.py 357 checks, independent_checks.py 21 checks, sensitivity.py, response_jets.py; corpus register in sources/	in the package manifest
19.7: joint history transfer	joint_history_transfer/src: calculate.py 106 checks, verify.py 31 checks, recording.py 96 executions, source_jets.py 10 derivatives	e7959e3c3693b618f734054777206841aae76a6b219fb2c47cdd3b7648e8cf87; 640c1a4f947c57de3d231e71ad9ab342181ceea508c8c251d9201e2084059562

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