Physical Matter Record Dynamics and Gauge Response in VERSF

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General reader summary

A camera flash can disturb a spinning top without changing how hard it is to push the top around a track. This paper asks a similar question about VERSF: when something happens and leaves a lasting trace, can that change how strongly things push or pull on one another? The calculations show why a disturbance and a change in force must be checked separately.

In one example, making a record changes what happens inside the system but leaves its resistance to a push unchanged. In another, the parts can adjust together, making the system easier to push. That adjustment reduces the resistance by about 27 percent in one test. A larger test finds different changes for the three kinds of interaction studied and explains how those changes depend on the types of particle included. These examples do not yet give the strengths measured in nature.

The paper also examines a push that changes with time and follows how it passes between the parts. This makes the remaining question clearer: why does VERSF choose one particular amount of resistance, and one particular rate of response? Both must be calculated for the same complete system before the three force strengths can be predicted. The paper provides the calculations and checks needed to test that next step.

Abstract

Nonlinear bond and record-composition interactions soften the quantum energy response, whereas recording disturbance alone can leave loop curvature unchanged. Proposition 16.1 proves exact Schur recovery for every source-independent positive quadratic canonical family in its domain. Proposition 16.2 reduces the leading twelve-direction correction to representation traces and Casimirs, giving fractional slopes $(\gamma_C, \gamma_W, \gamma_Y) = (0.08316481, 0.07547314, 0.04821986)$. The scalar periodic triangle has $R/w = 0.181279591933$ at $\eta = \hbar/\sqrt{mw} = 1$, compared with the harmonic value $1/4$, and delayed-flux inertia $M_f/m = 0.16099402$, compared with $3/16$. A separate charged-pair model has strong-coupling residual 0.39004739. Canonical matter normalization cancels from the shared-link vertex while the field-action scale survives in the interaction. A time-dependent source relocation preserves response only with its induced velocity connection. These results distinguish recording noise, static relaxation and dynamical response on their stated carriers. Physical force extraction requires electric and magnetic coefficients, current matching and normalization from one admitted action; Section 17.3 specifies the inputs and recovery tests.

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Notation

Symbol	Meaning in this paper
$J, j; J_{\mathrm{orb}}$	Independent source current and its orbital charge generator, written J in Sections 10–11.
$T_A; I_e^A$	Internal charge generator and matter current obtained by varying the gauge link.
$\mathcal{E}_j, \Phi_j; P_r$	Native channel, Heisenberg dual and internal terminal-support projector.
C_a, K_{ra}	Native excitation amplitudes and terminal-resolved Kraus operators.
$\mathcal{N}_\Phi, \Sigma; \rho_{49}, \rho_{50}$	Schwarz defect, state-contracted generator matrix and the two stated preparations.
$h; H, H_{\mathrm{int}}, \Delta H$	Hopping energy, Hamiltonian, flux-independent internal Hamiltonian and departure from matched transport.
$W_{\mathrm{prim}}, W, W_\perp; Z_A$	Common defect metric and auxiliary reduction; gauge stiffness after physical matching.
$q, Q, W_{m,p}; \varepsilon, \epsilon_{\mathrm{orb}}$	Primitive charge $6Y$, total charge, charge/parity isometry, parity eigenvalue ± 1 and binary orbit index.
$\mathcal{I}, \theta, \Phi; \mathcal{C}$	Current-orbit inertia, orbit angle, loop flux and the native dual in Section 11.
$\mathcal{A}_i, \mathcal{B}_i$	Recording-isometry connection and complementary derivative.
$\upsilon, \beta_\upsilon, \psi_s, \psi_t$	Endpoint overlap, preparation coefficient and endpoint vectors.
$\mathcal{F}_{\mathrm{eq}}; F, F_{\mathrm{term}}; F_j, F_\psi; \mathsf{H}_{\mathrm{act}}$	Equilibrium free energy; conditional information, whitened derivative maps and the action Hessian.
$c_r, \nu_r; \Theta$	Successor amplitudes, their squared magnitudes and total scalar record phase.
$D_{\mathrm{tr}}, \mathcal{D}, C_{\mathrm{rec}}(t)$	Trace distance, action defects and coherence ratio.
$K_f, G_{fc}, D_{cc}; c(x), c_A, b_c$	Field contact, mixed vertex, stretch feedback, stretch features and Laplace scale.
$\mathcal{Z}, \mathcal{Z}_{\mathrm{stat}}$	History functional and reweighted static integral.
$q_\alpha, P_\alpha, \nu_\alpha; g$	Completion coordinates, momenta, frequencies and single-mode matter coupling.
$a_{\mathrm{w}}, b_{\mathrm{w}}, c_{\mathrm{w}}; K_\lambda, \mathsf{H}_{\mathrm{lr}}$	Wheel potential weights, wheel stiffness and frequency-dependent link–record kernel.
$M, K; r_B, r_R, D_{BR}, K_\beta$	General quadratic matrices; scalar bond and record mismatch fractions, denominator and phase stiffness.
$\kappa_{\mathrm{sat}}; \eta$	Native saturation coefficient; exclusively the quantum parameter $\hbar/\sqrt{mw}$.
$\xi; \vartheta_A$	Eliminated auxiliary variables in (23); history-tilt coordinates in Section 13.2.
$K_A, k_{A\mathfrak{b}}, \chi_{\mathfrak{b}}$	Sector trace Gram, block trace contribution and normalized block Casimir load.
$G_m, V_A, \mathcal{X}_A; \mathcal{R}$	Matter kinetic metric, canonical vertex, current exchange and inverse link response.

Symbol	Meaning in this paper
$\mathcal{R}_f, M_f; G_f, D_f, \zeta$	Delayed-flux response and inertia; relocation generator, unitary and common action-scale factor.
$\mathsf{E}_A, \mathsf{B}_A, \delta_A$	Matched electric and magnetic action coefficients and leading temporal correction.

1 The question and the achieved result

This paper connects recording dynamics with the energetic response relevant to the force-strength problem raised in [1]. The common-action completion vertex yields coherent recording and propagation, and its nonlinear bond and composition terms change quantum response. The principal results are an exact quadratic recovery theorem, representation-resolved leading corrections, and a time-dependent source-covariance identity. Together they identify which effects can change a force response and which calculations must still share a physical action.

Status conventions. An identity or proposition is exact under its stated hypotheses; a numerical return belongs to the carrier, measure, state and regulator specified with it. A diagnostic or benchmark fixes inputs to test a mechanism. Physical admission additionally requires those inputs and their common normalization to follow from VERSF. None of the diagnostic numbers is a measured-force prediction, and results from different models are not additive without a common action. Local assumptions and the acceptance tests in Section 17 govern every result below. Numerical solver residuals are implementation checks, not uncertainties on physical couplings.

1.1 Main results

Standard completely positive-map identities, Schur elimination, oscillator displacement and time-dependent unitary covariance provide the mathematical tools. The contributions are their application to the VERSF matter–record carrier, explicit preparation and descent obstructions, and nonlinear scalar and representation-resolved response calculations. The table states the restriction of each result.

Result and location	Content	Hypothesis or status
Proposition 16.1; (121)	The full equilibrium response is exactly $C - BK^{-1}B^{T}$, with no further correction from solving the same harmonic dynamics.	Positive constant kinetic and stiffness matrices; linear source; canonical translation on the stated domain.
Proposition 16.2; (138), (139a)–(139b)	The leading sector slopes close in trace-Gram and Casimir data.	Three ordered group links, bi-invariant trace metric, equal weights, unit stretches and small η.
Current intertwining; (32)	Matched transport preserves total-current products and their Schwarz defect vanishes.	Source-independent isometry and the matched Hamiltonian family on its image.
Kinetic compression; (42)	Recording produces a covariant derivative and a positive geometric term.	Smooth pointwise isometry and the specified weighted Dirichlet generator; the complementary block (43) is retained.
Profiled information; (72)	Matter variations span the terminal changes from current variations, so the profiled current information is zero.	The stated fixture and complete six-dimensional terminal simplex tangent; this is not an energy statement.
Static pair feedback; (94)	The Laplace-weighted residual is exact and tends to zero at strong static feedback.	The reweighted classical pair integral (93), not the quantum Hamiltonian (96).
Time-dependent source covariance; (151)	A source-dependent unitary requires its velocity connection; static spectral equivalence alone does not fix a driven experiment.	Differentiable source unitary with the same state and physical preparation transformed consistently.
Quantum pair limit; Section 14.5	$r_{\infty} = 0.39004739.$	Strong-coupling limit of the four-coordinate Hamiltonian (96).
Static periodic benchmark; Section 16.4	$R/w = 0.181279591933$, versus $1/4$ harmonically.	Scalar torus ground state with equal weights and $\eta = 1$.
Delayed-flux benchmark; Section 16.12	$M_f/m = 0.16099402$, versus $3/16$ harmonically.	The same scalar model, with the composition source varied at fixed rotor coordinates.

Sections 3–11 develop the current and energetic controls. Sections 12–14 treat joint weighting and charged-pair relaxation. Sections 15–16 derive coherent dynamics and static and temporal responses. Section 17 gives the physical-admission tests and the executable specification.

2 What the corpus already supplies

2.1 The existing action and dynamics

The Master Substrate Action and Constitutive-Descent paper, MASD [2], supplies independent transported current, link, record and completion variables, the six-defect parent with its full cross metric, and matter transport through the same represented link. Its Sections 29–32 supply the CAR/Fock matter

carrier, canonical inclusion of occupied matter addresses into terminal record supports, and the typed completion bilinear. Sections 24–26 define the common reduced Hessian and its scalar and gauge compressions. Sections 47H–47J derive the representation embedding and locate the remaining response in nonfactorising blocks.

The BCB Fold Lagrangian [3, Section 12.7] supplies a continuum effective-field-theory matter and gauge action. The Unified Informational Field Theory [4] supplies the constrained tick-current sector tested in [1, Appendix E]. That tick current, an independent source-current coordinate, and a gauge matter current are not interchangeable. The zero-transfer result for the literal tick-sector recording attachment in [1] therefore does not settle the full matter problem.

The finite Master-Action fermion-kernel paper, MFKR [5], goes substantially further than an unspecified kinetic operator. It reconstructs the finite kinetic operator as a source functional, proves kinetic bounds, supplies an infrared principal-symbol closure on its stated refinement-geometry branch, and proves uniqueness of a supplied number-conserving one-particle transfer's Fock lift. Its published status ledger nevertheless retains the microscopic edge manifest and the record-semigroup-to-fermion-transfer intertwiner as separate obligations. Sections 24–28 retain the record-semigroup-to-fermion map, post-commitment selector and physical time attachment as separate conditions. We retain the established results and test the remaining connection.

2.2 The existing operation and source response

QCA-1 [6], integrated in RCHS-35 [7, Sections XIV.11–XIV.15], supplies the gauge-intertwining current–carrier–pointer isometry used here. It explicitly admits the orbit Hilbert space and invariant measure as construction premises. It supplies an implementing block Hamiltonian, but distinguishes inverse implementation from forward derivation from the master action. Its history-preservation theorem assumes a frozen current coordinate, specified preparation and central-link background.

Later calculations already follow recording-induced field and current disturbance, energy exchange, retained outcomes and coherent energy stores [8, Sections 15–19; 9]. The energy-conserving construction can approach the native instrument with a growing coherent reservoir; its preparation and isolation are not thereby selected by the complete physical action. The 29 October phase-record calculation also propagates a conditional kick through a nonlinear 226-variable parent [10]. Source History [8, Sections 18.7–18.9] also constructs energy-intertwining completions and states their selection limits. We use these results; neither the existence of backreaction nor energy intertwining is presented as new.

The current-rigidity paper [11, Section 14, Branch D] allows direct continuum action attachment. Thus a new current-dependent binary occurrence law is not a prerequisite for every force derivation. HMGBC [12, Section 56A] supplies the operational-history route while retaining its upstream generator, measure, background and source conventions. PCN fixes the common primitive cost at its declared premise grade; the present paper introduces no replacement overall normalisation. Chiral coarse graining [13, Sections 9.7–9.9] already carries source covariances, relaxed vertices and determinant weights into retained fermion interactions. Its matched physical covariance remains a substantive condition, not a name to assign to the new matrix below.

Further VERSF Deliberations on the Born Rule [30, Theorem 4 and Appendix A] supplies a conditional foundation for the probability rule used here. Its operational reconstruction requires the stated branch representation, admissible filter and readout experiments, phase invariance and consistent coarse graining. Under those premises, admitted alternatives carry squared-amplitude weights. The common measure scale cancels in normalized probabilities; it does not fix a kinetic coefficient or the force-strength

matching factor. The theorem does not itself establish the required operations on this paper's physical matter–record carrier, including its statistics and gauge constraints.

2.3 Review coverage

The sources comprise the public VERSF papers and recovered calculation packages listed in the references. Close reading concentrates on the common action, native recording operation, physical source selection and kinetic reconstruction. Appendix C identifies the controlling sources and the coverage registers.

3 The current selected by a gauge variation

3.1 The common link fixes the insertion

MASD writes matter transport using the same link as the bosonic closure action. After a specified canonical pairing and real-time reconstruction, consider its number-conserving hopping form on a finite regulator,

$$H_{\mathrm{kin}}[U]=-\sum_{e:s\to t}(\psi_t^{\dagger}\Gamma_e R(U_e)\psi_s+\mathrm{h.c.})\,. \qquad (1)$$

Here Γ_e contains the supplied spin and geometric hopping coefficient. Equation (1) is the Hamiltonian form to be returned by the admitted reconstruction; the Euclidean bilinear alone does not select its clock or every coefficient. For a left link variation $R(U_e(\theta))=e^{i\theta T_A}R(U_e)$, with the spin coefficient commuting with the internal generator, define the source current by

$$\hat{I}_{eA}=-\frac{\partial H}{\partial\theta_{eA}}\Big|_{0}=i(\psi_t^{\dagger}\Gamma_e T_A R(U_e)\psi_s-\mathrm{h.c.}). \qquad (2)$$

The sign is fixed by the displayed negative hopping convention. The link angle includes the chosen connection convention. Converting an angle into a continuum field requires its geometric and canonical normalisation; no additional coupling is inferred from (2). The insertion transforms in the target frame. A physical observable must contract or dress it consistently with the gauge quotient.

Equation (2) is a bilinear on the matter carrier. In the continuum BCB action its counterpart is the variation of the covariant matter kinetic terms, including the Higgs contribution where relevant. It is not multiplication by the independent configuration coordinate j. The non-Abelian internal generators also do not form a commuting coordinate algebra.

3.2 The common-carrier requirement

To use the preceding paper's propagation criterion physically, the observable in (2), the event isometry, the Hamiltonian and the initial state must act on the same admitted space. That space includes the required matter statistics and gauge constraints. A classical matter-population writer does not specify the corresponding coherent operation. A gauge intertwiner alone does not prepare a zero-Gauss state. A unique Fock lift of a supplied one-particle unitary does not supply an intertwiner for an unrelated diagnostic channel.

The present attempt first asks whether the native channel would preserve the charge insertions in (2). If it does not, the assumption of initial current preservation must be reconsidered before searching for a delayed effect. Sections 4–6 execute that diagnostic test. Section 10 supplies a conditional occupation-space encoding and joint transport.

4 The native channel and its protected coordinate

The unchanged diagnostic representation has sectors Q,u_R,d_R,L,e_R,N,H with dimensions 18,9,9,6,3,3,2. Its twelve Hermitian generators are eight colour generators, three weak generators and conventional hypercharge. Their trace Gram is

$$\mathrm{Tr}(T_A T_B)=\mathrm{diag}(6I_8,\frac{13}{2}I_3,\frac{21}{2})_{AB}. \qquad (3)$$

For $u=j/\|j\|$, write $p=uu^\dagger$ and use the published nonzero-response branch,

$$B_a=i[T_a,p],\quad S=\sum_{a=1}^{12}B_a^\dagger B_a,\quad s=1/2\,\mathrm{Tr}S,\quad C_a=B_a/\sqrt{s},\quad C_0=(I\text{-}S/s)^{1/2}. \qquad (4)$$

The terminal projectors P_r are the seven sector supports. With a=0,…,12, the native reduced channel and its dual are

$$K_{ra}=P_r C_a,\qquad \mathrm{E}_j(\rho)=\sum_{r,a}K_{ra}\,\rho K_{ra}^\dagger,\qquad \Phi_j(X)=\sum_{r,a}K_{ra}^\dagger XK_{ra}. \qquad (5)$$

The full QCA isometry acts pointwise in j on its admitted orbit construction space. Consequently every bounded multiplication observable $f(j)$ is fixed, with its products, when it acts trivially on the internal carrier. This is the protected coordinate statement used in [1]. It does not say that an internal matrix T_A, a terminal-support projector P_r, or the hopping current (2) is fixed.

Retain the equal-amplitude ray u=(1,…,1)/$\sqrt{50}$ and the preparation

$$\rho_{49}=\frac{I\text{-}|45\rangle\langle 45|}{49},\qquad s=1.3192. \qquad (6)$$

The omitted address uses zero-based numbering and is a sterile singlet. The equal ray and rank-49 state specify the test preparation. $Su=su$ and $\lambda_{\max}(S)=s$=1.3192, so (4) realizes the saturation prescription $\kappa_{\mathrm{sat}}=1/\lambda_{\max}(S)$ used in (54); Section 15.6 applies the same principle with its separately stated primitive-hypercharge convention.

5 The calculated generator disturbance

5.1 A positive matrix with a precise interpretation

For a unital completely positive dual define

$$\mathrm{N}_\Phi(X,Y)=\Phi(X^\dagger Y)\text{-}\Phi(X)^\dagger\Phi(Y),\qquad \Sigma_{AB}=\mathrm{Tr}[\rho_{49}\mathrm{N}_\Phi(T_A,T_B)]. \qquad (7)$$

In a Stinespring representation $\Phi(X)=V^\dagger\pi(X)V$, let $Q_\perp=I\text{-}VV^\dagger$ and $L_X=Q_\perp\pi(X)V$. Then

$$\mathrm{N}_\Phi(X,Y)=L_X^\dagger L_Y,\qquad v^\dagger\Sigma v=\mathrm{Tr}[\rho_{49}L_{\sum_A v_A T_A}^\dagger L_{\sum_A v_A T_A}]\geq 0. \qquad (8)$$

This is the standard completely positive Schwarz structure and multiplicative-domain criterion [14, 15], applied here to the native generators. For a self-adjoint X, zero operator defect means that X lies in the multiplicative domain. It need not mean that $\Phi(X)=X$. The distinction matters when interpreting preservation.

Direct Kraus evaluation and an independent stacked-isometry calculation agree to Frobenius residual 1.49×10^{-16}. The smallest eigenvalue of ReΣ is 0.004753643532, while the largest is 0.015911666450.

Thus every nonzero real linear combination of the twelve generators has strictly positive state-contracted defect at this fixture. Although ρ_{49} is not faithful, a positive expectation still proves a nonzero operator defect. A zero expectation alone would not prove the converse.

5.2 Sector contractions and correlations

The full matrix is computed before any averaging. Simultaneously rotating the ray and internal frame gives the expected adjoint covariance, checked to 3.79×10^{-16}. Since the preparation is gauge invariant, the exact quadratic Reynolds projection has the factor form

$$\overline{\Sigma}=\mathrm{diag}(\sigma_C I_8,\sigma_W I_3,\sigma_Y),\quad \sigma_C=1/8\ \mathrm{Tr}\Sigma_{CC},\quad \sigma_W=1/3\ \mathrm{Tr}\Sigma_{WW}. \qquad (9)$$

Sector	Invariant channel defect σ_A	Charge Gram G_A	σ_A/G_A
Colour	0.008344804651	6	0.001390800775
Weak	0.009195544222	6.5	0.001414699111
Hypercharge	0.015092613592	10.5	0.001437391771

The last column differs between sectors; its largest-to-smallest ratio is approximately 1.03350. This is another native diagnostic for which a common multiple of the charge Gram does not follow automatically. It is not an estimated correction to the previous paper's gauge coefficients. The invariant contraction averages the channel defect itself; it is not the Schwarz defect of a channel averaged over frames, which is a different nonlinear operation.

At the fixed frame, the twelve directions are correlated. The largest absolute normalised off-diagonal entry in the archived ordering is about 0.276782. Gauge averaging removes the forbidden cross-factor quadratic tensors, but does not erase the correlations present in a specified source frame or the higher-order mixed responses.

The fermion-address and Higgs-address contributions can also be separated algebraically. Let $P_F=\mathrm{diag}(I_{48},0_2)$, $P_H=I-P_F$ and $T_A=T_A^F+T_A^H$. Bilinearity of (7) gives

$$\sigma_A=\sigma_A^{FF}+\sigma_A^{HH}+2\mathrm{Re}\sigma_A^{FH}. \qquad (10)$$

Sector	Fermion-address term	Higgs-address term	Twice the cross term
Colour	0.008344804651	0	0
Weak	0.008719736512	0.000690488228	−0.000214680518
Hypercharge	0.014571260875	0.000669419093	−0.000148066376

Their sums reproduce the first table to less than 3.0×10^{-17}. These negative cross terms demonstrate why adding independently computed positive sector contributions can miss part of the joint result. The labels describe address blocks, not an already constructed interacting fermion–Higgs Fock channel.

6 Applying the test to a moving matter current

6.1 An exact shared-link restriction

Take the two-site one-address-space restriction of (1), with one scalar hopping coefficient h>0 and one retained generator T_A. Let B=$|t\rangle\langle s|$, set $\hbar$=1, and use

$$H(\theta)=-h(B\otimes e^{i\theta T_A}+B^\dagger\otimes e^{-i\theta T_A}),\quad H_0=-h\sigma_x\otimes I,\quad I_A=-\partial_\theta H(0)=h\sigma_y\otimes T_A. \qquad (11)$$

Equation (11) is a declared hopping restriction motivated by the common link in the source. It omits spin-dependent geometry, the other links, completion interactions and the physical gauge-state constraint. The native operation is applied collectively to the internal diagnostic, as $\mathrm{id}_{\mathrm{site}}\otimes \mathrm{E}_j$. A local recording event resolving the site would be a different channel. The calculation is therefore an operator-attachment test, not the full physical evolution.

The Heisenberg motion is exact:

$$I_A(t)=h[\sigma_y\cos(2ht)+\sigma_z\sin(2ht)]\otimes T_A. \qquad (12)$$

The site factor in square brackets squares to the identity. Since the channel acts only on the internal factor, its current defect is

$$\mathrm{N}_{\mathrm{id}\otimes\Phi}(I_A(t),I_B(t))=h^2 I_{\mathrm{site}}\otimes \mathrm{N}_\Phi(T_A,T_B). \qquad (13)$$

This holds for all times, including zero, and for every generator pair in the common zero-link hopping restriction. Any normalized site preparation therefore gives the current covariance $h^2\Sigma$, with the factor h^2 supplying current-squared units.

Five-point source differentiation checks the sign and insertion in (11). Independent matrix exponentials check (12), and direct 100-dimensional channel evaluation checks (13). The largest reported derivative residual is 2.67×10^{-12}, the evolution residual is 1.25×10^{-15} and the noise-identity residual is 3.79×10^{-15} for the tested colour, weak and hypercharge representatives and times. These are numerical verification errors, not physical uncertainty estimates.

6.2 What happens to the delayed propagation question

For an observable initially in the channel's multiplicative domain, [1, Proposition E1] locates the first exposed commutator in its Hamiltonian orbit. The current (11) fails that initial condition. Its first nonzero order is already r=0, so searching only for a later current velocity would miss its direct exposure.

The result does not invalidate the preceding coordinate theorem. Multiplication by j and the bilinear current (2) are different observables. Nor does it prove that the physical VERSF matter current is exposed immediately: that conclusion would require the admitted carrier and physical operation to restrict to (11) and (5), or an equivalent observable identity. The present result rejects automatic transfer of coordinate preservation to this source-motivated current attachment.

7 Conservation and the physical carrier

7.1 Reduced disturbance can coexist with total conservation

The full QCA construction retains the current orbit and excitation pointer. Its Ward identity is

$$V(J_A^{\mathrm{orb}}+T_A)=(J_A^{\mathrm{orb}}+T_A+t_A^{\mathrm{ptr}})V. \qquad (14)$$

The pointer hypercharge is zero; orbital current carries the corresponding exchange. In a finite regulator, or on a suitable common invariant domain, an intertwined total charge $Q_A^{\mathrm{out}}V=VQ_A^{\mathrm{in}}$ has $L_{Q_A^{\mathrm{out}}}=0$. If $Q_A^{\mathrm{out}}=X_A+Y_A$ splits into internal and compensating contributions, linearity gives

$$L_{X_A}=-L_{Y_A}, \qquad \mathrm{N}(X_A,X_B)=\mathrm{N}(Y_A,Y_B)=-\mathrm{N}(X_A,Y_B). \qquad (15)$$

Thus reduced internal charge exposure can be balanced by exactly correlated disturbance in the retained current and pointer. Equation (15) is a consequence of the existing intertwiner, not an extra source of charge. It does not calculate physical energy transport or the spatial gauge-current response. Those require the corresponding joint Hamiltonian and state. Section 10 constructs one such compatible transport and evaluates its response, without identifying it as the source-selected physical motion.

7.2 A quantitative check on the address identification

The source already warns that the 50-address direct sum is not a physical particle-conversion space [6; 7, Section XIV.12]. The matrix calculation makes that limitation explicit. For the equal ray, the native channel gives

$$\mathrm{Tr}[P_H\mathrm{E}(P_F/48)]=0.002223309121, \qquad \mathrm{Tr}[P_F\mathrm{E}(P_H/2)]=0.053359418906. \qquad (16)$$

The unequal probabilities reflect the block dimensions; unitality gives the exact balance $48p_{F\to H}=2p_{H\to F}$. These numbers are address-block transfers, not predictions that individual fermions turn into Higgs particles. Simply interpreting P_F and P_H as physical fermion and boson sectors and treating every environment state as even cannot implement this channel while preserving that system parity. Additional compensating degrees of freedom or a different carrier map are required. Section 10.1 supplies an explicit compensator for charge and parity; Appendix D evaluates the different reduction obtained by discarding that compensator and projecting onto the even observable algebra.

This is a failure of that naive direct interpretation, not a no-go theorem for a graded extension. A complete physical map could include fermionic environment states, many-particle processes and additional record structure. Its amplitudes and state preparation must be derived or shown equivalent for the requested observable. The MFKR uniqueness result for a supplied one-particle transfer remains intact; it does not identify this direct sum with that transfer.

Likewise, an internal projector P_r is not the appended output ledger projector $|r\rangle\langle r|$. Retention of a fact in the latter does not require the incoming internal sector observable to be fixed. The archive returns the internal-projector defects separately so the two meanings of record are not conflated.

8 Why the noise matrix is not a force correction

8.1 The exact variance identity

For self-adjoint X, the output variance obeys

$$\mathrm{Var}_{\mathrm{E}(\rho)}(X)=\mathrm{Var}_{\rho}(\Phi(X))+\mathrm{Tr}[\rho\mathrm{N}_{\Phi}(X,X)]. \qquad (17)$$

The positive term measures the channel's failure to preserve operator products. It equals the change from the original variance only when the other term is controlled appropriately, in particular when $\Phi(X)=X$. That condition holds for the retained coordinate and fails for the tested charge generators.

At ρ_{49}, every listed generator has a positive Schwarz defect, yet its output variance is slightly smaller than its input variance. The colour changes are approximately -1.156×10^{-4}, the weak changes approximately -1.221×10^{-4} and the hypercharge change is $-1.803041351\times10^{-4}$. The full values are in Appendix B and the

archive. Describing the positive entries of Σ as an equal increase in physical current fluctuation would therefore be incorrect even on this finite model.

8.2 An unchanged-state control using the same operation

Every C_a in (4), including C_0, is Hermitian and $\sum_a C_a^2 = I$. Hence

$$\mathrm{E}(I)=\sum_r P_r \left(\sum_a C_a^2\right) P_r = I, \qquad \mathrm{E}(\rho_{50})=\rho_{50}, \quad \rho_{50}=I/50. \qquad (18)$$

The generator defect at ρ_{50} is still positive definite; its smallest eigenvalue is 0.004713149193. Nevertheless, if the outcome is ignored and all later dynamics and probes act on the retained system alone, the recorded and unrecorded experiments start from the same state. They therefore have exactly the same later unconditioned statistics under any identical continuation. The statement also holds for an independent spectator tensor factor prepared in product with ρ_{50}.

The control excludes feedback through retained record correlations, selection on the outcome, probes acting during the event and initial correlations with external systems. Those are precisely circumstances in which a physical joint calculation can differ. The control establishes the narrower, sufficient point: positive channel defect alone does not imply a changed response, let alone a change of force strength. The earlier uniform-state cancellation in [8, Section 15.3] is retained; the new contribution is its explicit comparison with a strictly positive twelve-generator defect and the hopping-current identity.

For the actual rank-49 preparation, unitality gives another exact relation,

$$\mathrm{E}(\rho_{49})-\rho_{49}=\frac{|45\rangle\langle 45|-\mathrm{E}(|45\rangle\langle 45|)}{49}, \qquad D_{\mathrm{tr}}(\mathrm{E}(\rho_{49}),\rho_{49})\le\frac{1}{49}. \qquad (19)$$

Here $D_{\mathrm{tr}}(\rho,\sigma)=\frac{1}{2}\|\rho-\sigma\|_1$. The evaluated distance is 0.001195291355 for the stated one-event reduced-state comparison; a repeated, conditioned history is a different comparison.

9 The energetic response that must be calculated

9.1 Static curvature requires more than an event defect

Suppose an admitted complete finite Hamiltonian $H(\theta)$ and its equilibrium state are available on the physical quotient, with a fixed trace measure and inverse temperature β. Define $\mathcal{F}_{\mathrm{eq}}(\theta)=-\beta^{-1}\log\mathrm{Tr}e^{-\beta H(\theta)}$. Differentiating gives

$$\partial_A\partial_B\mathcal{F}_{\mathrm{eq}}=\langle H_{AB}\rangle-\int_0^\beta d\tau\,\langle\delta H_A(\tau)\,\delta H_B(0)\rangle, \quad H_A=\partial_A H, \quad H_A(\tau)=e^{\tau H}H_A e^{-\tau H}. \qquad (20)$$

The integral is the connected imaginary-time response, not generally β times an equal-time classical variance. Equation (20) is standard quantum response theory [16]; it is restated to identify the quantity needed here. The direct second derivative H_{AB} is the contact term. Replacing the full result by a positive matrix of recording noise would omit both this term and the spectrum that weights temporal correlations.

For a nondegenerate gapped ground state the same curvature can be written

$$\partial_A\partial_B E_0=\langle 0|H_{AB}|0\rangle-2\mathrm{Re}\sum_{n>0}\frac{\langle 0|H_A|n\rangle\langle n|H_B|0\rangle}{E_n-E_0}. \qquad (21)$$

This formula follows directly by differentiating the eigenvalue equation with a normalised eigenvector. Degeneracy requires the corresponding degenerate perturbation problem. Both formulas require the actual admitted state and dynamics; neither establishes that the physical completed-record ensemble is Gibbs. If the source changes the measure, physical subspace or event-conditioned preparation with the probe, those derivatives must also be retained.

9.2 The joint-history route

For an actual completed-record ensemble, let $M_h(\theta)$ contain the complete ordered joint evolution and marked operations, and let $w_h(\theta)$ include any specified waiting or completion weights not already inside M_h. The normalised history functional is built from

$$\mathrm{Z}(\theta)=\sum_h w_h(\theta)\mathrm{Tr}[M_h(\theta)\rho_{\mathrm{in}}(\theta)M_h(\theta)^\dagger]. \qquad (22)$$

The retained gauge response must differentiate the source functional appropriate to its conditioning, including every derivative in (22). For the trace of all histories of a complete trace-preserving operation, Z=1; its logarithm alone cannot serve as an energetic gauge action. A tilted observable functional, source work or an independently established effective-action relation is required. Normalisation does not erase all response information, but it does prevent this particular shortcut. This distinction is already present in [8, Sections 8 and 19.9].

The direct-action route is equally legitimate. Starting from the source-selected common Hessian, its auxiliary reduction has the schematic form

$$K_{\mathrm{red}}(\omega,k)=K_{gg}-K_{g\xi}K_{\xi\xi}^{-1}K_{\xi g}, \qquad Z_{AB}=\mathrm{T}_A^\dagger K_{\mathrm{red}}\mathrm{T}_B. \qquad (23)$$

Here ξ collects eliminated auxiliary variables and T_A embeds the retained gauge probe. All blocks use the same source, frequency, momentum and physical support. Gauge null directions are removed before inversion. Fermion determinants and their mixed derivatives enter once at the stage where those fermions are eliminated. The temporal kinetic coefficient is not obtained by inverting a static Schur stiffness. These requirements are inherited from MASD, RCHS-35 and the subsequent source-history and chiral calculations [2, 7, 8, 13].

Only after the small-momentum action has the canonically normalised gauge form do its stiffnesses define the gauge couplings. In conventional hypercharge coordinates the relation is $g_A^2=1/Z_A$; in primitive integer-charge coordinates $q=6Y$, the equivalent conversion is $g'=6/\sqrt{Z_q}$. The factor of six must be used once. Temporal and spatial matching, regulator limits, running, thresholds and the matching scale remain part of the observable calculation. If a measured coupling is used to determine a scale, it is a calibration input rather than an independent prediction.

10 Joint matter record transport and its energetic response

The preceding results leave open whether a conserved joint current can inherit the internal channel noise. We now construct one explicit completion and follow it through spatial motion and source response. The construction retains the native matrices and ledger, but its joint transport is a declared branch rather than a derivation of the full source-selected evolution.

10.1 Encoding the native operation on a joint sector

Retain the 50-address matrices, seven terminal projectors and 91 Kraus operators of Sections 4 and 5. Write $q=6Y$ for primitive hypercharge; its address eigenvalues are integers q_k. The first 48 addresses

have fermionic parity π_k=-1, and the two Higgs addresses have π_k=+1. This assignment is used only when the labels are embedded as physical occupation states.

Introduce an orbital reference with Fourier basis $|n\rangle$, charge $J|n\rangle$=-$n|n\rangle$, and a two-sector reference parity register $|\varepsilon\rangle$ with parity ε=±1. For any integer total charge m and total parity p=±1, define the isometry

$$W_{m,p}|k\rangle=|q_k\text{-}m\rangle\otimes|p\pi_k\rangle\otimes|k\rangle. \qquad (24)$$

Every encoded vector has Q=q+J=m and total parity p. The labels m,p select a joint sector; they are not proposed replacements for the Standard Model matter census. Internal matter charge remains q_k, with the difference carried by the reference.

For a native amplitude $(K_{ra})_{lk}$, extend its action by the required reference shifts,

$$\widetilde{K}_{ra}|n,\varepsilon,k\rangle=\sum_{l}(K_{ra})_{lk}\,|n+q_l\text{-}q_k,\ \varepsilon\pi_l\pi_k,\ l\rangle. \qquad (25)$$

Equation (25) conserves Q and total parity term by term. It obeys $\widetilde{K}_{ra}W_{m,p}$=$W_{m,p}K_{ra}$. Its completeness follows from native completeness: in a matrix element of $\sum_{ra}\widetilde{K}_{ra}^{\dagger}\,\widetilde{K}_{ra}$, the reference shifts factor independently of the summed intermediate address, and $\sum_{ra}K_{ra}^{\dagger}\,K_{ra}$=$I$ removes every off-diagonal input term. Appending neutral orthogonal pointer labels $|a,r\rangle$ therefore gives an isometry

$$\widetilde{V}=\sum_{r,a}\widetilde{K}_{ra}\otimes|a,r\rangle, \qquad Q_{\text{out}}\widetilde{V}=\widetilde{V}Q_{\text{in}}. \qquad (26)$$

The pointer is neutral under hypercharge, as in QCA [6]. This construction tests that Abelian subgroup, not the complete non-Abelian or chiral reconstruction.

The encoding is an occupation-space existence construction. The parity register may be represented by an ancillary fermionic mode: with p=-1, a fermionic matter address is paired with its empty state, and a Higgs address with its occupied state. A bosonic Higgs excitation and the occupied ancillary fermion then have the same total parity as a single fermionic matter excitation. Charge is compensated by the orbital reference. All encoded basis states are legitimate vectors of a fermion–boson occupation space. This does not select the ancillary mode's energy, its physical identification with the source current, a multi-occupation extension, or the full local Standard Model constraints.

There is also a direct orbit interpretation. On $U(1)\times Z_2$, take $j(\varphi,\epsilon_{\text{orb}})$=$e^{i\varphi q}\Pi^{\epsilon_{\text{orb}}}j_0$. Native covariance gives $K_{ra}(\varphi,\epsilon_{\text{orb}})$=$e^{i\varphi q}\Pi^{\epsilon_{\text{orb}}}K_{ra}(0)\Pi^{\epsilon_{\text{orb}}}e^{-i\varphi q}$. The encoded Fourier wavefunctions reproduce (24) and (25). The calculation checks this identity for all 91 Kraus operators on 64 orbit points, with maximum residual 1.78×10^{-16}. The underlying proof has no Fourier cutoff.

10.2 Cancellation in the total charge

Use the native rank-49 state in the encoded sector. On that sector J=mI-q, so the Schwarz defect defined in (7) satisfies

$$N(q,J)=\text{-}N(q,q), \qquad N(J,J)=N(q,q), \qquad N(Q,Q)=0. \qquad (27)$$

Equation (27) is operator-valued. Its noise is the product defect (7), not a total physical variance or, in general, a variance increment. Its state-contracted return is

Contribution	Native charge defect
Matter q term	0.543334089300
Compensating J term	0.543334089300
Twice their cross term	−1.086668178600
Total Q term	0 exactly

The matter entry is 36 times the Section 5 hypercharge value 0.015092613592, because $q=6Y$. Nothing has been fitted or suppressed. The cancellation retains the correlated compensator. It would be lost if the two positive diagonal entries were added while the cross term was omitted. Direct finite matrices agree with zero at approximately 10^{-15}.

Conservation of a total charge does not by itself determine a spatial current. We next supply the particular transport for which this charge becomes the link-current insertion.

10.3 A compatible joint transport

Let the same Abelian link act on the matter representation and on its compensating orbital reference. In this completion the input link is $U_{in}(\theta)=e^{i\theta Q_{in}}$ and the output link is $U_{out}(\theta)=e^{i\theta Q_{out}}$, acting trivially on the stored ledger. Equation (26) gives

$$U_{out}(\theta)\widetilde{V}=\widetilde{V}U_{in}(\theta). \qquad (28)$$

A graph hopping operator assembled from these links, with the same supplied hopping coefficients before and after recording, then satisfies

$$H_{\parallel,out}(\theta)\widetilde{V}=\widetilde{V}H_{\parallel,in}(\theta). \qquad (29)$$

Equation (29) is obtained edge by edge; it is not an identification of the static master Hessian with a temporal kinetic operator. In the fixed-m sector the graph Hamiltonian acts on position and charge m, while the native matrices act on the encoded internal factor. The kinetic energy is therefore insensitive to redistribution between matter charge and its compensator on this branch. All old ledger projectors commute with the output transport, so this particular free continuation preserves the written record.

The assumption that the reference travels with matter is substantive. MASD [2] treats source current and matter as independent variables with mixed couplings. Gauge covariance alone does not require their physical propagation to equal (29). This is an explicit extension compatible with the native intertwiner, not a proof that the full source selects that motion or makes all internal energies degenerate.

The construction is compatible with Abelian Gauss constraints: recording changes neither total local charge nor link electric flux. For a ring with a static charge $-m$ at vertex zero and a transported charge $+m$ at vertex s, choose integer electric flux

$$E_e=\begin{cases}-m, & e<s,\\ 0, & e\geq s.\end{cases} \quad E_x-E_{x-1}=m(\delta_{xs}-\delta_{x0}). \qquad (30)$$

Every component of the encoded record output has the same m, so recording preserves this constraint. The calculation checks the dressing for three positions and five background flux integers. This certifies a class of Abelian physical states; it does not impose the full colour, weak and chiral constraints or claim that this state is the physical vacuum.

A recording pulse can be combined with the free motion explicitly. On the input/output direct sum, write $H_f = H_{\parallel,\mathrm{in}} \oplus H_{\parallel,\mathrm{out}}$ and

$$H_{\mathrm{pulse}} = \Omega \begin{pmatrix} 0 & -i\widetilde{V}^{\dagger} \\ i\widetilde{V} & 0 \end{pmatrix}. \qquad [H_f, H_{\mathrm{pulse}}] = 0. \qquad (31)$$

At duration $\pi/(2\Omega)$ this implements recording alongside free evolution. This extends the existing QCA implementation by an explicit compatible transport. Neither Ω, the switch ending the pulse, the compensator energy nor a physical clock is source-selected here. The construction cannot establish irreversible completion merely by arranging a finite pulse.

10.4 The gauge current and energy response

For the source-independent encoding above, differentiate (29). With $I = -\partial_\theta H$, one obtains $I_{\mathrm{out}}\widetilde{V} = \widetilde{V} I_{\mathrm{in}}$, and the same relation for the contact operator $\partial_\theta^2 H$. Applying the first identity twice also gives preservation of the current product. Hence

$$\widetilde{V}^{\dagger} I_{\mathrm{out}} \widetilde{V} = I_{\mathrm{in}}, \qquad \mathrm{N}_{\widetilde{V}}(I_{\mathrm{out}}, I_{\mathrm{out}}) = 0. \qquad (32)$$

The full Heisenberg orbit obeys the same identities. This is stronger than cancellation in a static charge: it supplies the spatial-current and temporal-propagation connection on this transport branch. It does not identify the earlier internal Y insertion with the full current.

A source-independent isometry intertwining the Hamiltonian family preserves its spectrum on the image. Initial states transported by that isometry therefore have the same source-dependent energy and the same response under the matched continuation. This statement concerns the mapped sector and preparation. A thermal trace over additional, unprepared output states is a different ensemble and is not covered. Source-dependent encodings require their derivatives and cannot be inserted into (32) unchanged.

The native terminal effects provide a useful check. Their commutators with bare primitive hypercharge have Frobenius norms between 0.950699447 and 2.302153078. Their commutators with the compensated total charge vanish. Thus an energy-intertwining completion that also preserves the ledger is compatible with the joint transport, while the corresponding bare-charge link family with a source-independent operation and frozen reference fails that terminal-effect commutator test. This applies the earlier energy/record condition of [8, Sections 18.7–18.9] to the new matter-current attachment.

10.4.1 An open link has zero static flux curvature

The two-site phase used in Section 6 is a current-insertion diagnostic. With freely transforming endpoints and no external phase reference, its single Abelian link is pure gauge. Its spectrum is independent of the link phase. The ground-state source curvature must include both terms of (21).

For charge $m=1$ and hopping $h=1$, the contact and spectral terms are both 1, giving zero. Direct matrices return 2.22×10^{-16}. A positive current defect on an open-link diagnostic therefore cannot be read as a magnetic stiffness. A retained loop or another specified physical source observable is necessary.

10.4.2 A loop with unchanged recording response

For a three-site ring carrying total primitive charge m, fix the background Wilson-loop phase Φ and use

$$H_m(\Phi)=-h\sum_{x=0}^{2}(e^{im\Phi/3}|x+1\rangle\langle x|+\text{h.c.}),\qquad E_0(\Phi)=-2h\cos(m\Phi/3). \qquad (33)$$

The spatial ground-state branch is nondegenerate near zero flux and its internal degeneracy is flux-independent. Thus $E_0^{''}(0)=2hm^2/9$, unchanged by the matched recording. At $m=h=1$, the contact term is $2/9$ and the spectral subtraction is zero because the translation eigenvectors are flux-independent.

As implementation checks, finite-field differentiation agrees within 1.04×10^{-11} and the unchanged-energy comparison within 6×10^{-16}; the equality itself follows from the intertwiner.

The flux is an imposed background, not a dynamical coordinate integrated over here. Equation (30) separately establishes Gauss compatibility; the ring size, charge sector and $h=1$ specify this control.

10.5 The additional dynamics required for a correction

The completed transport above makes the native operation an exact intertwiner. It therefore provides a zero-correction existence witness. The physical question is whether the full source produces a different Hamiltonian on the same space and preparation.

Let $P=VV^\dagger$ and $Q_\perp=I-P$ for an admitted physical attaching isometry. For a complete source-selected Hamiltonian $H(\Phi)$, eliminating the complementary subspace gives the exact energy-dependent operator

$$H_{\text{eff}}(z,\Phi)=V^\dagger HV+V^\dagger HQ_\perp(z-Q_\perp HQ_\perp)^{-1}Q_\perp HV. \qquad (34)$$

This follows by solving the complementary component of the eigenvalue equation and substituting into the retained component. The inverse is taken on the complementary subspace. The expression is valid where that resolvent exists; eigenvalues satisfy the resulting energy-dependent problem. It is not a static covariance matrix or an identification of probability weights with energy.

Write $H=H_\parallel+\Delta H$. If the retained subspace reduces $H_\parallel$ and its compression is the already matched transport, the additional response comes from the direct compression $V^\dagger\Delta HV$ and the couplings $Q_\perp\Delta HV$ through the resolvent. Their source derivatives, the physical state, and any source dependence of V must all be retained. A nonzero mismatch is necessary to leave the exact-intertwining branch in this comparison, but is not sufficient to guarantee a nonzero curvature correction.

For VERSF these objects must come from the same mixed current, record, matter and completion dynamics with the inherited primitive metric and shared link. The present sources specify their action framework but do not instantiate this complete physical operator and attaching map. Assigning ΔH a convenient strength would replace that remaining derivation with a model choice. Section 11 now evaluates a kinetic restriction with its physical coefficient left symbolic and derives an isolated static link–record response directly from the common action.

The insufficiency of the operation alone is particularly sharp. At a fixed background flux, adding $\lambda(1-\cos\Phi)I$ to a Hamiltonian changes only the phase of its matter–record propagator, so its reduced instrument is unchanged, yet its energy curvature at zero shifts by λ. On a dynamical gauge field that same term is a genuine Wilson-loop potential. This is a counterexample to determining a gauge action from an instrument and symmetry alone. It is not a claimed freedom after the complete MASD action and normalisation have been fixed.

11 Additional dynamics and the loop energy response

The common generator is an explicit functional of its source data. This section derives its current-kinetic contribution and distinguishes a change in absolute flux curvature from a recording-induced change under the same dynamics. A common source potential can affect the first while leaving the second unchanged.

11.1 What the common action fixes

MASD [2, Sections 9, 13–17, 21–24 and 29–32] supplies

$$\Gamma_{\mathrm{bos}}=\Gamma_V+1/2\,\langle\mathbf{D},W_{\mathrm{prim}}\mathbf{D}\rangle,\qquad W_{XY}=\iota_X^{\dagger}W_{\mathrm{prim}}\iota_Y.\qquad(35)$$

The six defect families are closure, constitutive current, continuity, record composition, polar bond compatibility and scalar-to-completion stretch. In particular,

$$\mathrm{D}_J=J-\kappa(\rho_t-U\rho_s),\quad \mathrm{D}_T=\partial_\sigma\rho+\partial_U J,\quad \mathrm{D}_B=\Pi_t U\Pi_s-V_{ts}.\qquad(36)$$

The current J, substrate amplitude ρ, physical link U and record/completion variables are independent. Neither $\mathrm{D}_J=0$ nor $\mathrm{D}_B=0$ is a hard identity imposed on every fluctuation. At a common zero, fixed conductance gives

$$\delta\mathrm{D}_J=\delta J-\kappa(\delta\rho_t-U\delta\rho_s-\delta U\rho_s).\qquad(37)$$

Together with the support and polar derivatives in $\delta\mathrm{D}_B$, this supplies mixed current, endpoint, link and record terms. Their coefficients are the common metric overlaps, not independently adjustable couplings. The exact static Hessian is $G_V+D\mathbf{D}^{\dagger}W_{\mathrm{prim}}D\mathbf{D}$, followed by its physical quotient and complete auxiliary Schur reduction.

The fermionic spatial operator is also already explicit. MFKR [5, Sections 5–8] reconstructs

$$K_U^{\mathrm{src}}=T^{\sharp}\Gamma_E B_U+(T^{\sharp}\Gamma_E B_U)^{\sharp}.\qquad(38)$$

Here $B_U\psi$ is the transported edge difference and $T\psi$ evaluates its target; $\sharp$ is the adjoint in the source pairing. The completion bilinear has the typed coefficient $\Lambda_\star(A_{fL}^{(0)})^{\dagger}V_H^{\dagger}X_H A_{fR}^{(0)}$ [2]. These are concrete source functionals. Their physical time attachment, complete carrier and background must be supplied before subtracting the diagnostic Hamiltonian (33). The 50-address native fixture is not by itself that complete CAR/Fock carrier.

HMGBC [12, Section 56A] specifies the operational transfer and its generator,

$$\mathrm{T}_a=e^{-aV_{\mathrm{ref}}/2}e^{-aL_{\mathrm{op}}}e^{-aV_{\mathrm{ref}}/2},\qquad H_E=-a^{-1}\log\mathrm{T}_a.\qquad(39)$$

Once a common carrier and time unit have been established, the exact source definition is $\Delta H_E=H_E-H_{\|}$. At a fixed finite regulator, symmetric splitting gives $H_E=L_{\mathrm{op}}+V_{\mathrm{ref}}$ up to an $O(a^2)$ correction. Real-time interpretation additionally requires the source's continuation and fermionic transfer admission. HMGBC derives the response metric downstream of this history construction: inserting an independently selected six-defect metric back into (39) would not complete that derivation.

The missing input is therefore an instantiated common generator and attachment, not the existence of an action or of a spatial kinetic functional. In particular, D_T contains a derivative of ρ, not a freely prescribed rotor kinetic term for J. Independent configuration variables do not automatically have independent canonical momenta. A current inertia must follow from the operational generator or a valid constraint

reduction. Setting that inertia equal to a static susceptibility, to the identity, or to a fitted number would introduce an additional assumption.

11.2 Kinetic compression and complementary coupling

A useful component can nevertheless be derived without choosing its physical strength. Take the source's operational Dirichlet branch to have the local form

$$L_{\mathrm{op}}=-\frac{1}{2\mu}\partial_i(\mu g^{ij}\partial_j). \qquad (40)$$

This is a conditional differential restriction of the source generator, not an assertion that every finite-regulator transfer has this form. The measure μ, positive inverse kinetic metric g^{ij} and their gauge dependence must be inherited. Let $V(x)$ be the native pointwise recording isometry on the same configuration variables, with $V^{\dagger}V=I$. QCA [6] supplies that type of current-dependent isometry conditionally. Define

$$\mathcal{A}_i=V^{\dagger}\partial_i V, \qquad \mathcal{B}_i=(I-VV^{\dagger})\partial_i V, \qquad D_i=\partial_i+\mathcal{A}_i. \qquad (41)$$

Differentiating $V^{\dagger}V=I$ shows that $\mathcal{A}_i$ is anti-Hermitian. Applying the product rule twice gives the exact compression

$$V^{\dagger}L_{\mathrm{op}}V=-\frac{1}{2\mu}D_i(\mu g^{ij}D_j)+1/2\; g^{ij}\mathcal{B}_i^{\dagger}\mathcal{B}_j. \qquad (42)$$

Thus the additional kinetic terms include both a connection in the derivative and a positive geometric potential. Keeping only the last term is incorrect. A scalar multiplication potential in the retained configuration variables commutes through this pointwise isometry. An internal matrix potential H_{int} instead contributes $V^{\dagger}H_{\mathrm{int_{out}}}V-H_{\mathrm{int_{in}}}$. If the physical recording operation changes the underlying configuration or its preparation, this pointwise restriction must itself be replaced.

Compression alone is not complete evolution. The complementary coupling generated by (40) is

$$Q_{\perp}L_{\mathrm{op}}(V\psi)=-g^{ij}\mathcal{B}_i\partial_j\psi-\frac{1}{2\mu}Q_{\perp}\partial_i(\mu g^{ij}\partial_j V)\psi. \qquad (43)$$

Here $Q_{\perp}=I-VV^{\dagger}$; an internal potential adds $Q_{\perp}H_{\mathrm{int}}V\psi$. These terms enter the energy-dependent Schur resolvent (34). Equation (42) is a direct retained block, not a license to discard (43).

11.3 The native current orbit calculation

Use the unchanged native 50-address fixture, 91 terminal Kraus operators K_{ra} and preparation $\rho=(I-|45\rangle\langle 45|)/49$. The index 45 is zero-based. Write $\mathrm{C}(X)=\sum_{ra}K_{ra}^{\dagger}XK_{ra}$. On the Abelian current orbit, covariance gives

$$K_{ra}(\theta)=e^{i\theta q}K_{ra}(0)e^{-i\theta q}, \qquad \mathcal{A}_{\theta}=i(\mathrm{C}(q)-q). \qquad (44)$$

The orbital parameter θ is distinct from the spatial Wilson flux Φ. If this orbit has a flux-independent kinetic coefficient $g^{\theta\theta}=\mathrm{I}^{-1}$ and invariant measure, then $L_J=-\partial_{\theta}^2/(2\mathrm{I})$. The symbol I is an unspecified physical inertia; the calculations report coefficients multiplying $1/\mathrm{I}$ in units with $\hbar=1$.

A second exact identity is

$$\mathcal{B}_{\theta}^{\dagger}\mathcal{B}_{\theta}=\mathrm{C}(q^2)-\mathrm{C}(q)^2=\mathrm{N}(q,q). \qquad (45)$$

This connects the previous native Schwarz defect to an energetic contribution on a declared kinetic branch. It does not identify the Schwarz defect with the complete energy change.

In the fixed-m compensated sector, reference Fourier indices are q_k-m, so J=mI-q. The complete direct recording-energy difference for the reference kinetic term is

$$\Delta H_{J,\mathrm{ret}}=\frac{\mathrm{C}((mI\text{-}q)^2)\text{-}(mI\text{-}q)^2}{2\mathrm{I}}. \qquad (46)$$

This is the difference between the outgoing kinetic energy pulled back through recording and the incoming kinetic energy. Direct Fourier embedding and the connection formula (42) independently give (46).

For m=1, the numerical contractions are as follows. Every energy entry is a coefficient of 1/I.

Quantity	Coefficient
Positive geometric contribution	0.271667044650
Remaining connection contribution	−0.274673896047
Complete recording energy change	−0.003006851397
Reference kinetic energy before recording	4.234693877551
Reference kinetic energy after recording	4.231687026154

The operator in (46) has both signs: its extreme eigenvalues are approximately -7.198426006/I and 5.603605681/I. The tracial preparation gives zero energy change, as native unitality requires. For the omitted sterile-address pure state, the change is 0.147335718453/I; the rank-49 result is exactly its negative divided by 49. The negative ensemble value therefore does not establish universal cooling or a universal relaxation mechanism.

The outgoing kinetic operator no longer intertwines the recording operation. At unit inverse inertia the Frobenius norm of its intertwining mismatch is 14.4891382402, and its coupling from the recording image to its complement is 11.1858753372. The geometric-potential identity and complete compression agree within 1.3×10^{-13}; direct orbit differentiation agrees within 1.5×10^{-12}.

11.4 Why the additional internal energy leaves the loop response unchanged

Retain the earlier common transport of total charge m, but now allow a homogeneous, flux-independent internal Hamiltonian H_{int}. It can include the reference kinetic term just evaluated and any admitted local completion term of the same separable type. Then

$$H(\Phi)=H_m(\Phi)\otimes I+I\otimes H_{\mathrm{int}}, \qquad E_0(\Phi)=\text{-}2h\cos(m\Phi/3)+\lambda_{\min}(H_{\mathrm{int}}). \qquad (47)$$

Consequently $E_0''(0)=2hm^2/9$ for any such H_{int}, even if H_{int} fails to intertwine recording. For a fixed internal preparation the expected energy has the same flux dependence. Recording can change its constant internal expectation, but cannot change its curvature. This holds for an internal continuum with a well-defined lower spectral edge as well as for the finite matrices used here.

The H_{int}=J^2/(2I), h=m=I=1 implementation reproduces the exact 2/9 curvature within 6.6×10^{-10}; this is a code check of (47), not additional evidence for its algebraic consequence.

This also includes the complementary-space effect: in a translation sector of energy $e(\Phi)$, the exact compressed resolvent is $C((z\text{-}e(\Phi)\text{-}H_{\mathrm{int}})^{-1})$. All its poles translate by the same $e(\Phi)$, so their curvature is unchanged; no replacement of the full operator by (42) is required.

The restriction is substantial: the reference still travels with matter in (33), and I, the internal preparation and H_{int} have no external-flux dependence. Separately propagating constituents, position-dependent internal couplings, a flux-dependent operational metric, or a different physical recording attachment can invalidate the factorisation. The common action must decide these questions.

11.5 Flux response from the bond and record terms

There is no general cancellation theorem for the common action. Its polar bond and record-composition defects already contain a relevant coupling. To expose it, take a three-edge Abelian loop with unit occupied support, links $U_e=e^{i\Phi/3}$ and polar record phases $V_e=e^{i\beta_e}$. For positive record stretches fixed at one, the bond and single triangle-composition terms give

$$V_{BR}=w_B\sum_{e=1}^{3}[1\text{-}\cos(\Phi/3\text{-}\beta_e)]+w_R[1\text{-}\cos(\beta_1+\beta_2+\beta_3)]. \qquad (48)$$

This follows from one-half the squared moduli of $U_e\text{-}V_e$ and of the composition defect. The positive weights w_B,w_R denote the corresponding inherited entries on an orthogonal scalar restriction. They have not been calculated for the physical branch. Equation (48) isolates two actual action terms; it does not assert that all other defects, potentials or cross-metric blocks vanish in the full problem.

At quadratic order put $\Theta=\sum_e \beta_e$. Minimisation first makes the three phases equal and then gives

$$V_{BR}^{(2)}=\frac{w_B}{6}(\Phi\text{-}\Theta)^2+\frac{w_R}{2}\Theta^2, \qquad \Theta_\star=\frac{w_B}{w_B+3w_R}\Phi. \qquad (49)$$

The static relaxed source curvature is therefore

$$\frac{d^2\min_{\boldsymbol{\beta}}V_{BR}}{d\Phi^2}\Big|_0=\frac{w_Bw_R}{w_B+3w_R}. \qquad (50)$$

For the declared unit-weight check, the frozen-record curvature is 1/3, the auxiliary subtraction is 1/12, and the relaxed result is 1/4. Minimising the original nonlinear expression (48) and then using five-point differentiation returns 0.249999999999891, 0.249999999999993 and 0.250000000000000 at successively halved steps. This checks the derivative of the nonlinear action, not merely its quadratic matrix implementation.

The response vanishes when the composition penalty is removed and tends to $w_B/3$ when it pins Θ rigidly. With the full common metric, the corresponding expression is the appropriate source/auxiliary Schur complement, including every cross block and other relaxed variable. A physical quantum energy also requires kinetic and state information; its zero-point and spectral terms cannot be inferred from (50).

A common scalar source potential does not automatically produce a before/after recording difference. This calculation demonstrates where a genuine flux-dependent action response resides and why the internal-only calculation is not the last physical test.

12 Joint source assembly and preparation dependence

This calculation assembles the available source definitions and tests whether joint preparation can be replaced by fixed current magnitude and invariant direction statistics. It reproduces an existing quadratic branch, then performs a paired experiment with the representation-valued native instrument [18–23].

12.1 What the available complete quadratic branch returns

The recovered GNC-EX3/4 runner rebuilds the HM4-EX2A six-defect Jacobian and its potential rows from their saved definitions [19]. The defect matrix is 1125×334 with rank 309; adding 22 potential rows gives rank 313. Retaining all 144 link coordinates and stationary-relaxing the other 190 coordinates, with the archived unit Hilbert–Schmidt metric, gives

$$R_3=(6L+617I/40)\otimes I_8, \qquad R_2=(6L+2041I/120)\otimes I_3, \qquad (51)$$

$$R_Y=10L+1291I/72-36(L+36I)^{-1}, \qquad L=B_C^T B_C. \qquad (52)$$

The explicit Schur formula and independent least-squares projection agree to relative residual 3.45×10^{-17}, and the exact rational check passes. This rerun reproduces an existing result. On the 72 flat link-frame directions, the minimized coefficients are 15.425, 17.0083333 and 16.9305556, rather than zero. The scalar matter and record spans do not contain the simultaneous transformations of the complete unfixed gauge orbit. The result therefore cannot be released as a massless gauge kinetic matrix. It does not exclude the later covariant endpoint/current carrier.

The recovered HFB-G1 package instead supplies the representation-valued recording law used below [20]. Its previously executed hidden-memory response is a discrete response, not an energy Hessian; negative and complex eigenvalues in its history-only subspace also prevent direct identification with a positive self-adjoint heat transfer. That archived memory calculation was read, not rerun in this attempt. Its existence does not remove the physical source conditions in Section 9 or HMGBC Section 56A [12].

12.2 A pair with identical current and identical marginal laws

Use the EX2E constitutive residual on a single edge, with endpoints in the same 50-address diagnostic representation [22]:

$$D_J=j-(\psi_t-U\psi_s), \qquad j=\psi_t-\psi_s \quad \text{at } U=I. \qquad (53)$$

To make the dependence explicit, write the native operation (4) as

$$\rho_j=\frac{jj^\dagger}{j^\dagger j}, \quad K_a=i[T_a,\rho_j], \quad S=\sum_a K_a^\dagger K_a, \quad \kappa_{\mathrm{sat}}=\lambda_{\max}(S)^{-1}, \qquad (54)$$

$$C_0=\sqrt{I-\kappa_{\mathrm{sat}}S}, \quad C_a=\sqrt{\kappa_{\mathrm{sat}}}K_a, \quad p_{ar}=\|P_r C_a w\|^2, \quad p_r=\sum_a p_{ar}. \qquad (55)$$

Here $a=1,\ldots,12$ labels excitation amplitudes, while sums over outcomes include $a=0$. The seven terminal projectors are unchanged. The maximal-positivity prescription for κ_{sat} is inherited from the archived branch; positivity alone does not select it. Initially $w=\psi_s$ is normalized. No outcome-dependent classical score kick is added, so the fixed-instrument mixture requirement and the rejection of the specific feedback proposal in RCHS-36W are respected [21].

Draw an orthonormal pair (z,v) uniformly in C^{50}. Require $\mathrm{Re}v=0$ and use the two values $v=0$ and $v=0.8i$. Set

$$\beta_v=\frac{\bar{v}-1}{\sqrt{2}},\qquad \psi_s=\beta_v z+\sqrt{1-|\beta_v|^2}\,v,\qquad \psi_t=\psi_s+\sqrt{2}z. \qquad (56)$$

With $\mathrm{Re}v=0$, direct substitution gives

$$\|\psi_s\|=\|\psi_t\|=1,\qquad \psi_s^{\dagger}\psi_t=v,\qquad j=\sqrt{2}z. \qquad (57)$$

Each paired sample therefore has the same current vector, current ray, normalization and recording matrices at the probe origin. Each endpoint marginal and the current ray also have the same Haar distribution in the two families: the orthonormal-pair law is unitarily invariant and the vectors have fixed norm. The complement direction is uniform in the 49-dimensional space orthogonal to z.

The two families differ in the imaginary part of their endpoint coherence while both have $\mathrm{Re}v=0$ and current norm squared two. At a general link use the transported inner product. This one-edge comparison tests whether the stated marginal, intensity and constitutive information suffices; it does not construct a stationary full-wheel ensemble.

12.3 Differentiate the same coupled source

Probe $U(\theta)=\exp(i\sum_b \theta_b T_b)$, hold the endpoints fixed, and solve the current from (53). At the origin,

$$w_U=U\psi_s,\qquad \partial_b w_U=iT_b w,\qquad \partial_b j=-iT_b w. \qquad (58)$$

Both the transported input and the current-dependent recording matrices are differentiated. Although the matrices coincide at the origin, their source derivatives need not coincide because the induced-current derivative depends on the endpoint preparation. Define the conditional information matrices

$$F_{bc}=\sum_{a,r}\frac{\partial_b p_{ar}\,\partial_c p_{ar}}{p_{ar}},\qquad F_{bc}^{\mathrm{term}}=\sum_{r}\frac{\partial_b p_r\,\partial_c p_r}{p_r}. \qquad (59)$$

Each sector readout is the trace of its diagonal generator block divided by 8, 3 or 1. Hypercharge uses Y, not $q=6Y$.

The execution uses 256 independent orthonormal pairs, shared between the two preparation families, with frozen seed 720261107. The table reports means of the conditional terminal information matrices; parentheses give one Monte Carlo standard error. Ratios are ratios of means.

Terminal response	$v=0$	$v=0.8i$	**Ratio**
Colour	0.00012888 (0.00000381)	0.00261689 (0.00004729)	20.31
Weak	0.00032091 (0.00001121)	0.00284624 (0.00008458)	8.87
Hypercharge Y	0.00070667 (0.00004805)	0.02629193 (0.00051359)	37.21

Resolving the microscopic current-outcome label as well gives full-mark means (0.0104786,0.0111554,0.0206851) and (0.0234415,0.0248912,0.133094). Their ratios are (2.2371,2.2313,6.4343). The hypercharge-minus-colour ratio contrast is 4.1972±0.2118 under paired-sample uncertainty propagation. The change is therefore not one common rescaling of the mean conditional information matrix.

The first fixed pair already provides a finite witness, independently of extrapolating the sample means: its current difference is 9.36×10^{-17} and recording-matrix difference 1.20×10^{-14}, while its terminal responses differ. The vectors and all sample arrays are retained [23]. Numerical checks are given in Appendix B.

The mean of conditional Fisher matrices is not the Fisher matrix after an unobserved preparation has been marginalized. Neither is automatically an action Hessian. The calculation establishes consequential joint-preparation dependence in this experiment.

12.4 The remaining physical return includes circulating current

PCN fixes the common primitive ruler (6,13/2,21/2) in the colour, weak and conventional hypercharge basis [18]. It does not permit a second fitted overall scale. The source extension also distinguishes endpoint-generated gradient current from independent circulating current [18, Sections 17.92 and 17.98–17.108]. An endpoint-preparation calculation cannot by itself normalize that independent cycle sector. The published projective operation has zero derivative along the common radial cycle direction; its dependence on the current ray does not recover current magnitude.

The source gives the following conditional form for a minimal magnitude-bearing successor, rather than an already evaluated physical operation:

$$D_{J_{\mathrm{cyc}}}\mathrm{K}_r=c_rV_rE_r,\qquad \nu_r=|c_r|^2. \qquad (60)$$

Here E_r are the central terminal projectors and V_r are probability-invisible partial isometries in the classified successor. The required sector shape is

$$\nu_Q=\lambda_J,\quad \nu_e=\lambda_J,\quad \nu_d+\nu_u=2\lambda_J,\quad 3\nu_L+\nu_H=4\lambda_J. \qquad (61)$$

These relations are a check on a proposed source return, not a derivation of the amplitudes or of λ_J. The source must supply the actual operation, preparation, survival branch and relevant mixed response. A record-copying isometry acts after a record amplitude is supplied and therefore does not justify setting the upstream coefficients c_r to one. Positivity, distinguishability and rank completeness do not fill these slots in the cited constructions.

The two preparation families are not a regulator comparison. Their information values are therefore not inputs to the running-coupling calculation; the physical-response and matching outputs remain unevaluated.

13 Closed loop response and joint weighting

The closed-loop control [24] evaluates an energetic response with specified weights. The joint-weighting calculation [25] derives mixed information from explicit source laws and tests whether it descends to the defects in the action.

13.1 A conditional closed loop action control

On the seven-site wheel with twelve edges and the existing 50-component representation, retain independent complex current and substrate amplitudes. With d_U the covariant edge difference, the unit-weight static restriction is

$$S(J,\psi;U)=V(\psi)+\frac{1}{2}\|J-d_U\psi\|^2+\frac{1}{2}\|d_U^{\dagger}J\|^2,\qquad V(\psi)=\frac{1}{4}\sum_v\left(\|\psi_v\|^2-1\right)^2. \qquad (62)$$

The current/continuity weights, constitutive factor, potential parameters and flat complex integration volume are benchmark choices on this restriction. These commuting amplitudes do not implement a physical chiral Grassmann determinant. The full six-defect mixed metric is not evaluated by (62).

Completing the square integrates all 1,200 real current coordinates exactly. Up to a field-independent constant,

$$S_{\text{eff}}(\psi;U)=V(\psi)+\frac{1}{2}\psi^{\dagger}K_U\psi+\text{logdet}Q_U, \qquad (63)$$

$$Q_U=I+d_U d_U^{\dagger}, \qquad L_U=d_U^{\dagger}d_U, \qquad K_U=L_U-I+(I+L_U)^{-1}. \qquad (64)$$

The determinant coefficient is one for complex current variables. The remaining 700 real amplitude coordinates are sampled jointly under $\exp(-S_{\text{eff}})$; differentiating this integral gives the contact-minus-variance response, including the determinant. Four independently seeded chains provide 20,000 retained states each [24]. The parentheses below give the standard deviation of the four chain means divided by $\sqrt{4}$, not an independence assumption for all 80,000 states. Appendix B records the block-size comparison. The sector assignments are the inherited face-mode choices.

Sector	Face eigenvalue	Current–matter response
Colour	4	0.255638 (0.000043)
Weak	5	0.232937 (0.000040)
Hypercharge Y	1	1.085134 (0.000440)

Every wheel face mode has positive response, so this block stiffens the field. The diagnostic sum with the earlier phase/record branch in [24] suppresses cross blocks; the following derivation addresses the missing joint weighting.

13.2 Mixed weights from the canonical history

For a declared row-normalized tilt $K_\vartheta(z'|z)\propto K_0(z'|z)\exp(\vartheta_A\Xi_A(z,z'))$, its score is $S_A=\Xi_A-\text{E}[\Xi_A|z]$. Direct differentiation gives the joint metric

$$W_{AB}=\sum_z \pi(z)\text{Cov}_{K_0}(\Xi_A,\Xi_B|z). \qquad (65)$$

All mixed and diagonal entries use one probability law. On a full Markov carrier, conditional score means vanish, giving orthogonal transition-score increments and this per-step information rate. A partially observed history with memory requires its full conditional score or an enlarged carrier. Equation (65) cannot bypass that history selection.

The canonical wheel sends the hub uniformly to all seven sites; every rim row assigns 1/4 to the hub, itself and its two neighbors. Its stationary measure is (7,4,4,4,4,4,4)/31, with all 31 supported stationary transitions equally weighted. The site kernel is reversible; its base law has no odd circulation. Directed score deformations can still distinguish oriented changes.

HMGBC Sections 14B and 14F.4 [12] require the complete coordinate family $(C,J_{\mathrm{w}},T_c,T_s,R,B_c,B_s,H_{\mathrm{w}})$, including both continuity and bond harmonics. The subscript w distinguishes scalar wheel labels from physical current and Hamiltonian variables. Recomputing (65) gives

$$W_{CC}=W_{RR}=\frac{12}{31},\qquad W_{J_{\mathrm{w}}J_{\mathrm{w}}}=W_{H_{\mathrm{w}}H_{\mathrm{w}}}=\frac{75}{434},\qquad W_{TT}=W_{BB}=\frac{21}{124}I_2. \tag{66}$$

Its only nonzero mixed blocks are

$$W_{J_{\mathrm{w}}H_{\mathrm{w}}}=-\frac{33}{434},\qquad W_{TB}=\frac{3}{248}\begin{pmatrix}1 & \sqrt{3}\\ -\sqrt{3} & 1\end{pmatrix},\qquad W_{BT}=W_{TB}^{\mathrm{T}}. \tag{67}$$

This reproduces an existing source result rather than deriving a new physical metric. The matrix is positive definite. Its current–persistence correlation is -11/25, and the two continuity–bond canonical correlations are 1/7. Minimizing over independently adjustable persistence and continuity defect coordinates yields

$$W_{J_{\mathrm{w}},\mathrm{eff}}=\frac{108}{775},\qquad W_{B,\mathrm{eff}}=\frac{36}{217}I_2. \tag{68}$$

The fractional reductions are 121/625=19.36% and 1/49=2.0408%. Keeping only the aligned scalar continuity–bond slice gives 1/196=0.5102% for the latter. The full doublet therefore quadruples that local correction. These are independent-defect minima, not configuration-level physical relaxations: the actual defects share variables and constraints. The canonical transition law is also a diagnostic kernel, distinct from HMGBC's physical transfer construction. Its scalar entries cannot be copied onto representation-valued carriers without the typed maps required in Section 56A.

13.3 Joint differentiation of the native recording law

Return to the native operators (54)–(55), now varying independent current and matter together. With normalized incoming state $w=U\psi_s/\|\psi_s\|$, the committed outcome is the terminal label alone:

$$p_r(j,w)=w^{\dagger}E_r(j)w,\qquad E_r(j)=\sum_{a=0}^{12}C_a(j)^{\dagger}P_rC_a(j). \tag{69}$$

The unobserved Kraus index a is summed before differentiation. Resolving it would give the different full-mark experiment already distinguished in Section 12.3. The calculation uses the archived seven-site prime-chirp amplitudes and their constitutive currents. It is a genericity fixture, not a stationary physical background. In particular, its current is an endpoint gradient with nonzero static divergence; it does not supply the independent conserved cycle background sought in Section 12.4.

Let $B_j=\partial p/\partial j$ and $B_\psi=\partial p/\partial\psi$ in real coordinates. At $U=I$ and unit incoming amplitude,

$$(B_\psi)_{r,:}=2(\mathrm{Re}(E_rw\text{-}p_rw)^{\mathrm{T}},\ \mathrm{Im}(E_rw\text{-}p_rw)^{\mathrm{T}}). \tag{70}$$

For B_j, differentiate the current ray, its commutators and the saturated normalization in (54). The square-root derivative obeys $C_0\delta C_0+\delta C_0C_0=\delta(I-\kappa_{\mathrm{sat}}S)$ on the fixed-rank tangent; its exact ray kernel is retained analytically. Define $F_j=\mathrm{diag}(p)^{-1/2}B_j$ and $F_\psi=\mathrm{diag}(p)^{-1/2}B_\psi$. Then

$$\mathrm{I}_{j,\psi}=\begin{pmatrix}F_j^{\mathrm{T}}F_j & F_j^{\mathrm{T}}F_\psi\\ F_\psi^{\mathrm{T}}F_j & F_\psi^{\mathrm{T}}F_\psi\end{pmatrix}. \tag{71}$$

This joint conditional Fisher matrix retains its mixed block. On the first edge its Frobenius norm is 3.8383276826; a fixed pair of directions gives mixed KL curvature -0.002155957918, checked by finite differences within 1.84×10^{-9}.

At each edge, both derivative maps have rank six and fill the same probability tangent, so all six canonical correlations equal one algebraically. Over twelve edge contexts the shared-endpoint map has rank 72, unchanged when independent current and link variations are added. The calculation retains 1,200 current, 700 endpoint and 144 link coordinates; strictly positive edge exposures preserve these span statements.

The current-score image is therefore contained in the matter-score image. With $\Pi_\psi=F_\psi F_\psi^+$, projection gives the exact consequence

$$\mathrm{I}_{j|\psi}=F_j^{\mathrm{T}}(I-\Pi_\psi)F_j=0. \qquad (72)$$

Matter adjustments reproduce every first-order terminal-probability change caused by current adjustments. This is identifiability, not vanishing current energy. The implementation gives relative projection residual 3.64×10^{-15} and score norm 2.23×10^{-15} on the 84 local gauge variations. Separately, $p_r(cj,w)=p_r(j,w)$ for every nonzero complex c proves the conditional law is blind to current magnitude and phase.

13.4 A common endpoint obstruction to defect descent

At $U=I$, keep both static defects $D_J=j-d\psi$ and $D_T=d^\dagger j$. Consider

$$\delta\psi_v=a \text{ for all } v, \qquad \delta j=\delta U=0, \qquad \mathrm{Re}(\psi_v^\dagger a)=0 \text{ for all } v. \qquad (73)$$

The seven real norm-tangency constraints leave 93 real directions. They satisfy $d\,\delta\psi=0$, so both defect differentials vanish. The quartic potential in (62) also has zero quadratic variation along them at unit local norm. Yet the terminal-score map on this subspace has rank 72 and spans the entire observed score space. Its largest and smallest positive singular values are 4.638681525 and 0.001572802523. The input norm here is the common amplitude norm; the seven-site configuration norm is $\sqrt{7}\|a\|$.

Restricting matter adjustment to these common shifts alone leaves relative current and link score remainders of 1.29×10^{-13} and 9.07×10^{-14}. The next singular value is only 1.72×10^{-12} of the smallest retained one. A direct finite-difference check of the strongest witness has derivative error 1.01×10^{-8} at step 10^{-4}.

For a score form to descend through a defect map D, it is necessary that $\ker D'\subseteq\ker F$. This condition fails for $D=(D_J,D_T)$ at the fixture. The record distinguishes configurations that these two defect differentials identify. No metric on those two defects alone reproduces the full terminal Fisher form there. This does not exclude the complete six-defect descent, another admitted preparation or a physically selected background. It specifies a test those additions must satisfy; the 72 visible directions cannot simply be removed as gauge.

13.5 The missing contributions to a complete joint law

Let $\delta=(\delta j,\delta\psi)$ and resolve a complete history experiment into its increments and record. Probability factorization and the zero conditional mean of the record score give

$$q_\theta(\delta,r|z)=k_\theta(\delta|z)p_\theta(r|z,\delta), \qquad \mathrm{I}_q=\mathrm{I}_k+\mathrm{E}_k[\mathrm{I}_{p|\delta}]. \qquad (74)$$

This is an accounting identity, not a proposed causal ordering. It applies to every mixed block. If the increments are hidden, their marginal record generally contains less information. The conditional operation supplies a record family; its physical embedding, increment kernel k and averaging ensemble remain additional returns. Conditional recording information cannot determine the omitted I_k.

The missing joint law in (74) is therefore an evaluated physical law, not an unspecified choice of probability exponent. Once the admitted joint state, evolution and readout amplitudes are supplied, the Born reconstruction [30] fixes their probability weights. It does not by itself return the increment kernel, the state being averaged, or the occurrence and waiting-time laws. Nor does a common Hilbert-space probability measure select the configuration-space measure or kinetic metric of the coupled action.

For an event probability h_{ev} per opportunity and terminal probabilities conditional on occurrence,

$$\mathrm{I}_{\mathrm{event}}=\frac{\nabla h_{\mathrm{ev}}\nabla h_{\mathrm{ev}}^{\mathrm{T}}}{h_{\mathrm{ev}}(1\text{-}h_{\mathrm{ev}})}+h_{\mathrm{ev}}\mathrm{I}_p. \qquad (75)$$

Here h_{ev} is distinct from the hopping energy h. For a marked Poisson process the corresponding per-time information is $\nabla\lambda\nabla\lambda^{\mathrm{T}}/\lambda+\lambda\mathrm{I}_p$. Occurrence information can therefore carry magnitude sensitivity absent from (69). The hazard-rigidity source [11] constrains relative sector rates on its stated attachment branch, but this calculation does not select a common intensity or physical current-dependent rate.

If an independently derived positive matter penalty A_ψ is supplied, minimizing the quadratic information form (71) plus that penalty gives

$$\mathrm{I}_{j,\mathrm{eff}}=F_j^{\mathrm{T}}\left(I+F_\psi A_\psi^{-1}F_\psi^{\mathrm{T}}\right)^{-1}F_j. \qquad (76)$$

It tends to zero as the penalty vanishes on the tested score range and to fixed-matter information as the penalty becomes large. This equation identifies a dependence, not permission to fit A_ψ or to identify the sum with a physical action. Equations (74)–(76) describe the recording-history route. The alternative direct-action route already noted in Section 2.2 does not require deriving an event rate first; it instead requires the complete physically selected action and measure.

13.6 Mixed current matter blocks in the action

Suppose the common source supplies a metric on the actual current and continuity defect carriers. At fixed links, write

$$D_J=J\text{-}d\psi, \qquad D_T=bJ, \qquad W=\begin{pmatrix}A & X\\ X^\dagger & B\end{pmatrix}. \qquad (77)$$

The operators A,B,X act on the typed carriers; they are not scalar wheel entries or the connection matrices of Section 11. On realified tangent spaces, expand $\Gamma=V(\psi)+\frac{1}{2}D^\dagger WD$. The Hessian blocks, denoted $\mathrm{H}_{\mathrm{act}}$ to distinguish them from the Hamiltonian, are

$$\mathrm{H}_{\mathrm{act}_{JJ}}=A+Xb+b^\dagger X^\dagger+b^\dagger Bb, \qquad (78)$$

$$\mathrm{H}_{\mathrm{act}_{J\psi}}=\text{-}(A+b^\dagger X^\dagger)d, \qquad \mathrm{H}_{\mathrm{act}_{\psi\psi}}=V''+d^\dagger Ad. \qquad (79)$$

Even X=0 does not remove the mixed configuration block: current and matter share D_J. Provided the null and compatibility conditions allow current elimination,

$$\mathrm{H}_{\mathrm{act}_{\psi,\mathrm{eff}}}=\mathrm{H}_{\mathrm{act}_{\psi\psi}}\text{-}\mathrm{H}_{\mathrm{act}_{\psi J}}\mathrm{H}_{\mathrm{act}_{JJ}}^{+}\mathrm{H}_{\mathrm{act}_{J\psi}}. \qquad (80)$$

The unit choice A=B=I, X=0, b=$d^{\dagger}$ recovers the quadratic part of (62)–(64); exact integration also contributes its determinant. For all six defects at a zero-defect background, the corresponding form is V''+$\mathrm{J}_D^{\dagger} W \mathrm{J}_D$. Nonzero defects, variable W, link variations and nonlinear integration require their further derivatives and fluctuations. These formulas account for mixed terms without assigning their unreturned physical values.

The positive relaxed current cost 48/53 in the stated unit-metric source of [11] is compatible with (72): an action cost and profiled terminal information are different objects with different constraints. PCN fixes its declared primitive cost unit; it does not equate these forms or determine every representation-resolved mixed entry. The result of this section is a derived conditional joint response and a specific descent obstruction, together with the action formulas required for the next physical execution.

14 Joint record weighting and quantum response

The stretch investigation [26] supplies an algebraic field–record vertex. We follow it into the joint probability law, retain its feedback and calculate the energy response of its simplest quantum realization [27].

14.1 Source admission and the common weighting

The six-defect action of MASD [2, Sections 9–10.1.1 and 17] requires every mixed block to descend from one operational metric. HMGBC [12, Section 56A] provides the proposed operational heat transfer and its Perron-normalized joint history law. It expressly distinguishes the physical typed derivatives and transported defect increments from the canonical wheel representatives. Sections 13.2–13.4 therefore cannot replace that full construction by their diagnostic scores.

The source analysis in [27] retains the operational-metric and refinement-regularity obligation, the full physical defect lift and tilt normalization, and the information-to-action bridge. No evaluated complete joint matrix and spectrum were located in that review. The direct-action route remains available; this is not a proof that a new postulate is necessary. The ensemble, integration measure and kinetic law below are declared restrictions, rather than inferred solely from the action's algebraic form.

14.2 Mixed coefficients from one action

Work in real coordinates on a fixed physical tangent quotient. Let f denote field probes, y the coordinates that enter quadratically and can be integrated out, and $c(x)$ a vector of quadratic record-stretch features. On a restriction with constant metric and constant linear maps, write

$$\mathrm{D}=L_f f+L_y y+Nc(x), \qquad \Gamma=U_0(x)+1/2\ \mathrm{D}^T W \mathrm{D}. \qquad (81)$$

All applicable defect families are included in these matrices. This notation does not assume that the physical six-defect map actually reduces to (81). Terms outside this restriction must be retained in a complete calculation.

Define A_y=$L_y^T W L_y$. If it is positive on the retained quotient, Gaussian integration gives

$$W_{\perp}=W\text{-}WL_y A_y^{-1} L_y^T W,$$

$$\Gamma_{\mathrm{red}}=U_0+1/2\ (L_f f+Nc)^T W_{\perp}(L_f f+Nc)+1/2\ \mathrm{logdet}A_y. \qquad (82)$$

A pseudoinverse is permissible only after the null quotient, range condition and finite integration volume have been justified. If A_y depends on x or f, its determinant contributes to the weight or response and cannot be dropped.

Writing the retained polynomial part as

$$\Gamma_{\mathrm{red}}=U_0+1/2\, f^T K_f f-f^T G_{fc} c+1/2\, c^T D_{cc} c,$$

$$K_f=L_f^T W_\perp L_f,\quad G_{fc}=-L_f^T W_\perp N,\quad D_{cc}=N^T W_\perp N, \qquad (83)$$

shows that the field contact, mixed vertex and quartic feedback are outputs of one projection. They cannot be selected separately. In particular,

$$\begin{pmatrix} K_f & -G_{fc} \\ -G_{fc}{}^T & D_{cc} \end{pmatrix} \succcurlyeq 0. \qquad (84)$$

For a field-independent remaining measure, the correctly coupled static weight and response are

$$p_f(dx)=\frac{e^{-U_0(x)-c(x)^T D_{cc} c(x)/2+f^T G_{fc} c(x)}\, d\nu(x)}{\int e^{-U_0-c^T D_{cc} c/2+f^T G_{fc} c}\, d\nu},$$

$$R=K_f-G_{fc}\mathrm{Cov}_{p_0}(c,c)G_{fc}{}^T. \qquad (85)$$

The covariance is evaluated after the $c^T D_{cc} c/2$ feedback has reweighted the joint fluctuations. Using the uncoupled covariance generally gives a different answer. Field-dependent support, measure, metric, kinetic terms or omitted vertices add derivatives to (85).

Extending the scalar triangle restriction of (48)–(50) by the stretch-induced shift gives

$$\min_y\left[\frac{w_B}{2}\|a-y\|^2+\frac{w_R}{2}(\mathbf{1}^T y-c)^2\right]=\frac{k}{2}(F-c)^2,\quad F=\mathbf{1}^T a,\quad k=\frac{w_B w_R}{w_B+3w_R}. \qquad (86)$$

Thus $K_f=G_{fc}=D_{cc}=k$ on that restriction. Unit weights give $k=1/4$. The wheel diagnostic weights $w_B=21/124$, $w_R=12/31$ give $k=0.0492668621701$.

14.3 The joint law of charged stretch features

On a fixed occupied support, two Hermitian stretch generators obey the local polar-product expansion [26]

$$\mathrm{Pol}(e^{\epsilon Q} e^{\epsilon P})=I+\frac{\epsilon^2}{2}[Q,P]+O(\epsilon^3),\qquad C=-\frac{i}{2}[Q,P]. \qquad (87)$$

For a diagonal generator T, one unordered address pair contributes

$$c_{T,ab}=(t_a-t_b)\mathrm{Im}(Q_{ab}P^*_{ab}),\qquad \mathrm{Tr}(TC)=\sum_{a<b} c_{T,ab}\,. \qquad (88)$$

The existence of this algebraic vertex does not establish that the physical record carrier admits that address transition. In particular, stretches commuting with hypercharge produce no hypercharge response through (88). A proposed transition between different chiral or charge sectors must satisfy the actual transport and completion rules.

For a centered harmonic reference, collect the real stretch coordinates in x with covariance Σ, and write $c_A=x^T M_A x/2$, with M_A real symmetric. The covariance includes the effects of other coupled coordinates. In

a classical quadratic model with precision blocks H_{xx},H_{xy},H_{yy}, it is the inverse Schur complement, not H_{xx}^{-1}:

$$\Sigma=(H_{xx}-H_{xy}H_{yy}^{-1}H_{yx})^{-1}. \qquad (89)$$

Temperature and units are absorbed into this declared precision. The joint characteristic function and connected second moment are

$$\phi(t)=\det(I-i\Sigma\sum_A t_A M_A)^{-1/2},$$

$$\langle c_A\rangle= 1/2\ \mathrm{Tr}(M_A\Sigma),\quad \mathrm{Cov}(c_A,c_B)= 1/2\ \mathrm{Tr}(M_A\Sigma M_B\Sigma). \qquad (90)$$

The square-root branch is continuous from $\phi(0)=1$. Equation (90) determines the full Gaussian-reference pushforward, including mixed cumulants. Equation (85) must still reweight that pushforward. A ground-state coordinate covariance does not by itself provide the spectral susceptibility needed for a quantum energy response.

For one complex pair set $P_{ab}=(p_1+ip_2)/\sqrt{2}$, $Q_{ab}=(q_1+iq_2)/\sqrt{2}$. Let (p_1,q_1) and (p_2,q_2) be independent centered Gaussian copies with covariance

$$\Sigma_2=\begin{pmatrix} v_P & u \\ u & v_Q \end{pmatrix}, \qquad d=v_Pv_Q-u^2\geq 0. \qquad (91)$$

Then $c_T=(\Delta t/2)(p_1q_2-p_2q_1)$ has exactly the Laplace distribution

$$p_{\mathrm{bare}}(c)=\frac{e^{-|c|/b_c}}{2b_c}, \qquad b_c=\frac{|\Delta t|}{2}\sqrt{d}, \qquad \phi(t)=\frac{1}{1+b_c^{\,2}t^2}. \qquad (92)$$

For $d=0$ this becomes a point mass at zero. This makes the joint dependence explicit: at fixed marginal variances, changing the correlation changes the response. It vanishes for perfectly aligned stretches. Gauge covariance, positivity and fixed marginals alone do not select that correlation. This is not a proof that the complete VERSF action permits every such choice.

14.4 Exact static feedback and mixed responses

Combining (92) with (86) yields the fully reweighted static integral

$$\mathrm{Z_{stat}}(f)=\int_{-\infty}^{\infty}\frac{dc}{2b_c}\exp[-\frac{|c|}{b_c}-\frac{k}{2}(f-c)^2]. \qquad (93)$$

Put $z=kb_c^{\,2}$ and define $I(z)=\int_0^\infty e^{-x-zx^2/2}\,dx$. The residual response relative to k is

$$r_{\mathrm{stat}}(z)=\frac{[-\log \mathrm{Z_{stat}}]''(0)}{k}=\frac{I(z)^{-1}-1}{z}, \qquad I(z)=\sqrt{\frac{\pi}{2z}}\,\mathrm{erfcx}(\frac{1}{\sqrt{2z}}). \qquad (94)$$

It approaches 1 as $z\to 0$ and behaves as $\sqrt{2/(\pi z)}$ at large z. By contrast, substituting the bare variance $2b_c^{\,2}$ into the response would give $1-2z$, which is already negative at $z=1$. That substitution omits the feedback being calculated.

A common pair can couple to several probes. With $\Gamma=U_0+\frac{1}{2}(f-vc)^TK_f(f-vc)$, the complete response is

$$R=K_f-K_fv\,\chi_c\,v^TK_f, \qquad (95)$$

where χ_c is the coupled static variance, or the coupled spectral susceptibility in the quantum calculation. The off-diagonal entries follow from the same vertex. For the illustrative choices K_f=I_2, v=$(1,-1)^T/\sqrt{2}$, the response eigenvalues are 1 and the scalar residual r. No separate mixed coefficient is inserted.

Even a zero mixed second moment need not imply independent weighting. In the unrestricted 50-address, Hilbert–Schmidt-isotropic Gaussian control of [26], with unit coordinate variances, the three bare commutator responses have diagonal covariance (150,325/2,262). Their mixed fourth cumulants are nevertheless

Pair	$\mathrm{cum}(c_A,c_A,c_B,c_B)$
Colour and weak	459/8
Colour and hypercharge	641/8
Weak and hypercharge	297/4

For example, reweighting by $\exp(-k_B c_B^2/2)$ gives $\partial_{k_B}\mathrm{Var}(c_A)\big|_{k_B=0}$ equal to minus one half of this cumulant when the mixed covariance vanishes. Separate sector averages would miss this coupling. These values are an unrestricted carrier diagnostic, not a physical admission of all address pairs. In a fully gauge-invariant unbroken vacuum, quadratic mixing between inequivalent gauge factors is constrained by symmetry; that fact does not eliminate cross-defect blocks or mixed higher moments.

14.5 Quantum energy response of the same reduced pair

Use four real quantum coordinates x=(p_1,p_2,q_1,q_2) and the explicit positive Hamiltonian

$$H_\lambda(f)=-\frac{1}{2}\nabla_x^2+\frac{1}{2}|x|^2+\frac{\lambda}{2}\,[f-c(x)]^2,\qquad c(x)=p_1q_2-p_2q_1. \qquad (96)$$

Here $\hbar$, the common mass and the uncoupled oscillator frequency are one. The charge factor is absorbed into the field and coupling coordinates, and λ is the model parameter. At zero coupling the ground-state coordinate variance is $1/2$, so the bare Laplace scale is b_c=$1/2$ and z=$\lambda/4$.

The static comparison uses the uncoupled ground-state coordinate density as its Gaussian reference and reweights it by (93). It is not asserted to be the thermal state or Euclidean path measure of (96). Matching that initial coordinate distribution makes explicit why snapshot probabilities do not determine the quantum response.

The coupled ground-state response is calculated from the same operator, including the entire $\lambda c^2/2$ interaction:

$$r_Q(\lambda)=\frac{E_0''(0)}{\lambda}=1-2\lambda\langle 0|c\,(H_\lambda(0)-E_0)_\perp^{-1}\,c|0\rangle. \qquad (97)$$

The expectation of c vanishes by the exchange symmetry. The inverse acts on the orthogonal complement of the ground state. Replacing this resolvent by an equal-time covariance would discard the excitation energies.

An orthogonal change of coordinates gives c=$(r_u^2-r_v^2)/2$ for two two-dimensional vectors. Rotational symmetry reduces the ground state and its scalar-source response to two radial oscillator indices. The calculation uses the complete projection of c^2 onto each retained basis, rather than squaring an already truncated c matrix.

$z=\lambda/4$	Static residual	Quantum residual
0.01	0.98093234	0.98111335
0.1	0.86029685	0.86961353
1	0.52513528	0.62051260
10	0.21923162	0.45826641
100	0.07626175	0.40622424
Strong-coupling limit	0	approximately 0.39004739

The strong-coupling statement follows from a scaling reduction, followed by a converged numerical solution of the limiting operator. Setting $x=\lambda^{-1/6}u$ and $s=\lambda^{1/3}f$ gives

$$H_\lambda(f)=\lambda^{1/3}[-1/2\,\nabla_u^2+1/2\,\lambda^{-2/3}|u|^2+1/2\,(s-c(u))^2]. \qquad (98)$$

The limiting operator is still confining. In the original scaled two-vectors $p,q\in\mathrm{R}^2$, $c=p_1q_2-p_2q_1$. At fixed p, the q direction transverse to p is a harmonic oscillator, giving $-\frac{1}{4}\Delta_q+\frac{1}{4}(s-c)^2\geq|p|/4$; interchanging p and q gives $|q|/4$. Adding these bounds to the remaining kinetic term yields $H_\infty(s)\geq-\frac{1}{4}(\Delta_p+\Delta_q)+\frac{1}{4}(|p|+|q|)$ as quadratic forms. The right-hand operator has compact resolvent, and so does $H_\infty(s)$. Transverse zero-point energy therefore closes the classical escape valleys.

Consequently r_Q is the second derivative in s of the scaled ground-state energy. Setting the scaled quadratic coefficient to zero yields 0.39004738815 numerically. Radial cutoffs 32 and 48 and three additional basis frequencies agree at the displayed eight decimal places. This is a calculated limit of (96), not a universal lower-bound theorem for VERSF or for arbitrary coupled stretch models.

For the two-probe extension $H_0+\lambda\|f-vc\|^2/2$ with the unit vector v above, divide the response by its unrelaxed contact coefficient. At $z=1$ this gives

$$\frac{R_Q}{\lambda}=\begin{pmatrix}0.81025630 & 0.18974370\\ 0.18974370 & 0.81025630\end{pmatrix}. \qquad (99)$$

The normalized eigenvalues are 1 and 0.62051260, obtained from one joint energy calculation for the selected pair and probes.

14.6 Consequences for the normalization mechanism

The earlier matching example requires an auxiliary residual near 0.04011447 under its equal direct/auxiliary split [1, 27]. In the static pair integral, achieving that residual would require $z\simeq377.57$. This is a target inversion, not a prediction or a parameter choice for the physical theory. In the quantum model, a 31-point scan over $10^{-4}\leq z\leq10^6$ decreases toward the approximately 0.39005 limiting residual and does not approach the target. The scan is not a proof of monotonicity at every parameter value.

Under the illustrative equal direct/auxiliary split, the limiting total coefficient would be $(1+0.39004739)/2\simeq0.69502369$, rather than the approximately 0.52006 matching factor.

There is a second limitation. Equation (87) is a small-stretch expansion. For the unit-weight triangle, a charge difference of 1/2, equal independent coordinate variances v, and $k=1/4$, the static parameter is $z=v^2/64$. Its target inversion requires root-mean-square coordinates about 12.47, outside a controlled small-stretch expansion. Even an exact solution of the reduced polynomial model cannot establish the

behavior of the complete polar action there. Terms such as field-dependent contacts, changing occupied support, other defect couplings, the measure and the chiral fermion sector may matter.

The result therefore narrows the mechanism: a single isolated charged pair with this isotropic kinetic law is insufficient in the calculated strong-coupling limit. A collective or differently coupled mechanism must be derived from the full source action if it is to change this outcome. Its effect cannot be inferred from a large bare commutator variance.

15 Coherent recording and propagation from the common action

The source-selection question can be tested by retaining the responsive record variables in the common action and deriving their joint evolution with matter before taking a readout. This supplies both the coherent recording phases and the intervening motion on specified branches. The completion and wheel calculations below are exact under their declared kinetic and preparation conditions [28].

15.1 Extracting the common action interaction

MASD [2] contains the shared-link matter kinetic term and the local completion vertex

$$\Gamma_{LR}=\Lambda_{*}\sum_{f}[\overline{\Psi}_{fL}(A_{fL}^{0})^{\dagger}V_{H}^{\dagger}X_{H}A_{fR}^{0}\Psi_{fR}+\text{h.c.}]\,. \qquad (100)$$

The raw address maps, completion support and kinetic normalization must be those of the same source. Expand the complete completion/Higgs quadratic block into mass-normalized responding modes q_{α}. If the component of the logarithmic stretch in mode α is E_{α}, the fixed-orientation contribution to the canonical matter coupling is

$$\widehat{O}_{\alpha}^{F}=\Lambda_{*}\sum_{f}[\widehat{\psi}_{fL}^{\dagger}\mathrm{A}_{fL}^{\dagger}V_{H,*}^{\dagger}E_{\alpha}\mathrm{A}_{fR}\widehat{\psi}_{fR}+\text{h.c.}]\,. \qquad (101)$$

Here A_{fX} includes the source's canonical matter normalization. Moving polar orientation, support and address maps supply their own derivatives when those vary. Equation (101) is a fermion-parity-preserving bilinear, not a conversion between a bosonic Higgs address and a one-fermion state.

The general definition is $\widehat{O}_{\alpha}=(\partial H/\partial q_{\alpha})_{*}$. It also includes the current and link terms obtained from the same mixed bosonic Hessian, and derivatives of the kinetic operator if its metric varies. Thus the local flat-metric expansion has the form

$$H_{\text{joint}}=H_{S}+\sum_{\alpha}1/2\,(P_{\alpha}^{2}+\nu_{\alpha}^{2}q_{\alpha}^{2})+\sum_{\alpha}q_{\alpha}\,\widehat{O}_{\alpha}+H_{\text{higher}}. \qquad (102)$$

The squared frequencies are eigenvalues of the *kinetically normalized* coupled record/completion block. They are not inferred from its static Hessian alone. The coefficients in (101) and (102) have evaluation addresses in the common action; their physical numerical values have not been supplied by the unit diagnostic branch.

For example, on MASD's minimal charged unit branch, restrict to one real chiral pair at zero spatial momentum and freeze its polar orientation. Its canonical one-particle mass block is proportional to σ_{x}. A responding completion mode along that same real vertex gives $\widehat{O}=g\sigma_{x}$. The commuting case can therefore be solved exactly. It is a restriction of the existing vertex, rather than a separately invented measurement coupling.

15.2 Deriving recording and propagation together

For a specified admitted joint Hamiltonian, let

$$U(t)=e^{-itH_{\text{joint}}/\hbar}. \qquad (103)$$

If the source supplies an initial product preparation with record state $|\chi\rangle$ and a resolved readout basis $|r,\nu\rangle$, then the operation on the retained system is

$$K_{r\nu}(t)=\langle r,\nu|U(t)|\chi\rangle, \qquad \mathrm{I}_r(\rho)=\sum_{\nu} K_{r\nu}\,\rho K_{r\nu}^{\dagger}. \qquad (104)$$

Unitarity gives $\sum_{r,\nu} K_{r\nu}^{\dagger} K_{r\nu}=I$. Both the amplitudes and their phases in (104) are fixed once the joint Hamiltonian, preparation, duration and readout are fixed. A record-controlled phase change is a change to this implementation unless accompanied by the corresponding passive transformation of the entire propagation and readout.

Equation (104) does not derive its preparation or its readout. A correlated stationary matter–record state cannot in general be replaced by $\rho\otimes|\chi\rangle\langle\chi|$ to obtain a state-independent channel. In that case the full joint state and its history must be evolved. The existing FC commitment and renewal maps must be used where their carrier identification applies; reversible precommitment dynamics is not a replacement for that source closure.

For a normalized preparation and an admitted pointer realization of (104), the Born result gives each outcome probability as the trace of its corresponding unnormalized output state. Reference [30, Appendix A] establishes this passage from an isometric measurement model to its instrument probabilities; identifying the model with a physical apparatus remains a separate premise. Thus the Born-measure reconstruction fixes how admitted joint alternatives are weighted once their amplitudes are known; the remaining force-strength calculation must derive those amplitudes and their energetic response from the common physical action.

Between events the same $U(\Delta t)$ acts, including the continuing record interaction. Repeated readouts of the same responsive record use blocks $\langle r_{k+1}|U|r_k\rangle$. Replacing every incoming r_k by a fresh χ is a reset assumption requiring a source-derived renewal or preparation operation. It is not implied by tracing over the record once.

15.3 Exact matter and completion propagation

Consider one mass-normalized mode from (102), with a fixed real chiral vertex:

$$H=\epsilon\sigma_x+1/2\,(P^2+\nu^2q^2)+gq\sigma_x. \qquad (105)$$

The free matter mass and this restricted coupling commute. In the eigenstate $\sigma_x|s\rangle=s|s\rangle$, $s=\pm1$, the record is an oscillator with force $-sg$. Starting it in its local unforced ground state gives

$$q_s(t)=-\frac{sg}{\nu^2}(1-\cos\nu t), \qquad p_s(t)=-\frac{sg}{\nu}\sin\nu t. \qquad (106)$$

These are actual trajectories of the conditional means, not an assignment of a momentum impulse followed by an unspecified motion. In creation-operator language the conditional displacement is

$$\alpha_s(t)=-\frac{sg}{\sqrt{2\hbar\nu^3}}(1-e^{-i\nu t}). \qquad (107)$$

Let $\psi_0(Q)=(\nu/\pi\hbar)^{1/4}e^{-\nu Q^2/(2\hbar)}$, $P_s=(I+s\sigma_x)/2$, and

$$\phi(t)=\frac{g^2}{2\hbar\nu^3}(\nu t-\sin\nu t)-\frac{\nu t}{2}. \qquad (108)$$

The exact continuous-coordinate recording operation obtained from (104) is

$$K_Q(t)=\sum_{s=\pm1}e^{-is\epsilon t/\hbar+i\phi(t)}\,\psi_0(Q-q_s(t))e^{ip_s(t)[Q-q_s(t)/2]/\hbar}P_s. \qquad (109)$$

Its phases follow from (105). Its normalization is $\int dQ\,K_Q^\dagger K_Q=I$. The readout likelihoods are the two displaced Gaussians $|\psi_0(Q-q_s)|^2$. They can be integrated over specified bins, but no identification of those bins with the seven native terminal types is asserted.

Without conditioning on the readout, the matter coherence between the two σ_x eigenstates is multiplied, apart from its known mass phase, by

$$C_{\rm rec}(t)=\exp[-\frac{2g^2}{\hbar\nu^3}(1-\cos\nu t)]. \qquad (110)$$

This quantity is a calculable overlap of the two record states. It is not imposed as a phenomenological decoherence rate.

Time	Record mean (s=+1)	Coherence ratio
0.25	-0.03108757829	0.93971827454
1	-0.45969769413	0.39876006323
pi	-2	0.01831563889
2 pi	0	1

This execution sets $g=\nu=\hbar=1$ as a declared canonical single-mode check and factors out the commuting mass phase. A 32-level oscillator calculation reproduces the trajectories and overlaps to approximately 10^{-14}. The full complex wavefunction, including the phase in (109), agrees with direct propagation to within 5.1×10^{-14} in norm over these four times. These are dimensionless test values, not a determination of the physical g or ν.

At $2\pi/\nu$ the record states coincide again. This isolated coherent mode therefore creates a reversible record precursor, not permanent commitment. Retaining more bath modes changes the overlap and memory; permanent Facts still require the already specified commitment/renewal mechanism on the same physical carrier. The recurrence is a test of this restricted model, not a contradiction of FC.

15.4 The induced interaction and its energy response

For a commuting system observable O, completing the same oscillator square gives

$$1/2\,P^2+1/2\,\nu^2q^2+qO=1/2\,P^2+1/2\,\nu^2(q+O/\nu^2)^2-\frac{O^2}{2\nu^2}. \qquad (111)$$

Thus the induced term and the coherent recording operation have a common origin. For $O=g\sigma_x$, the induced term is $-g^2I/(2\nu^2)$: it shifts both chiral energies equally and does not change their splitting. For a sum of current and matter operators, O^2 also contains their mixed interactions; it cannot generally be replaced by a scalar.

Equation (111) is a direct spectral reduction when $[O,H_S]=0$. If the observable fails to commute with the remaining dynamics, the oscillator transformation also changes H_S. Eliminating the record then produces time dependence and memory, not just the static term in (111). Likewise, if g or v changes with an external gauge field, the shift can contribute to a gauge response. The constant shift in this restricted branch is not a general force-sector cancellation.

15.5 Propagation on the existing wheel bond branch

MASD Section 47A supplies a second useful execution with spatial link coordinate x and responsive spatial-record coordinate y. These are distinct from the local completion mode of Section 15.3. On a transverse wheel mode of eigenvalue λ, its quadratic potential is

$$V_\lambda = 1/2\, a_w \lambda x^2 + 1/2\, b_w \lambda y^2 + 1/2\, c_w (x-y)^2. \qquad (112)$$

The source unit branch is $a_w=b_w=c_w=1$, and the transverse spectrum is {1,2,2,4,4,5}. Add the explicitly declared identity kinetic metric to execute its canonical temporal continuation. This kinetic choice is a condition of the test, not a value derived by the spatial branch. Then

$$H_\lambda = 1/2\, p^T p + 1/2\, z^T K_\lambda z, \quad z=(x,y)^T, \quad K_\lambda = \begin{pmatrix} \lambda+1 & -1 \\ -1 & \lambda+1 \end{pmatrix}. \qquad (113)$$

The normal frequencies are $\sqrt{\lambda}$ and $\sqrt{\lambda+2}$. Writing $\Omega=K_\lambda^{1/2}$ gives the exact between-readout flow

$$\begin{pmatrix} z(t) \\ p(t) \end{pmatrix} = \begin{pmatrix} \cos\Omega t & \Omega^{-1}\sin\Omega t \\ -\Omega\sin\Omega t & \cos\Omega t \end{pmatrix} \begin{pmatrix} z(0) \\ p(0) \end{pmatrix}. \qquad (114)$$

In particular, the record position receives contributions $A_{yx}x(0)+B_{yx}p_x(0)$ fixed by (114). At dimensionless $t=1$:

Cycle eigenvalue	A_{yx}	B_{yx}
1	0.35042942222	0.13580544281
2	0.28604526566	0.12190364261
4	0.17687944660	0.09706097491
5	0.13114792883	0.08601002790

The joint ground state has covariance $\Sigma_z=\hbar K_\lambda^{-1/2}/2$. Its link–record covariance is

$$\langle xy \rangle_0 = \frac{\hbar}{4}(\lambda^{-1/2} - (\lambda+2)^{-1/2}). \qquad (115)$$

These are sustained ground-state correlations of the coupled action. They are not the product preparation used to define the readout check below. At $\lambda=1$, the stationary covariance is $0.10566243270\hbar$.

Prepare both oscillators in their local ground states at frequency $\nu_{loc}=\sqrt{\lambda+1}$ and read the record in that same number basis. The propagator gives $K_n=\langle n|U(1)|0\rangle$. At $\lambda=1$ and $t=1$, the first three probabilities are 0.94366125822, 0.04909029637 and 0.00640737257. These number labels differ from the seven terminal-record classes. Increasing the cutoff through 8, 12, 16 and 20 reduces the covariance error against (114) from 4.3×10^{-6} to 2.2×10^{-15}.

Keeping the same responsive oscillator for a second readout gives a joint outcome distribution whose total variation distance from an independently reset calculation is 0.03156081120. This quantifies the importance of retaining the responding record.

An external linear source $-fx$ shifts the ground energy by $-f^2(K_\lambda^{-1})_{xx}/2$. Consequently

$$k_{\mathrm{red}}=\frac{1}{(K_\lambda^{-1})_{xx}}=\lambda+\frac{\lambda}{\lambda+1}. \qquad (116)$$

This reproduces the static MASD Schur result exactly. Solving the temporal quantum problem has not produced an additional static force-strength enhancement in this harmonic linear-source branch.

15.6 Testing the native thirteen channel target

For the native-operation comparison in this subsection, the RCHS primitive convention uses $Q=6Y$ inside the unweighted Kraus sum. This is distinct from the conventional-hypercharge diagnostic in Section 4; changing the generator there changes the law, not just the notation. In this convention the explicit source instrument uses $C_0=\sqrt{I-S/s}$ and $C_a=K_a/\sqrt{s}$, with $K_a=i[T_a,P_j]$. Its saturation and normalized-current prescription must remain distinguished from the action-derived operations above. Neither the Gaussian completion readout nor the wheel readout is asserted to be that instrument under a change of labels.

It is possible to calculate exactly what interaction would implement the target in a minimal-rotation collision construction. Stack the twelve excitation maps into A, put $E=A^\dagger A$, and define

$$B=Af(E), \qquad f(e)=\frac{\arcsin\sqrt{e}}{\sqrt{e}}, \qquad f(0)=1. \qquad (117)$$

The block Hamiltonian

$$H_{\mathrm{rot}}=\frac{\hbar}{\tau}\begin{pmatrix}0 & -iB^\dagger\\ iB & 0\end{pmatrix} \qquad (118)$$

satisfies

$$e^{-i\tau H_{\mathrm{rot}}/\hbar}\begin{pmatrix}\psi\\ 0\end{pmatrix}=\begin{pmatrix}\sqrt{I-E}\,\psi\\ A\psi\end{pmatrix}. \qquad (119)$$

The terminal copying map can subsequently retain the source projectors. Since the maximal-positivity prescription gives an eigenvalue one of E, the largest rotation angle is $\pi/2$. In this implementation $\|B\|=\pi/2$. The primitive-Q execution on archived edge $0\to4$ reproduces the native stacked isometry with norm error 1.1×10^{-14}.

Equations (117)–(119) derive an explicit target for action matching. They are an inverse construction from the requested instrument, not a derivation of that interaction from MASD. The source's existing direct-sum dilation already establishes implementability [7, XIV.15]; this calculation resolves the vacuum and excitation rotation and its finite pulse area. The duration τ, pointer carrier and interaction must still be obtained from the common action or its admitted completion operation.

The saturated operation is also not an infinitesimal regular unitary step. In (118), the maximally responding input has excitation probability $\sin^2(\pi t/2\tau)$, which vanishes quadratically as $t\to0$ and reaches one at $t=\tau$. A pointwise saturated update cannot be assigned to every arbitrarily small interval while holding its generator finite. This does not exclude a finite-duration event, a source-defined stopping time, or the inherited irreversible commitment rule.

15.7 The remaining physical selection

The completion interaction (105) fixes the operation (109) and motion (106); the spatial bond interaction fixes the propagator (114), correlations (115) and normalized readout. Their remaining physical inputs

are the kinetic metric, complete mixed spectrum, preparation and commitment or renewal attachment. Section 17.3 specifies these returns and their acceptance tests. The inverse target (118) supplies a matching test, rather than an action-selected interaction.

16 Static and time dependent gauge response

The preceding coherent calculation supplies motion but leaves the wheel's harmonic static response unchanged. We first establish that quadratic result and retain the nonlinearity of the existing scalar bond and composition restriction [29]. We then extend the static response to all twelve gauge directions [33], combine canonical matter coupling with the quadratic propagator, and evaluate a delayed quantum response [35]. The scalar, twelve-direction and quadratic constructions retain their distinct declared metrics and restrictions; they are not assembled into an unselected physical parent.

16.1 Exact response for a displaced quadratic system

Proposition 16.1. Work on a fixed finite-dimensional configuration quotient with canonical coordinates $z \in \mathrm{R}^n$, momenta p, and a field source $f \in \mathrm{R}^k$. Let M and K be real symmetric positive definite, and let B,C be real matrices with $C=C^T$. All four matrices, the canonical measure and the operator domain are independent of f. Assume also that the translations used below act unitarily and preserve the operator domain, as in the standard Schrödinger representation on the full configuration space. Suppose the full source dependence is

$$H(f)=\frac{1}{2}p^T M^{-1}p+\frac{1}{2}z^T Kz-f^T Bz+\frac{1}{2}f^T Cf. \qquad (120)$$

Then every eigenvalue, including its multiplicity, is shifted by the same scalar. The ground-energy response and the equilibrium free-energy response at any fixed temperature are

$$E_j(f)=E_j(0)+\frac{1}{2}f^T Rf, \qquad R=C-BK^{-1}B^T. \qquad (121)$$

Proof. Put $s=K^{-1}B^T f$ and complete the square:

$$H(f)=\frac{1}{2}p^T M^{-1}p+\frac{1}{2}(z-s)^T K(z-s)+\frac{1}{2}f^T Rf. \qquad (122)$$

Translation by s is unitary on the specified canonical space and leaves the kinetic operator unchanged. The first two terms therefore have exactly the spectrum of $H(0)$. The partition function receives only the common scalar factor. No commutation between M and K is required. This proves (121).

Gauge null directions must first be quotiented with a compatible source. A pseudoinverse does not repair a source that couples to an unremoved flat direction. The proposition does not cover a changing domain, fixed boundaries not preserved by translation, compact global coordinates with a nonlinear periodic potential, field-dependent mode matrices or measure, nonquadratic interactions, or an arbitrarily prepared nonequilibrium state. It is an exact statement about the displayed canonical family, not a theorem that quantum effects never alter a gauge response.

Adding coupled harmonic modes can change K and B, and hence the full Schur response. What (121) excludes is an additional static correction obtained merely by solving the temporal quantum motion of that same quadratic family. The wheel result (116) is one instance. A different kinetic metric changes its frequencies and time correlations while leaving (121) unchanged if it remains independent of the source.

16.2 The first omitted term is already in the action

MASD [2, Sections 15–17] defines record composition and polar bond compatibility as actual differences of transport maps. On the occupied scalar triangle restriction used in (48), one-half of each squared phase difference gives exactly the two cosine interactions there. Keeping positive stretches fixed at one and the orthogonal weights w_B,w_R>0, their first departure from the quadratic potential is

$$V_4(\Phi,\beta)=-\frac{w_B}{24}\sum_{e=1}^{3}(\Phi/3-\beta_e)^4-\frac{w_R}{24}(\mathbf{1}^T\beta)^4. \qquad (123)$$

The coefficients $-w_B/24$ and $-w_R/24$ follow from the cosine expansion; no new quartic coefficient is inserted. The negative quartic polynomial is not used as a globally stable potential. It is a local asymptotic term of the full bounded periodic action, which is retained in the numerical calculation below.

Other defect families, metric cross blocks, occupied-support changes and fermions remain outside this scalar restriction.

16.3 Leading quantum softening with a general fixed kinetic metric

Give the three record phases a constant positive kinetic matrix M, so that the local Hamiltonian is $p^TM^{-1}p/2+V(\Phi,\beta)$. This temporal attachment is explicit and conditional. Write

$$D_{BR}=w_B+3w_R,\quad K_\beta=w_BI_3+w_R\mathbf{1}\mathbf{1}^T,\quad \beta_*(\Phi)=\frac{w_B\Phi}{3D_{BR}}\mathbf{1},\quad r_B=\frac{w_R}{D_{BR}},\quad r_R=\frac{w_B}{D_{BR}}. \qquad (124)$$

Here $r_B\Phi$ is the bond mismatch and $r_R\Phi$ the total record phase at the quadratic minimum. The harmonic ground covariance of $u=\beta-\beta_*$ is

$$G=\langle uu^T\rangle_0=\frac{\hbar}{2}M^{-1/2}(M^{-1/2}K_\beta M^{-1/2})^{-1/2}M^{-1/2}. \qquad (125)$$

Evaluate V_4 in this displaced ground state and differentiate twice with respect to Φ. The Φ^2u^2 terms give

$$R=\frac{w_Bw_R}{D_{BR}}+\Delta R^{(1)}+O(\hbar^2),\qquad \Delta R^{(1)}=-\frac{1}{2}[w_Br_B{}^2\mathrm{Tr}G+w_Rr_R{}^2\mathbf{1}^TG\mathbf{1}]<0. \qquad (126)$$

The remainder is a local semiclassical expansion at fixed positive M,w_B,w_R. Sextic terms and second-order quartic perturbations contribute beyond the displayed order; global tunnelling is not calculated by that local power series. The sign in (126) holds for every such positive fixed kinetic matrix on this restriction.

For $M=mI_3$, the coefficient is explicit:

$$\Delta R^{(1)}=-\frac{\hbar}{4\sqrt{m}}[2\sqrt{w_B}\,r_B{}^2+\frac{w_Br_B{}^2+3w_Rr_R{}^2}{\sqrt{D_{BR}}}]. \qquad (127)$$

An independent derivation differentiates the zero-point energy of the local normal modes at the classical minimum. Their stiffnesses are $w_B\cos(r_B\Phi)$ twice and $w_B\cos(r_B\Phi)+3w_R\cos(r_R\Phi)$ once, through order Φ^2. It gives (127). A nondiagonal positive M check also agrees with (126), without assuming a common mode mass.

For equal weights $w_B=w_R=w$, define the dimensionless quantum parameter $\eta=\hbar/\sqrt{mw}$. Then

$$\frac{R}{w}=\frac{1}{4}-\frac{\eta}{16}+O(\eta^2),\qquad \frac{R}{R_{\mathrm{quad}}}=1-\frac{\eta}{4}+O(\eta^2). \qquad (128)$$

In physical terms, the applied flux reduces the local restoring curvature of the cosine interactions. The zero-point energy consequently has a negative flux curvature. This contribution is absent when the same interactions are replaced everywhere by their quadratic approximation. It is an energetic correction from an existing action term, rather than a recording-noise coefficient reinterpreted as energy.

16.4 Full periodic calculation and independent response checks

To test (128) beyond its small-η expansion, retain the exact potential (48) on the declared space $L^2(\mathrm{T}^3, d^3\beta/(2\pi)^3)$ with periodic boundary conditions, common inertia m, and its ground state. Dividing by w gives

$$\frac{H(\Phi)}{w} = -\frac{\eta^2}{2}\sum_e \partial_{\beta_e}^2 + \sum_e [1-\cos(\Phi/3-\beta_e)] + 1-\cos(\mathbf{1}^T\beta). \qquad (129)$$

The periodic scalar phase carrier, flat measure, equal weights and inertia are declared diagnostic choices; the source action supplies the potential but does not by itself select this complete quantum problem. The calculation neither resets a record after an event nor identifies these phases with the native terminal outcomes.

With $x_e = \beta_e - \Phi/3$, the same operator has potential

$$\frac{V(\Phi,x)}{w} = \sum_e (1-\cos x_e) + 1-\cos(S+\Phi), \qquad S = \mathbf{1}^T x. \qquad (130)$$

For the dimensionless operator $h = H/w$, its normalized ground state $|0\rangle$ and energy e_0 at zero flux, the exact curvature is

$$\frac{R}{w} = \langle \cos S\rangle_0 - 2\langle 0|\sin S\,(h-e_0)_\perp^{-1}\sin S|0\rangle. \qquad (131)$$

Both the contact term and the spectral subtraction are retained. The inverse acts on the orthogonal complement of the ground state. Fourier truncation to integer momenta $|n_e| \le N$ permits a sparse ground-state solve and a projected linear solve for the second term. Results are as follows; $R_{\mathrm{quad}}/w = 1/4$ throughout.

Quantum parameter η	Leading R/w	Full periodic R/w	R/R_{quad}
0.10	0.24375000	0.24371177	0.97484709
0.20	0.23750000	0.23734129	0.94936514
0.50	0.21875000	0.21762762	0.87051050
1.00	0.18750000	0.18127959	0.72511837

The final cutoffs are $N = 22,16,12,8$, respectively. Comparing the last two cutoffs changes R/w by less than 10^{-10} in each reported row. Independent fourth-order finite-field energy differences at $\eta = 0.1$ and 1 agree with (131) within 1.4×10^{-9} across the tested steps.

The effective second-order coefficient $c_{2,\mathrm{eff}}/w = (R/w - 1/4 + \eta/16)/\eta^2$ is $-0.00382286, -0.00396787, -0.00448950, -0.00622041$ at $\eta = 0.1,0.2,0.5,1$, respectively. Thus the smallest tabulated point estimates $c_2 \simeq -0.0038w$; the saved $\eta = 0.05$ control gives $-0.00375472w$. The

drift records higher orders rather than a constant fitted coefficient or a proof of series convergence. At $\eta = 1$, the full result is 3.32 percent below the leading-order value $0.1875w$.

At η=1, the contact and spectral terms in (131) are 0.631446485165 and 0.450166893232. Placing the same source symmetrically on the three bonds instead gives 0.262000249934 and 0.080720658001. Both differences are 0.181279591933 to the displayed precision. An explicit unitary change of phase coordinates verifies the equivalence. This check shows why neither the contact term nor the fluctuation subtraction can be interpreted in isolation.

The unit-parameter execution therefore reduces the resistance of this bond–record block by approximately 27.49% relative to its own quadratic value. The scalar triangle and charged-pair models answer different questions; the status convention in Section 1 applies.

16.5 Coefficients and physical admission

The following ledger separates the inherited interaction from the conditional quantum realization. A formula for an input is distinguished from an evaluated physical value.

Quantity	Source or calculation	Present status
Bond and composition potential	MASD Sections 15–17; equation (48)	Exact on the occupied scalar restriction
Quartic coefficients	Expansion of the same two cosines	Fixed as $-w_B/24$ and $-w_R/24$
Common residual weights and mixed blocks	$W_{XY}=\iota_X^\dagger W_{\mathrm{prim}}\iota_Y$	Defined by the common source; physical entries unevaluated here
Kinetic metric M	Operational generator and physical reduction	Positive constant matrix in the proof; mI in the execution
Quantum parameter η	$\hbar/\sqrt{mw}$ after normalization	Scanned for a diagnostic; no physical value selected
Measure and preparation	Full quantum history or admitted action	Flat torus measure and ground state declared here
Readout and permanent commitment	Native terminal maps and existing FC mechanism	Not needed for this equilibrium control; physical recording attachment remains open
Gauge-sector projection and units	Common representation and PCN conventions	No physical colour, weak or hypercharge coefficient returned

The existing principles constrain these entries together; the ledger does not establish that any one is an arbitrary freedom of VERSF. It identifies which evaluations this calculation has and has not performed. Fitting η to the desired normalization would not supply the missing derivation.

The next force-response execution should retain the corresponding nonlinear vertices inside the physically returned mixed current–matter–record operator and measure. It must recover the quadratic identity when those vertices are removed, reproduce a finite-field derivative of the same energy or effective action, and demonstrate numerical and regulator stability before sector matching.

16.6 All twelve gauge directions

The scalar result can be enlarged without assigning physical values to its remaining coefficients. Use the 47-address charged carrier comprising three copies of Q, u, d, L, e and one Higgs doublet, with standard hypercharges. Retain eight colour, three weak and one hypercharge generator, normalized by the trace Gram

$$K_{ab} = \mathrm{Tr}(T_a T_b) = \mathrm{diag}(6I_8, 13/2\, I_3, 21/2), \qquad t_a = T_a/\sqrt{K_{aa}}. \qquad (132)$$

This charged gauge carrier is not the native 50-address recording channel. Give each of three record links $V_e \in G = SU(3) \times SU(2) \times U(1)$ the common bi-invariant trace metric with inertia $m > 0$ and product Haar measure. Fix stretches to one and use equal bond and composition weights $w > 0$. For a source fT, define the ordered restriction

$$V(f)/w = \sum_{e=0}^{2} \mathrm{ReTr}\,(I - V_e) + \mathrm{ReTr}\big(I - e^{ifT} V_0 V_1 V_2\big). \qquad (133)$$

$$H(f) = -\frac{\hbar^2}{2m} \sum_{e=0}^{2} \Delta_{G,e} + V(f), \qquad \eta = \frac{\hbar}{\sqrt{mw}}. \qquad (134)$$

There are 36 local gauge coordinates. The ordered product explicitly defines this non-Abelian extension of the commuting-source restriction. Current and matter motion, radial stretches, completion and bath response, fermions and inter-cell refinement are not included. Equal weights, common inertia and this isolated carrier remain declared assumptions. This calculation does not propose a replacement physical radial-current metric.

For sufficiently small f, the stable local classical minimum is $V_e = \exp(-ifT/4)$. Its energy is $4w\mathrm{ReTr}\big(I - e^{ifT/4}\big)$, so $R_T^{\mathrm{class}} = wK_T/4$, with $K_T = \mathrm{Tr}T^2$. The expansion below concerns that minimum; it does not solve the finite-η quantum problem.

16.7 The noncommuting correction

Write $V_e = e^{-ifT/4}\exp(ix_{ea}t_a)$ and let $\mathsf{A}(f)$ be the Hessian of V/w in these orthonormal right-invariant frames. At zero source, $\mathsf{A}_0 = \big(I_3 + \mathbf{1}\mathbf{1}^{\mathsf{T}}\big) \otimes I_{12}$, with eigenvalue 1 on 24 modes and 4 on 12 modes. Its exact blocks are

$$\mathsf{A}_{ee,ab} = 2\mathrm{ReTr}(e^{ifT/4}\{t_a, t_b\}/2). \qquad (135)$$

$$\mathsf{A}_{eg,ab} = \mathrm{ReTr}\big(e^{i(1+d)fT/4} t_a e^{-idfT/4} t_b\big), \quad d = g - e > 0. \qquad (136)$$

The lower blocks are transposes. The first zero-point contribution is $(w\eta/2)\mathrm{Tr}\sqrt{\mathsf{A}(f)}$. For this smooth fixed metric, the Haar/curvature terms and the quantum shift of the minimum affect the energy at the next semiclassical order. Define

$$\mathcal{Q}_T = \sum_b \mathrm{Tr}\,\big(T^2 t_b^2\big), \qquad \mathcal{C}_T = \sum_b \mathrm{Tr}\,([T, t_b]^\dagger [T, t_b]). \qquad (137)$$

Proposition 16.2. On the restriction (132)–(134), the local ground-energy curvature obeys

$$\frac{R_T}{w} = \frac{K_T}{4} - \eta\left(\frac{\mathcal{Q}_T}{16} + \frac{11\mathcal{C}_T}{2304}\right) + O(\eta^2). \qquad (138)$$

For the reduction, set $P_L = \big(\mathbf{1}\mathbf{1}^{\mathsf{T}}/3\big) \otimes I_{12}$ and $P_T = I - P_L$. The coefficient of $w\eta$ is

$$1/4\,\mathrm{Tr}[(P_T + P_L/2)\mathsf{A}''] - 1/8 \parallel P_T\mathsf{A}'P_T \parallel_F^2 - 1/64 \parallel P_L\mathsf{A}'P_L \parallel_F^2 - 1/12 \parallel P_T\mathsf{A}'P_L \parallel_F^2. \qquad (139)$$

All source derivatives in (139) are evaluated at zero source. Substitution of (135)–(136) gives $-\mathcal{Q}_T/16 + 5\mathcal{C}_T/96$ from the direct second derivative and $-131\mathcal{C}_T/2304$ from mode mixing. Their sum proves (138). This commutator contribution is absent in a Cartan-only calculation; counting additional directions without their mixing would miss it.

16.8 Separate sector responses

Representation closure of Proposition 16.2. On each irreducible address block $\mathfrak{b}$, define its normalized Casimir load by

$$\chi_{\mathfrak{b}} = \frac{C_2^C(\mathfrak{b})}{K_C} + \frac{C_2^W(\mathfrak{b})}{K_W} + \frac{Y_{\mathfrak{b}}^2}{K_Y}. \qquad (139a)$$

Let $k_{A\mathfrak{b}} = \mathrm{Tr}_{\mathfrak{b}}(T_A^2)$, including all copies of that block. For a conventional generator in factor A,

$$\mathcal{Q}_A = \sum_{\mathfrak{b}} k_{A\mathfrak{b}}\,\chi_{\mathfrak{b}}, \qquad \mathcal{C}_A = C_2^{\mathrm{adj}}(A), \qquad C_2^{\mathrm{adj}}(C,W,Y) = (3,2,0). \qquad (139b)$$

Indeed, $\sum_b t_b^2$ restricts to $\chi_{\mathfrak{b}} I$ on each block. The double-commutator identity gives $\sum_b [t_b,[t_b,T_A]] = C_2^{\mathrm{adj}}(A)T_A/K_A$; tracing against T_A cancels K_A. Substitution into (138) gives $\gamma_A = \sum_{\mathfrak{b}} k_{A\mathfrak{b}}\,\chi_{\mathfrak{b}}/(4K_A) + 11C_2^{\mathrm{adj}}(A)/(576K_A)$. No numerical matrix contraction remains in this formula.

Address family	$k_{C\mathfrak{b}}$	$k_{W\mathfrak{b}}$	$k_{Y\mathfrak{b}}$	$\chi_{\mathfrak{b}}$
Q with three generations	3	9/2	1/2	836/2457
u with three generations	3/2	0	4	50/189
d with three generations	3/2	0	1	44/189
L with three generations	0	3/2	3/2	38/273
e with three generations	0	0	3	2/21
One Higgs doublet	0	1/2	1/2	38/273

The ordering of the slopes follows from these weighted loads and the adjoint terms. Hypercharge has no adjoint contribution and places 2/7 of its Gram on the low-load charged-lepton singlets, where $\chi = 2/21$. Every coloured block also carries weak or hypercharge load, and colour has the largest adjoint Casimir. These facts explain the ordering for this census; they are not a representation-independent ordering theorem.

Census sensitivity. A second Higgs doublet changes the trace Gram in (132) to (6,7,11). Recomputing both the normalized metric and the source Gram gives the following exact test.

Charged census	γ_C	γ_W	γ_Y
One Higgs doublet	26155/314496	989/13104	2488/51597
Two Higgs doublets	661/8064	223/3168	709/15246
Added sterile singlets only	Unchanged	Unchanged	Unchanged

The second-doublet slopes are (0.08196925,0.07039141,0.04650400), all lower than the original values. Colour changes through the weak and hypercharge weights on shared coloured blocks, even though K_C is unchanged. Adding doublet contributions while freezing the old normalization is a different perturbation. Sterile singlets have zero generator trace and zero Casimir load, so they change none of these coefficients. These census checks falsify an implementation that misses shared-block weighting or changes the normalized law without recording it.

For the trace Gram (132), the representation formula gives the following exact contractions and fractional slopes, defined by $R_A/R_A^{\mathrm{class}} = 1 - \gamma_A\eta + O(\eta^2)$.

Sector	K_T	Q_T	C_T	**Exact** γ_A	**Decimal** γ_A
Colour	6	1447/819	3	26155/314496	0.083164809727
Weak	13/2	38/21	2	989/13104	0.075473137973
Hypercharge	21/2	4976/2457	0	2488/51597	0.048219857744

The unnormalized responses are

$$R_C/w = 1.5 - 0.124747214591\eta + O(\eta^2), \qquad R_W/w = 1.625 - 0.122643849206\eta + O(\eta^2), \qquad (140)$$

$$R_Y/w = 2.625 - 0.126577126577\eta + O(\eta^2). \qquad (141)$$

Every generator inside a simple factor has the same response; mixed source curvatures vanish at the symmetric origin by factor covariance. The earlier four commuting directions [32] give slopes (0.022334147334,0.021520146520,0.021815706340) in colour, weak and hypercharge order. Restoring all twelve directions therefore changes both the magnitude and relative pattern. Hypercharge has no commutator term, but its trace contraction changes because colour and weak fluctuations act on shared charged addresses. Primitive $q = 6Y$ multiplies its raw curvature and Gram by 36 while leaving the fractional slope unchanged.

These coefficients are derivatives at $\eta = 0$, not finite-$\eta = 1$ reductions. An electromagnetic result would additionally require electroweak matching and running.

16.9 Checks and the remaining fluctuation scale

Analytic matrix jets and the contraction formula agree within 8.4×10^{-17} across all twelve generators. Five-point derivatives of the zero-point energy at three source steps agree within 1.0×10^{-9}. Independent derivatives of the original matrix potential along nine random 36-dimensional directions at source 0.37 reproduce its Hessian within 1.82×10^{-9}; the stationary-gradient residual is below 1.68×10^{-12}. Seven mixed-source polarizations are zero within 5.6×10^{-17}. Exact rational arithmetic checks the fractions in the table [33].

The fluctuation scale is consequential. With the representation, w and $\hbar$ held fixed, replacing m by $4m$ halves η and hence the leading correction. Both operators retain the tested group symmetry, self-adjoint

unitary evolution, Born probabilities and energy conservation. These structural conditions alone therefore do not select the nonlinear response. This is not a claim that both choices satisfy all VERSF axioms or refinement conditions. A primitive selection theorem, or an observable-equivalence theorem for fully admitted alternatives, is still required. A change of time units cannot remove this dimensionless difference.

16.10 Canonical matter coupling and the combined response

The combined calculation [35] combines the matter insertion with the field response. It has three distinct parts: an exact shared-link normalization identity on the 47-address carrier, the frequency response of the quadratic link–record parent, and the delayed quantum response of the scalar model (129)–(130).

For a positive, gauge-invariant matter kinetic matrix G_m, the same matrix multiplies the kinetic term and its shared-link insertion. With $\widehat{\Psi} = G_m^{1/2}\Psi$, the canonical vertex is

$$V_A = G_m^{-1/2} G_m T_A G_m^{-1/2} = T_A, \qquad [G_m, T_A] = 0. \qquad (142)$$

This implements the existing coupling-universality theorem [36, Sections 22–23]. A non-diagonal generation metric on the 45 fermion addresses, with a separate metric on the two scalar addresses, verifies all twelve vertices to residual below 1.8×10^{-14}. A five-point link derivative agrees. The cancellation is algebraic; these numerical checks verify its implementation. It does not identify the independent MASD constitutive current with the canonical matter current. That microscopic matching remains the separate condition described in [36, Section 23.2].

16.11 Frequency dependent exchange on the link record parent

Retain the spatial potential of (112) and supply explicit positive temporal coefficients m_x, m_y. With Euclidean frequency ω and wheel eigenvalue λ, its two-coordinate kernel is

$$\mathsf{H}_{\mathrm{lr}}(\omega, \lambda) = \begin{pmatrix} m_x\omega^2 + a_{\mathrm{w}}\lambda + c_{\mathrm{w}} & -c_{\mathrm{w}} \\ -c_{\mathrm{w}} & m_y\omega^2 + b_{\mathrm{w}}\lambda + c_{\mathrm{w}} \end{pmatrix}. \qquad (143)$$

To test charge-Gram factorization, assign the full block $K_A\mathsf{H}_{\mathrm{lr}}$, with $K_A = (6, 13/2, 21/2)$ per generator in colour, weak and hypercharge order, and couple canonical matter to x. This factorization and the temporal coefficients are declared assumptions. They are not values selected by the full physical measure. Eliminating the record gives the exact current-exchange coefficient

$$\mathcal{X}_A = \frac{\left(\mathsf{H}_{\mathrm{lr}}^{-1}\right)_{xx}}{K_A} = \frac{1}{K_A \mathcal{R}}, \qquad \mathcal{R} = m_x\omega^2 + a_{\mathrm{w}}\lambda + \frac{c_{\mathrm{w}}\left(m_y\omega^2 + b_{\mathrm{w}}\lambda\right)}{c_{\mathrm{w}} + m_y\omega^2 + b_{\mathrm{w}}\lambda}. \qquad (144)$$

The static limit and induced low-frequency inertia follow from the same inverse:

$$\mathcal{R}(0, \lambda) = a_{\mathrm{w}}\lambda + \frac{b_{\mathrm{w}} c_{\mathrm{w}}\lambda}{c_{\mathrm{w}} + b_{\mathrm{w}}\lambda}, \qquad \left.\frac{\partial \mathcal{R}}{\partial \omega^2}\right|_0 = m_x + \frac{{c_{\mathrm{w}}}^2 m_y}{(c_{\mathrm{w}} + b_{\mathrm{w}}\lambda)^2}. \qquad (145)$$

The second identity recovers the conditional record-kinetic sensitivity already considered in the retained CLSN source [18, Sections 17.77–17.79]. Its continuity-only temporal attachment supplies no corresponding record inertia at this quadratic level. Adding m_y without deriving it would change the parent.

For $a_{\mathrm{w}} = b_{\mathrm{w}} = c_{\mathrm{w}} = m_x = m_y = 1$,

$$\mathcal{X}_A(\omega, \lambda) = \frac{1}{2K_A}\left(\frac{1}{\omega^2 + \lambda} + \frac{1}{\omega^2 + \lambda + 2}\right). \qquad (146)$$

The real-time squared mode frequencies are λ and $\lambda + 2$. Each squared-frequency pole has coefficient $1/(2K_A)$ in (146). Thus the propagation and coupling to the external canonical matter current have both been calculated on this branch. The mixing factor one half is not a derivation of the force-normalization correction near 0.52.

The wheel eigenvalues 1,2,2,4,4,5 are internal-mode labels, not an automatic continuum momentum. If a transverse continuum family with $\lambda \to k^2$ is additionally supplied, then $\mathcal{R} = (m_x + m_y)\omega^2 + (a_{\mathrm{w}} + b_{\mathrm{w}})k^2 + O\left(\left(m_y\omega^2 + b_{\mathrm{w}}k^2\right)^2/c_{\mathrm{w}}\right)$. This extension is conditional.

Scale all five coefficients of (143) by $\zeta > 0$ at fixed action unit. The pole locations and propagation speed are unchanged, while

$$\mathcal{X}_A \mapsto \frac{\mathcal{X}_A}{\zeta}, \qquad Z_A \mapsto \zeta Z_A, \qquad g_A^2 \mapsto \frac{g_A^2}{\zeta}. \qquad (147)$$

Here the last two relations apply after a common continuum attachment. Matter normalization cancels in (142), but the field-action scale survives in the interaction. This agrees with the earlier current–link normalization attempt [37]. It is a change in $S/\hbar$, not a change of units. The test does not prove that all scaled parents satisfy VERSF admissibility; the physical history measure may select one.

16.12 The nonlinear delayed flux response

Return to the scalar periodic Hamiltonian (129), with its declared flat rotor measure and common inertia. Define the driven experiment by varying the source f in the composition potential (130), while holding its rotor coordinates fixed. Let $O = \partial_f H|_0$, $C = \partial_f^2 H|_0$ and $\Delta_n = E_n - E_0$. Its ground-state linear response to a time-dependent loop flux has the spectral kernel

$$\mathcal{R}_f(i\omega) = \langle C\rangle - 2\sum_{n>0} \frac{\Delta_n |\langle n|O|0\rangle|^2}{\Delta_n^2 + (\hbar\omega)^2}. \qquad (148)$$

The static curvature R and induced flux inertia M_f are therefore

$$\mathcal{R}_f(i\omega) = R + M_f\omega^2 + O(\omega^4), \qquad M_f = 2\hbar^2 \sum_{n>0} \frac{|\langle n|O|0\rangle|^2}{\Delta_n^3}. \qquad (149)$$

Sparse ground-state and resolvent solves evaluate the inverse moments without retaining only a few excited states. With $w = \hbar = 1$ and $m = \eta^{-2}$, two Fourier cutoffs $|n_e| \le N$ were run for each row.

η	**Cutoffs** N	R/w	M_f/m
1.0	6 and 8	0.18127959	0.16099402
0.5	8 and 10	0.21762762	0.17806264
0.2	12 and 16	0.23734129	0.18414979
Harmonic limit	Analytic	0.25000000	0.18750000

The largest cutoff changes are 9.5×10^{-11} in R/w and 2.8×10^{-9} in M_f/m. The independent harmonic calculation gives

$$\mathcal{R}_f^{\mathrm{harm}}(i\omega) = w\frac{m\omega^2 + w}{m\omega^2 + 4w}, \qquad R_{\mathrm{harm}} = \frac{w}{4}, \qquad M_{f,\mathrm{harm}} = \frac{3m}{16}. \qquad (150)$$

At $\eta = 1$, the nonlinear static response is about 27.5 percent below its harmonic value, while the normalized delayed response is about 14.1 percent below its harmonic value. Including time dependence does not eliminate the fluctuation-scale dependence.

The source type remains decisive. If $f = d_{\mathrm{spatial}}A$ is a spatial loop flux, the induced $\dot{f}^2$ term represents a derivative of magnetic curvature, such as $\left(\partial_t F_{ij}\right)^2$. It is not automatically the leading electric term F_{0i}^2. This delayed-flux result cannot supply the electric gauge coefficient without the physical source attachment.

16.13 Covariance under time dependent source relocation

The static source-relocation check in Section 16.4 needs an extra term when the source varies in time. Define $G_f = (n_1 + n_2 + n_3)/3$ and $D_f = \exp\left(if\,G_f\right)$. Let H_c have the source in the composition angle as in (130), and let H_b have bond angles $\beta_e - f/3$ and an unshifted composition angle. The static identity is $H_c = D_f H_b D_f^{\dagger}$. Transforming the state equation gives

$$H_b^{\mathrm{dyn}} = D_f^{\dagger} H_c D_f - i\hbar D_f^{\dagger}\dot{D}_f = H_b + \hbar\dot{f}G_f. \qquad (151)$$

The velocity term is required by the coordinate change. Without it, one has changed the driven experiment. At $\eta = 1$, the bare relocated Hamiltonian gives $M_b = 0.0305590298$, compared with $M_f = 0.1609940190$ for the original source, although their static curvatures agree. Including the connection in (151) restores the original delayed response with error below 1.1×10^{-14} across all six runs.

The check uses $O_c = O_b + i\left[G_f, H_0\right]$. Its real odd vectors obey $a_c = a_b - (H_0 - E_0)G_f|0\rangle$, which restores the inverse-moment expression (149). In the harmonic limit, the bare relocated inertia is $m/48$, compared with $3m/16$ for the original experiment. Static equivalence alone is insufficient for propagating-source response.

16.14 Conversion to separate force coefficients

The twelve-direction static slopes in Section 16.8 do not include their temporal counterparts. The scalar response in Section 16.12 and the quadratic parent in Section 16.11 are different restrictions and cannot be combined with those slopes as one physical action.

Suppose one admitted parent and source normalization return low-energy electric and magnetic coefficients E_A, B_A. With dimensionless action, common continuum units and a common light cone, the conversion is

$$c_A^2 = \frac{\mathsf{B}_A}{\mathsf{E}_A}, \qquad Z_A = \sqrt{\mathsf{E}_A\mathsf{B}_A}, \qquad g_A^2 = Z_A^{-1}. \qquad (152)$$

All sectors must share the same speed to give the usual couplings in a single relativistic spacetime; separate sector-dependent time rescalings do not establish this. For the conditional extension after (146), $Z_A = K_A\sqrt{\left(m_x + m_y\right)(a_{\mathrm{w}} + b_{\mathrm{w}})}$. Its unit-coefficient values (12,13,21) are a benchmark, not a physical return.

If the static slopes are physically identified as $\mathsf{B}_A = \mathsf{B}_A^{(0)}(1 - \gamma_A\eta)$ and a matched temporal calculation gives $\mathsf{E}_A = \mathsf{E}_A^{(0)}(1 - \delta_A\eta)$, then

$$\frac{g_A^2}{g_{A0}^2} = 1 + \frac{\gamma_A + \delta_A}{2}\eta + O(\eta^2), \qquad \frac{c_A^2}{c_{A0}^2} = 1 + \big(\delta_A - \gamma_A\big)\eta + O(\eta^2). \qquad (153)$$

An unchanged common speed would require $\delta_A = \gamma_A$ at this order. If a common speed renormalization is allowed, only the differences $\delta_A - \gamma_A$ must be equal across sectors. These relations do not fix the baseline action coefficient, the physical η or the higher-order response. The remaining calculation must return both coefficients and the matter-current matching from the same selected parent.

17 Physical admission and falsifiable next steps

17.1 What the calculations rule out

The controls exclude three identifications: source-coordinate protection with matter-current protection, positive recording noise with energetic softening, and static curvature with a temporal gauge coefficient. Matched transport and flux-independent internal additions preserve loop curvature. Joint preparation affects terminal information, and the common-endpoint witness prevents that information from descending through the two tested defects alone.

The constructive calculations locate the surviving mechanisms. Coherent completion dynamics supplies recording and propagation; the coupled pair has the stated strong-coupling residual; and nonlinear bond and composition terms escape the quadratic recovery theorem. Representation closure explains the unequal leading sector corrections. The dynamic relocation identity and canonical vertex calculation retain the need for a common physical source and field normalization. The tests below distinguish completion of that task from reproduction of a diagnostic.

17.2 Explicit tests

PMRG F1, current identification. A proposed physical attaching map must transport the source variation (2), including its canonical normalisation. If it maps only the independent coordinate j, it has not identified the matter gauge current. Agreement of dimensions or charge labels is insufficient.

PMRG F2, propagation absence. On a supplied finite physical carrier of dimension d, recording adds no Schwarz noise to a self-adjoint current at any time precisely when its Hamiltonian orbit lies in the channel's multiplicative domain. The finite test in Appendix A uses commutators through order d^2-1. A zero result closes this particular noise route for that carrier and operation; it does not exclude other contributions to the gauge response.

PMRG F3, response attachment. A claimed energetic correction must be reproduced by differentiating the same complete source functional, including the contact term or its action analogue. A nonzero Σ together with an unchanged source response, as in Section 8's unchanged-state control and Sections 10–11's loop calculations, falsifies the identification of those two quantities in that experiment.

PMRG F4, physical carrier. An asserted direct physical implementation must preserve the admitted statistics and local gauge constraints with all compensating systems included. The block transfers (16) reject the naive interpretation with only even auxiliary states; Section 10.1 supplies a conserving occupation-space completion. Full chiral, multi-occupation and non-Abelian Gauss admission remain unproved.

PMRG F5, force prediction. A claimed force-strength result must return stable, source-selected sector coefficients under the stated refinement and matching prescription, with any empirical calibration inputs disclosed. A successful finite channel calculation, or a fit of its normalisation, does not satisfy this test.

PMRG F6, internal-energy insufficiency. Under the exact factorisation (47), every flux-independent internal addition leaves the loop curvature unchanged. A claimed nonzero correction in that class fails this test unless it identifies where the factorisation breaks. A positive geometric term or a nonzero recording-energy change alone does not pass the response test.

PMRG F7, preparation sufficiency. A proposed reduction to current vector and endpoint marginal laws must reproduce the unequal conditional information responses of Section 12, or supply a physical principle that excludes one of its preparations. The calculation rejects that simplification for the stated probe, not an otherwise specified physical source theory.

PMRG F8, cycle-source release. For the regular successor class (60), derive the amplitudes from the common source and check (61), including the survival complement and Abelian closure. Failure of the shape relations rejects that successor; passing them alone does not establish energetic attachment or regulator stability.

PMRG F9, joint-score descent. A claimed metric on selected defects must satisfy $\ker \mathrm{J}_D \subseteq \ker F$ on the admitted tangent. The common-endpoint witness (73) falsifies this claim for (D_J, D_T) and the tested terminal experiment. A full six-defect construction must remove that obstruction by its actual defect map, preparation or admissibility constraints; numerical projection alone is not a physical derivation.

PMRG F10, mixed-response completion. A physical force claim must retain the mixed blocks of its selected joint law or action and evaluate the corresponding relaxed response. The unit-weight model (62) is not that selection. If an independently derived physical block retains the positive response sign of Section 13.1, that block cannot supply the proposed softening; omitted interactions may still change the complete response. In Section 14 the contact, mixed vertex and feedback must all follow from the same projection; the bare stretch covariance cannot replace the covariance or spectral susceptibility of the coupled state.

PMRG F11, coupled-state and energy attachment. A claimed relaxation must evaluate the fluctuations under the same coupled weight or Hamiltonian that supplies its contact and mixed terms. Equations (93)–(98) give a direct countertest to replacing that response by a bare variance or a static snapshot. The approximately 0.39004739 limit applies to (96); promoting it to a universal lower bound, or promoting the static vanishing limit to a physical force prediction, fails this test.

PMRG F12, operation and propagation selection. A claimed physical recording operation must be obtained from the same admitted joint generator, preparation and readout that propagate the system between events. Equation (109) passes this construction test on its declared branch; it does not establish native terminal identification. The isolated recurrence in (110) excludes permanent commitment by that one coherent mode alone. Inserting the inverse target (118) into the action without deriving it, or resetting a responsive record without an admitted renewal rule, fails the selection test.

PMRG F13, quadratic recovery and nonlinear response. On the domain of Proposition 16.1, a claimed additional equilibrium correction must vanish beyond the complete Schur response. With the nonlinear action terms retained, the reported correction must equal the derivative of the same full energy, including contact and spectral terms, and be unchanged by equivalent source coordinates. A numerical response at an assumed η does not establish physical normalization or regulator stability.

PMRG F14, sector response and radial information. The twelve-direction restriction must reproduce the exact contractions and finite-source Hessian checks in Section 16. A physical promotion must additionally derive its kinetic and interaction weights, retained fields and source matching. A normalized-ray instrument with the invariance (155) cannot supply nonzero pure-radial score rows; inserting a preferred Gram or relabelling gauge scores fails the magnitude-bearing source test.

PMRG F15, temporal source and force normalization. A time-dependent change of source coordinates must include the connection (151); agreement of static curvatures alone does not pass this test. A physical coupling claim must return the electric and magnetic coefficients and canonical current matching in (152) from the same admitted parent. A delayed spatial-flux term, an unchanged speed or a convenient unit-coefficient choice cannot substitute for that normalization.

17.3 The next executable source return

The required output is one transverse current-exchange kernel, expanded in frequency and spatial momentum after all responding variables have been eliminated. Its measure, action unit, current and electric and magnetic coefficients must belong to the same admitted parent. The table makes the recovery tests operational.

Input to be returned	Where it enters	Acceptance test
Complete kinetic metric, measure and mixed current–matter–record Hessian	(23), (77)–(90), (120)–(121)	On removing nonlinear vertices, recover the complete Schur response (121); on the unit wheel restriction, recover (116). Include both retained and complementary blocks in (34).
Nonlinear bond, composition and other surviving vertices	(48), (123), (129)–(131)	Restrict to the scalar torus: reproduce the contact-minus-spectral result (131) and an independent finite-field energy derivative. With only quadratic terms retained, recover $R/w = 1/4$.
Physical clock and time-dependent source attachment	(143)–(151)	Transform the same driven experiment with its velocity connection. The two source placements must agree by (151), including preparation and readout.
Same-parent transverse electric and magnetic coefficients and canonical matter vertex	(142), (152)–(153)	Return both coefficients in (152), establish a common propagation speed and current normalization, and check refinement stability. The unit parent must reproduce (144)–(146). A delayed spatial-flux inertia alone does not pass.
Joint preparation, successor amplitudes and survival complement on the history route	(60)–(61), (74)–(75)	For the regular successor restriction, reproduce all four shape relations (61), Abelian closure and normalized survival. Include occurrence information where relevant.
Magnitude-bearing current law and complete typed defect map on the history route	(73)–(80), (154)–(156); PMRG F9	Check $\ker D' \subseteq \ker F$. The two-defect fixture must recover the existing failure witness; a physical completion must remove that failure by its actual map or admissibility conditions.
Joint evolution, recording attachment and commitment or renewal map	(103)–(110), (117)–(119)	Recover the coherent single-mode operation when other couplings are switched off. Derive any native terminal identification and renewal; an inverse implementation alone is insufficient.

The direct-action route in Section 2.2 can supply the common response without first replacing it by a recording-information metric. The history-route rows apply when that route is claimed. After source

selection, compare regulators and perform common-scale sector matching and running. A fitted fluctuation parameter does not satisfy the specification.

17.4 The magnitude bearing current law

The source-selection analysis [33] identifies the following boundary. The current PMS edition, through EX126 [31, Sections 110–114], explicitly tests whether the existing principles select the missing scalar radial-current metric. Its information-geometric form is

$$M_{JJ} = \left(D\Phi_J\right)^* g_{\mathrm{op}}\left(D\Phi_J\right). \qquad (154)$$

A target-space Fisher or Fubini–Study metric does not determine the physical current-to-state differential $D\Phi_J$. Gaussian operational states with mean $A\epsilon$ and unit covariance have Fisher matrix $A^{\mathsf{T}}A$, so any positive-definite factor Gram can be realized by a suitable map. This reproduces the source's EX125 non-identifiability test; it is not a prescription for choosing that map.

The executed PFDMI current instrument uses the normalized ray

$$\rho_J = \frac{|J\rangle\langle J|}{\langle J|J\rangle}, \qquad J(\epsilon) = e^{\epsilon}J \quad \Rightarrow \quad \partial_\epsilon \rho_J = 0. \qquad (155)$$

Its effects and conditional mark probabilities therefore have zero pure-radial derivative. The raw constitutive residual remains magnitude bearing, so this instrument result is not a theorem that the physical radial stiffness or gauge response is zero. The Born probability rule [30] can be retained in full while this physical state-to-operation map remains unselected.

On the fully observed simple marked-counting restriction, take positive predictable intensities λ_e that depend differentiably on the sector sources, with parameter-independent support and no simultaneous distinct marks. Write $s_{Ae} = \partial_{\epsilon_A} \log \lambda_e$, $\left(S_J\right)_{Ae} = s_{Ae}$ and $\Lambda = \mathrm{diag}(\lambda_e)$. Assume a finite stationary information rate and an initial-state information contribution that grows sublinearly with observation time. The covariance of the compensated counting increments gives

$$\left(M_{JJ}\right)_{AB} = \lim_{\tau\to\infty} \frac{1}{\tau} \mathbb{E}\left[\int_0^\tau \sum_e \lambda_e\, s_{Ae} s_{Be}\, dt\right] = \left\langle S_J \Lambda S_J^{\mathsf{T}} \right\rangle_{\mathrm{stat},AB}. \qquad (156)$$

The brackets average the joint product over the stationary history law. For constant intensities and scores they reduce to the unaveraged matrix product; otherwise replacing the product by separate factor means is not justified.

Orthogonal primitive mark innovations do not make sector scores orthogonal when two perturbations alter the same mark. A common factor metric requires three cross-score orthogonality equations and two equal-norm equations. EX126 does not return the magnitude-bearing score rows. Gauge/representation scores cannot be retyped as radial-current scores. The PMS obstruction concerns its scalar radial/flavour carrier; its specific portal census is not a universal restriction on the full gauge response.

HMGBC [12, Section 56A.11] likewise distinguishes a sealed execution from derivation of its upstream operational generator, measure, injections, background and terminal map. The Hamiltonian existence theorem [34] supplies a generator for a specified continuous reversible evolution; it does not select every physical matrix element. On the recording-history route, the complete calculation must derive a magnitude-bearing primitive recording law and its propagation, retain the full current–matter–record interactions, and then evaluate the same-source energetic response. The three coefficients in Section 16.8 are not a substitute for that return.

18 Conclusion

The paper establishes a route from the common action to recording dynamics and energetic response, together with tests that separate them. Matched joint transport preserves total-current products and loop response. Kinetic compression can change recording energy while flux-independent internal terms leave the loop curvature unchanged. The joint-weighting calculations expose preparation dependence and a concrete obstruction to reducing terminal information to two defects.

The constructive results identify where a force response can change. The completion vertex generates coherent recording and propagation. Proposition 16.1 gives exact quadratic Schur recovery, while the existing nonlinear bond and composition terms produce quantum softening. Proposition 16.2 closes the leading twelve-direction slopes in representation data and Casimirs, making their sector dependence and census sensitivity explicit.

Three benchmarks delimit these mechanisms: the charged-pair strong-coupling residual is 0.39004739; the scalar periodic response at $\eta = 1$ is $R/w = 0.181279591933$; and its delayed-flux inertia is $M_f/m = 0.16099402$. They answer different response questions. Equation (151) supplies the connection needed to preserve a driven experiment under source relocation. Canonical matter normalization cancels from the shared-link vertex, while the field-action scale remains in the interaction.

The remaining task is the same-parent evaluation specified in Section 17.3: electric and magnetic response, canonical current matching and their physical normalization, followed by regulator and common-scale checks. The projective current instrument alone does not supply radial magnitude information. The results establish neither the three physical strengths nor a theorem that VERSF leaves them free.

Appendix A The propagation and conservation identities

For a fixed finite-dimensional unital completely positive dual Φ, a self-adjoint output observable X and a time-independent self-adjoint H, define

$$\delta_H X=\frac{i}{\hbar}[H,X],\quad X(t)=e^{itH/\hbar}Xe^{-itH/\hbar},\quad L_n=(I-VV^\dagger)\pi(\delta_H^n X)V. \qquad \text{(A1)}$$

If $r\geq 0$ is the first index with $L_r\neq 0$, the norm-convergent Taylor series and (8) give

$$\mathrm{N}_\Phi(X(t),X(t))=\frac{t^{2r}}{(r!)^2}L_r^\dagger L_r+O(t^{2r+1}). \qquad \text{(A2)}$$

The extension to $r=0$ simply includes observables that were not initially protected. It is the case realised by Section 6. If all L_n vanish, the noise is identically zero. Conversely, a zero defect for every time forces the analytic vector-valued function $(I-VV^\dagger)\pi(X(t))V$ to vanish and hence all its Taylor coefficients to vanish. By Cayley–Hamilton on the d^2-dimensional operator space, testing $0\leq n\leq d^2-1$ is sufficient; a smaller invariant span can reduce this cost. Infinite-dimensional or unbounded systems require domain and convergence control, not a formal use of that finite bound.

The criterion concerns added operator noise. Preservation of the actual orbit and its products requires the stronger fixed-observable conditions when unchanged statistics are claimed. The distinction is visible in (17) and (18). For non-self-adjoint observables both adjoint-product conditions are required for multiplicative-domain membership.

For the conservation statement, suppose $Q_{\text{out}}V=VQ_{\text{in}}$. Since $(I-VV^{\dagger})V=0$, one obtains $L_{Q_{\text{out}}}=0$. Writing $Q_{\text{out}}=X+Y$ gives $L_Y=-L_X$. Applying the bilinear identity (8) proves every equality in (15). The argument is exact at the operator level under the stated intertwining hypothesis; it does not require a faithful state or assume independent compensating fluctuations.

Appendix B Reproduction and numerical returns

The original companion archive contains the native representation, generator/current matrices and corpus evidence; its joint_connection/ and additional_dynamics/ folders reproduce Sections 10–11 and Appendix D. Separate archives contain the Section 12 source assembly and paired samples [23], Section 13.1 exact current integration and sampling [24], and Section 13.2–13.6 mixed derivatives and obstruction witnesses [25]. The stretch investigation [26] supplies the polar-commutator vertex; [27] supplies Section 14's weighting and quantum solvers, [28] the Section 15 operations and propagators, and [29] the Section 16 nonlinear response, convergence checks and source snapshot. Each package retains its own code, inputs and results.

The complete generator return is shown below. The generator ordering is the archived symmetric and antisymmetric fundamental basis followed by diagonal generators, then the weak basis and conventional hypercharge. Variance changes are output minus input in ρ_{49}; they are not Schwarz defects.

Generator	Σ_{AA}	Actual variance change
C1	0.007765566785	−0.000115583144
C2	0.008692347370	−0.000115568804
C3	0.007765566785	−0.000115583144
C4	0.008692347370	−0.000115568804
C5	0.007765566785	−0.000115583144
C6	0.008692347370	−0.000115568804
C7	0.008692347370	−0.000115568804
C8	0.008692347370	−0.000115568804
W1	0.007928130950	−0.000122094434
W2	0.009829250858	−0.000122067639
W3	0.009829250858	−0.000122067639
Y	0.015092613592	−0.000180304135

Verification	Residual or return
Native completeness	1.64×10^{-14}
Native unitality	1.05×10^{-14}
Kraus versus Stinespring covariance	1.49×10^{-16}
Covariance Hermiticity	3.45×10^{-19}
Full-group covariance check	3.79×10^{-16}
Fermion-address and Higgs-address sum	2.96×10^{-17}
Hopping source differentiation	2.67×10^{-12}

Verification	Residual or return
Direct hopping evolution	1.25×10^{-15}
Direct hopping noise identity	3.79×10^{-15}

The positivity margin exceeds the observed double-precision algebraic residuals by many orders of magnitude. This supports the stated finite numerical rank; it is not an interval-arithmetic proof or a claim of robustness over untested physical backgrounds. The analytic channel and hopping identities are proved independently of the finite checks.

For the joint completion, the fixture is reconstructed exactly from the unchanged native module. Direct native covariance on 64 charge/parity orbit points has Frobenius residual below 1.3×10^{-14}; the encoded-wavefunction identity has maximum entry residual 1.78×10^{-16}. The total-current product-defect residual is below 8.8×10^{-15}, and the ring spectrum finite difference agrees with 2/9 within 1.04×10^{-11}. The post-recording curvature is inherited analytically from the checked energy intertwiner; it is not an independently fitted second Hamiltonian. A separate channel-applied state calculation checks unchanged energy to below 6×10^{-16}.

For Section 11, the native input is again byte-identical. The geometric-potential and full kinetic-compression identities agree within 1.3×10^{-13}; direct orbit differentiation agrees within 1.5×10^{-12}. The full 150-dimensional ground spectrum gives loop curvature 2/9 within 6.6×10^{-10}, while the independently evaluated prepared before/after curvature difference is below 7.2×10^{-11}. The exact compressed-resolvent translation check is below 1.1×10^{-15}. The tracial recording-energy control vanishes within 1.9×10^{-16}. Nonlinear minimisation of (48) followed by flux differentiation agrees with the unit-weight static value 1/4 within 1.1×10^{-13}.

For Section 12, probability normalization is accurate to 9.99×10^{-16}, derivative normalization to 3.91×10^{-16} and Kraus completeness to 2.35×10^{-14}. Independent five-point directional differences at steps 10^{-4} and 3×10^{-4} agree with the analytic derivatives within 2.44×10^{-10} relative error on the two fixed witnesses.

After reconciling the original EX2E terminal ordering, the reconstructed recording matrices agree with the archived arrays within 5.37×10^{-9} relative error and fixed-current probability derivatives within 2.85×10^{-8}. The archived saturated square root retains roundoff contributions on its exact kernel; the reconstruction enforces that known kernel. The independently archived on-shell finite-difference derivative agrees within 6.51×10^{-5}. Simultaneous gauge transformation of current and incoming state leaves terminal derivatives zero to 2.04×10^{-16}.

Common endpoint-amplitude rescalings by 10^{-4} and 10^{4}, with incoming state normalized and induced-current derivative scaled consistently, change probabilities by at most 1.95×10^{-16} and derivatives by 6.20×10^{-15} relative. This confirms the inherited projective-amplitude blindness. The explicit quadratic Schur reduction and independent least-squares projection agree to 3.45×10^{-17} relative error, and the exact rational verifier passes. Reproduction commands, source hashes and fixed arrays are retained in [23].

For Section 13, the canonical wheel calculation is exact in rational and radical arithmetic. The joint terminal derivative has normalization residual 1.21×10^{-15} and local gauge-score norm 2.23×10^{-15}. The common-endpoint score has 72 positive singular values, with its first excluded singular value smaller than the smallest retained one by a factor 1.72×10^{-12}. Finite differences verify the mixed KL curvature and defect-fibre witness. The event-information identity has residual 5.24×10^{-17}; the general action-block

expansion agrees with direct multiplication to relative residual 1.56×10^{-16}. The independent four-chain sampling checks and model uncertainty of Section 13.1 are documented in [24].

For Section 13.1, the four chain means give standard errors $(4.33029\times10^{-5}, 3.95679\times10^{-5}, 4.40466\times10^{-4})$ in colour, weak and hypercharge order. Contiguous blocks of 50–1,000 retained states give smaller errors, respectively $(3.07–3.18)\times10^{-5}$, $(2.81–2.95)\times10^{-5}$ and $(2.70–2.81)\times10^{-4}$. The table uses the larger between-chain estimates; the saved block and split-chain diagnostics are in [24].

For Section 14, common-metric elimination agrees with direct minimization to 2.2×10^{-14}. The Gaussian characteristic-function check reproduces the complex-pair Laplace law to 2.3×10^{-16}; quadrature and field differentiation independently check the static response. The three mixed fourth cumulants are exact rational results. Quantum reduced-resolvent and finite-field results differ by at most 3.1×10^{-6} in the displayed table. Radial cutoffs 32 and 48 and three additional basis frequencies agree on the strong-coupling residual to better than 10^{-9}. An independent 10,626-state Cartesian basis converges toward the radial result, giving 0.39015166 versus 0.39004739 for the limiting operator. That independent cutoff is less converged and is retained as such.

For Section 15, a 32-level oscillator calculation verifies the analytic completion trajectories and coherence to approximately 10^{-14}. The full complex wavefunction agrees within 5.1×10^{-14} over the four reported times. On the wheel branch at $\lambda=t=1$, increasing the oscillator cutoff from 8 to 12, 16 and 20 reduces covariance error from 4.3×10^{-6} to 2.2×10^{-15}; the final Kraus completeness residual is 6.2×10^{-14}. Retained and reset two-readout distributions have total variation distance 0.03156081120. Independent numerical integration checks the companion note's complex Gaussian kernel within 5.8×10^{-17}. The primitive-Q inverse construction reproduces its target isometry within 1.1×10^{-14} and has maximal rotation angle $\pi/2$.

For Section 16, direct completion of the square agrees within 7.2×10^{-15} on a positive nondiagonal-matrix control. Quartic Gaussian contraction and normal-frequency differentiation agree within 1.4×10^{-17} for three isotropic parameter pairs; an independent nondiagonal kinetic example agrees within 1.8×10^{-12}. The four reported periodic responses change by less than 10^{-10} at the last cutoff increase; the additional $\eta=0.05$ control agrees within 2.1×10^{-12} between $N=26$ and 32. Spectral and finite-field responses agree within 1.4×10^{-9}. Source relocation has operator residual 3.0×10^{-13} and response difference below 10^{-12}. The analytic formulas, arrays, solver residuals and exact cutoffs are retained in [29].

For Sections 16.6–16.9, [33] supplies nonabelian_response.py, verify_direct.py and selection_checks.py, their JSON outputs and source hashes. The first script evaluates all twelve generator responses and mixed polarizations; the second differentiates the original matrix potential independently and verifies exact rational contractions. The third checks current-geometry alternatives, the inertia scaling and the BCB arithmetic check in this appendix.

For Sections 16.10–16.14, [35] supplies calculate_exchange.py, calculate_response.py, generators.py and verify.py, with saved arrays and source provenance. The canonical vertex and its five-point link derivative agree within 1.8×10^{-14}. Symbolic inversion verifies the exchange kernel, two-pole identity and common-scale transformation. Across six rotor runs, the largest ground-state residual is 1.8×10^{-13} and the largest frequency-solve residual is 3.2×10^{-12}. The cutoff changes are below 9.5×10^{-11} in R/w and 2.8×10^{-9} in M_f/m. A separate small-frequency extrapolation reproduces the inverse-moment inertia to relative difference below 6×10^{-9}. Static source-relocation errors are below 4.3×10^{-15} and covariant dynamic relocation errors below 1.1×10^{-14}.

Data availability. The numerical packages are identified by their exact archive filenames in [23]–[29], [33] and [35]; the four-direction calculation [32] is retained in [33]. These are author-held supplementary files. No public repository URL or DOI is supplied in this manuscript. Public deposition is therefore still

required for readers to obtain and independently execute the complete archived calculations. The public source PDFs are linked separately in the bibliography.

The representation closure (139a)–(139b) is checked by exact rational arithmetic for every address family. It reproduces the three fractions in Section 16.8, leaves all values unchanged on adding sterile singlets, and gives $(661/8064, 223/3168, 709/15246)$ on adding a second Higgs doublet with its trace metric recomputed. The second-order diagnostics in Section 16.4 are calculated directly from the converged saved returns of [29], including the $\eta = 0.05$ control.

A separate source arithmetic check prevents the older BCB estimate from supplying a missing numerical input. Appendix G.3 of [3] prints $\epsilon_{\mathrm{bit}} = 10^{-11}$ GeV, $\Lambda = 0.2$ GeV, curvature 6, $\beta_0 = 7$ and $M_Z = 91.2$ GeV. These give $\epsilon_{\mathrm{bit}}/\Lambda = 5 \times 10^{-11}$ and $\log[(M_Z/\Lambda)^2] = 12.2449856190$, so its displayed formula yields $K = 5.3855874062 \times 10^{-10}$ and $K/\log[(M_Z/\Lambda)^2] = 4.3981982288 \times 10^{-11}$, not the quoted 0.147. Even retaining its quoted $K \simeq 5.4 \times 10^{-7}$ gives approximately 4.41×10^{-8} with that logarithm. These are diagnostics of the printed substitution, not revised physical predictions or a rejection of the separate structural BCB conservation results. The estimate is not used in the calculations here.

Appendix C Source coverage and boundaries

The controlling sources are MASD for field types, interactions and common-link structure [2]; QCA and RCHS for the recording operation [6–7]; MFKR for kinetic reconstruction [5]; HMGBC and PMS for physical history and current selection [12, 31]; and the source-history, chiral and gauge-response papers for response accounting and matching [8, 13, 36]. The Born and Hamiltonian results supply their stated probability and generator premises [30, 34]. The recovered CLSN and execution packages support the source and finite-carrier checks [18–29, 32–33, 35, 37].

Snapshot inventories, hashes, retrieval dates and search expressions are recorded in the companion packages, including coverage.json in [33]. These registers document a broad text screen and targeted derivation checks, not independent verification of every corpus theorem. Archive access status is stated in Appendix B; search absence is not an impossibility proof.

Appendix D Parity reduction and observable identification

There is a second reason to retain the physical carrier explicitly. If one instead interprets the original 50-address sum directly as odd fermion and even Higgs states while discarding any compensating reference, physical preparations must commute with its parity operator Π [17]. The native output is terminal-block diagonal, but its unrestricted dual maps even charge observables to operators with odd components.

Let $\mathrm{D}(X)=(X+\Pi X\Pi)/2$. A parity-covariant extension agreeing with the native map on every even input is $\mathrm{E_e}=\mathrm{ED}$, with dual $\Phi_\mathrm{e}=\mathrm{D}\Phi$. Its homogeneous Kraus operators are $K_{ra}P_F$ and $K_{ra}P_H$; an environment with the corresponding parities supplies a conserving dilation. It is a different reduction from the retained-reference construction of Section 10.1.

For the even generators T_A, let $O_A=(1-\mathrm{D})\Phi(T_A)$. On an even state,

$$\Sigma^{\mathrm{e}}_{AB}-\Sigma_{AB}=\mathrm{Tr}(\rho O_A^\dagger O_B). \qquad \text{(D1)}$$

This is a positive Gram correction, despite the equality of the two state maps on physical inputs. The native and parity-projected sector contractions are

Sector	Original defect	Defect after parity projection
Colour	0.008344804651	0.008468623857
Weak	0.009195544222	0.009762429360
Hypercharge	0.015092613592	0.015847461752

The state-output difference at the inherited preparation is below 6.2×10^{-17}, while the Gram identity residual is below 1.4×10^{-17}. This does not invalidate the native mathematical channel or assert that its fully retained QCA operation violates parity. It shows that discarding a compensator and restricting the observable algebra changes the product-defect diagnostic. Its physical meaning cannot be settled by the 50 labels alone.

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