CAS Observable Interface Calculation Pack I

Calibration-Free Push-Forward, Spectral Carrier Poles, and Quantum-Readout Gates

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Version 1.0 – June 2026

Abstract

This calculation pack is not a new foundational paper in the CAS series. Its purpose is to turn the seven-paper architecture into a checkable interface between spectral-affine gates and possible observables. The pack introduces a push-forward formalism from internal gate variables to external channels, proves a calibration-free prediction criterion, derives a finite-dimensional Feshbach pole equation for a compact spectral carrier, gives an explicit perturbative pole calculation, states the conditions under which readout couplings may be compared with renormalized quantum field theory couplings, and provides a Markov event-class calculation for branch observables. The central claim is deliberately limited: a CAS quantity is not an observable merely because it is mathematically defined; it becomes externally meaningful only after a readout map, an uncertainty push-forward, a no-inverse-fitting audit, and, when quantum comparison is intended, a specified quantization or effective QFT lift. The document is designed as a reproducible calculation bridge responding to the criticism that the previous papers are mathematically strong but not yet sufficiently connected to phenomenology or quantum physics.

Contents

1 Purpose and scope

The seven papers constructed a sequential mathematical architecture: physical non-nullity and affine substrate, relational time and quotient dynamics, Lorentzian signature readout, metric-affine locking, spectral matter architecture, gauge normal forms, and branch/event classes. That architecture is intentionally cautious. It avoids naming particles before spectral gates are available, avoids declaring gauge couplings before kinetic normal forms are established, and avoids cosmological storytelling before branch dynamics has a mathematical state space. The strength of that caution is also its weakness from the point of view of external physics: a reader can reasonably ask where the measurable quantities enter.

This calculation pack answers that question at the interface level. It does not claim to predict a measured mass, a scattering cross section, a dark sector abundance, or a cosmic parameter. It instead specifies the calculation chain that must exist before such claims become admissible. The pack is written around four concrete operations. First, an internal CAS gate variable is mapped to an external quantity through a readout map. Second, uncertainty or branch measure is pushed forward through that map, producing a distribution on candidate observables. Third, calibration-free status is audited by checking whether the readout map was fixed before the target datum was used. Fourth, when the output is to be compared with quantum field theory, a separate quantum or effective-QFT lift is required.

This is a deliberately conservative position. It is stronger than a narrative promise because each step can fail. If the spectral island is not isolated, there is no carrier. If the Feshbach complement is singular, the pole calculation is not valid. If the readout map depends on the target datum, the result is a calibration rather than a prediction. If the QFT lift is absent, a readout coupling cannot be directly compared with a running coupling in a renormalization scheme. These failure modes are not secondary caveats; they are the scientific content of the interface.

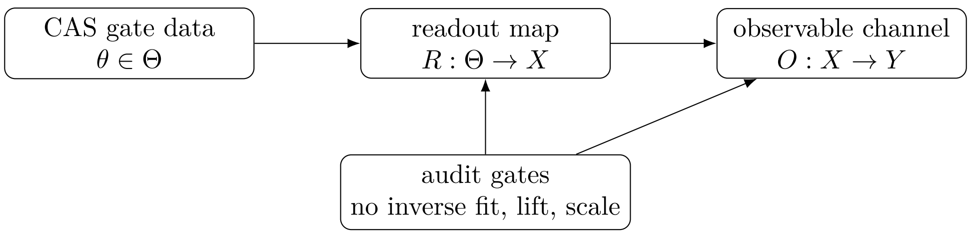

Figure 1: The observable interface is not a new physical postulate. It is a map-and-audit layer between internal gate variables and external candidate observables. A CAS quantity becomes externally meaningful only after the readout map and its audits are fixed.

2 Interface variables and observable push-forward

Let Θ denote the space of internal gate data produced by the previous papers. An element $\theta \in \Theta$ may contain spectral projectors, reduced Hessians, Schur complements, normal-form kinetic matrices, branch chamber coordinates, or event-class generators. The essential point is that θ is not yet an experimental observable. It is an internal mathematical state or a finite collection of state-dependent invariants.

Definition 2.1 (Readout channel)**.** *A readout channel is a triple (X, R, O) consisting of an external comparison space X, a readout map $R : \Theta \to X$, and an observable projection $O : X \to Y$*

into a target data space Y. The composite

$$\Phi = O \circ R : \Theta \longrightarrow Y \tag{2.1}$$

is called the observable interface map.

The external comparison space X is intentionally abstract. In a gauge application it may be a space of coupling constants at a readout scale. In a spectral-carrier application it may be a space of pole locations or widths. In a cosmological branch application it may be a space of event-class probabilities. The formalism remains the same because the central question is not what the target is, but whether the mapping to that target has been fixed without using the target itself.

Definition 2.2 (Push-forward prediction)**.** *Let μ_Θ be a probability measure, uncertainty measure, or finite ensemble on Θ. A readout channel produces a push-forward measure*

$$\mu_Y = \Phi_* \mu_\Theta, \qquad \mu_Y(B) = \mu_\Theta(\Phi^{-1}(B)) \tag{2.2}$$

for measurable subsets $B \subseteq Y$. When μ_Θ is a point mass, the push-forward is a sharp candidate prediction. When μ_Θ contains uncertainty, μ_Y is the induced observable uncertainty.

Theorem 2.3 (Observable push-forward theorem)**.** *Assume that Θ and Y are measurable spaces, that μ_Θ is a probability measure on Θ, and that $\Phi : \Theta \to Y$ is measurable. Then $\Phi_*\mu_\Theta$ is a probability measure on Y. Moreover, for every bounded measurable function $f : Y \to \mathbb{R}$,*

$$\int_Y f(y)\, \mathrm{d}(\Phi_*\mu_\Theta)(y) = \int_\Theta f(\Phi(\theta))\, \mathrm{d}\mu_\Theta(\theta). \tag{2.3}$$

Proof. The set function $\Phi_*\mu_\Theta(B) = \mu_\Theta(\Phi^{-1}(B))$ is nonnegative, countably additive because inverse images commute with countable unions of disjoint measurable sets, and normalized because $\Phi^{-1}(Y) = \Theta$. The integral identity follows first for indicator functions, then by linearity for simple functions, and finally by bounded monotone approximation or dominated convergence for bounded measurable functions. □

This theorem is elementary, but it is the correct mathematical bridge. A predicted number without a push-forward construction is only an internal value. A predicted distribution without a fixed readout map is only a parametrization. CAS becomes experimentally meaningful only when the composite map Φ and the uncertainty measure on its input are specified before comparison with data.

3 Calibration-free status and anti-fitting

The central danger in any ambitious foundational framework is that a later matching map absorbs the information that the theory was supposed to predict. The previous papers introduced anti-fitting language in several places. Here it is formulated as a testable criterion.

Definition 3.1 (Target-independent readout)**.** *Let $D \in Y$ be a target datum or dataset. A readout channel (X, R, O) is target-independent relative to D if the definition of R, the definition of O, and all continuous or discrete coefficients appearing in them are fixed without using D or any statistic derived from D.*

Definition 3.2 (Calibration-free candidate prediction)**.** *A push-forward output $\mu_Y = \Phi_*\mu_\Theta$ is a calibration-free candidate prediction for a target datum $D \in Y$ when Φ is target-independent relative to D, the input measure μ_Θ is fixed by upstream theory or independently specified uncertainty, and the comparison between μ_Y and D is performed only after these choices are locked.*

Theorem 3.3 (No inverse-fitting theorem)**.** *Let Y be a set containing at least two possible target values. Suppose that for every $D \in Y$ the readout map $\Phi_D : \Theta \to Y$ is allowed to depend on D. Then the statement $D \in \Phi_D(\Theta)$ has no predictive content unless a target-independent restriction on the admissible family $\{\Phi_D\}$ is supplied.*

Proof. If Φ_D may depend freely on D, choose any nonempty Θ and fix $\theta_0 \in \Theta$. Define $\Phi_D(\theta) = D$ for all $\theta \in \Theta$. Then $D \in \Phi_D(\Theta)$ holds for every target value. Therefore the statement does not discriminate among possible targets. Predictive content can only enter through restrictions on Φ_D that are fixed independently of the target. □

This theorem is intentionally blunt. It is the mathematical form of the external criticism: a theory is not physical merely because it can reproduce known quantities. It becomes predictive only when the map from its internal variables to those quantities is fixed before the comparison.

4 Spectral carrier interface and the vorton gate

The spectral matter paper defined matter candidates through spectral islands and finite-rank projectors rather than by naming particles. This section extracts the minimal calculation that turns such an island into a carrier whose poles can be tracked. The word "vorton" is used here only for a compact spectral carrier satisfying isolation, finite rank, circulation, and Feshbach stability gates. It is not a particle name and not an experimentally identified object at this stage.

Definition 4.1 (Compact spectral carrier)**.** *Let K be a closed operator on a Hilbert space $\mathcal{H}$, and let $\Gamma \subset \mathbb{C}$ be a positively oriented contour enclosing an isolated compact component of* $\operatorname{Spec}(K)$*. The Riesz projector*

$$P_\Gamma(K) = \frac{1}{2\pi i} \oint_\Gamma (z - K)^{-1} \, \mathrm{d}z \tag{4.1}$$

defines a compact spectral carrier if $P_\Gamma(K)$ has finite rank and the isolated spectral component remains separated by a positive gap under the perturbations considered.

Definition 4.2 (Vorton carrier gate)**.** *A compact spectral carrier is called a vorton carrier, in the restricted sense used in this pack, if in addition it carries a nonzero internal circulation operator J_V on $\mathcal{H}_V = \operatorname{Ran} P_\Gamma(K)$, if the circulation index $\nu_V = \operatorname{Tr}_{\mathcal{H}_V} J_V$ or its normalized variant is stable under admissible deformations, and if its coupling to the eliminated complement admits a meromorphic Feshbach kernel near the island.*

This definition is stricter than a suggestive name. It makes the carrier falsifiable at the mathematical level. If the contour cannot be chosen, if the rank is unstable, if the circulation is representation-dependent, or if the Feshbach complement is singular at the relevant spectral parameter, then the vorton carrier is not available.

Theorem 4.3 (Vorton pole gate)**.** *Let K be block decomposed with respect to $P = P_\Gamma(K_0)$ and $Q = I - P$. Suppose that $Q(K-z)Q$ is invertible for z in a punctured neighborhood of the isolated spectral island. Then the spectral poles of the carrier sector are zeros of the finite-dimensional Feshbach determinant*

$$\det F_P(z) = 0, \qquad F_P(z) = P(K - z)P - PKQ\,[Q(K - z)Q]^{-1}QKP. \tag{4.2}$$

Proof. Write an eigenvector candidate as $\psi = p + q$ with $p = P\psi$ and $q = Q\psi$. The equation $(K - z)\psi = 0$ gives the coupled system

$$P(K - z)Pp + PKQq = 0, \tag{4.3}$$
$$QKPp + Q(K - z)Qq = 0. \tag{4.4}$$

By invertibility of $Q(K - z)Q$, the second equation gives

$$q = -[Q(K - z)Q]^{-1}QKPp. \tag{4.5}$$

Substituting into the first equation yields $F_P(z)p = 0$. A nonzero carrier component p exists if and only if the finite-dimensional operator $F_P(z)$ has nontrivial kernel, equivalently $\det F_P(z) = 0$. Conversely, any nonzero solution p of $F_P(z)p = 0$ reconstructs q by the displayed formula and therefore gives a solution of the original block equation. This proves the equivalence on the domain where the complement inverse exists. □

5 Explicit two-mode Feshbach calculation

The following finite calculation is included because it is the smallest nontrivial place where the spectral-carrier language produces a checkable pole equation. It is not a fit and not an experimental prediction. It is a diagnostic model proving that the interface is algorithmic rather than rhetorical.

Consider a two-dimensional carrier sector coupled to a one-dimensional eliminated sector. On the carrier sector let

$$K_{PP} = mI_2 + \omega\sigma_2, \tag{5.1}$$

where m is the carrier center and ω is the internal circulation splitting. Let the eliminated sector have eigenvalue M, and let only the first carrier component couple to it with amplitude b. Then

$$F_V(z) = (m - z)I_2 + \omega\sigma_2 -$$

rac|b|$^2 M - z \begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}$.(5.2) The pole condition is

$$\det F_V(z) = 0. \tag{5.3}$$

Multiplying by $(M - z)$ gives the exact cubic equation

$$(M - z)\big((m - z)^2 - \omega^2\big) - |b|^2(m - z) = 0. \tag{5.4}$$

When $|b|$ is small relative to the spectral gaps $|M - m \mp \omega|$, the two carrier-like roots are

$$z_\pm = m \pm \omega -$$

rac|b|$^2 2(M - m \mp \omega) + O(|b|^4)$,(5.5) and the complement-like root remains near M with the compensating shift determined by the trace of the cubic.

Proposition 5.1 (Second-order carrier shift). *Assume $M \neq m \pm \omega$. The two roots of* (5.4) *that converge to $m \pm \omega$ as $b \to 0$ satisfy* (5).

Proof. Set $z = m + s + \delta$, where $s = \pm\omega$ and $\delta = O(|b|^2)$. Then

$$m - z = -(s + \delta), \qquad (m - z)^2 - \omega^2 = (s + \delta)^2 - \omega^2 = 2s\delta + O(\delta^2). \tag{5.6}$$

Substituting into (5.4) and keeping terms through order $|b|^2$ gives

$$(M - m - s)(2s\delta) + |b|^2 s = 0. \tag{5.7}$$

Since $s \neq 0$, division by s gives

$$\delta = -\frac{|b|^2}{2(M - m - s)} + O(|b|^4), \tag{5.8}$$

which is exactly (5). $\square$

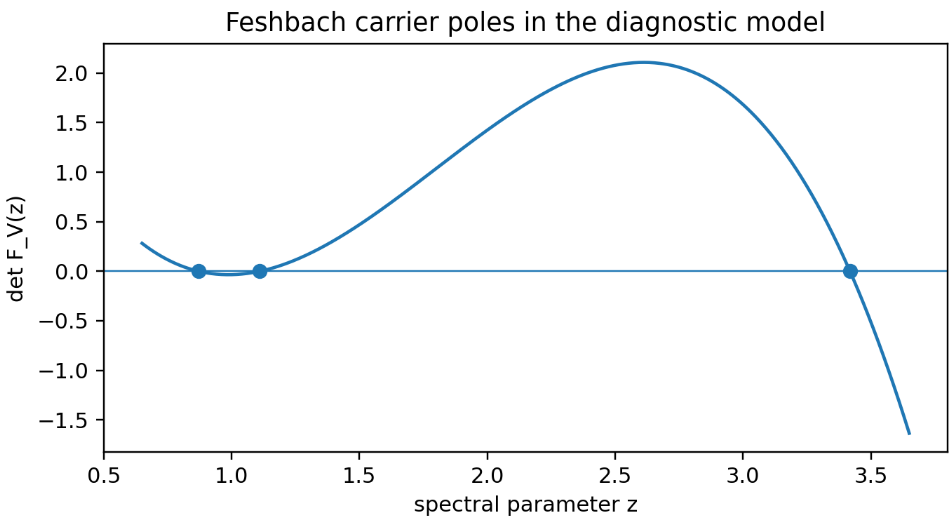

Figure 2: Diagnostic Feshbach pole calculation for the two-mode carrier model. The plotted determinant is the exact cubic in (5.4); the zeros mark the pole locations. The plot is included as a verification of the algebraic pipeline, not as a phenomenological fit.

For the diagnostic parameters $m = 1$, $\omega = 0.12$, $M = 3.40$, and $|b| = 0.21$, the exact roots are recorded in `tables/feshbach_poles.csv`. The calculation demonstrates that the Feshbach carrier gate produces a finite polynomial problem whose perturbative shifts are explicitly controlled by spectral gaps.

6 Gauge readout and QFT running interface

Paper 6 derives effective readout couplings from kinetic normal forms through

$$g_a = \kappa_a^{-1/2}. \tag{6.1}$$

This identity is not yet a statement about a measured running coupling at an accelerator scale. It is a readout-scale normalization. To compare it with a renormalized QFT coupling, one must specify a field content, a renormalization scheme, a beta function, thresholds, and a comparison scale.

In a one-loop QFT interface with beta convention

$$\frac{\mathrm{d}g_a}{\mathrm{d}\log\mu} = \frac{b_a}{16\pi^2} g_a^3, \tag{6.2}$$

one obtains

$$\frac{1}{g_a^2(\mu)} = \frac{1}{g_a^2(\mu_R)} - \frac{b_a}{8\pi^2}\log\frac{\mu}{\mu_R}. \tag{6.3}$$

The readout value $g_a(\mu_R) = \kappa_a^{-1/2}$ supplies an initial condition only after μ_R is physically identified. The beta coefficients b_a are not supplied by the equation itself; they belong to the selected effective QFT. Therefore a comparison with experiment is meaningful only after the QFT lift has been specified independently.

Diagnostic 6.1 (Readout scale versus renormalization scale)**.** *A coupling value derived from a kinetic normal form is not directly comparable with a reported experimental coupling unless the readout scale, field content, thresholds, and renormalization convention are supplied. If these are adjusted after looking at the target data, the comparison is a calibration rather than a prediction.*

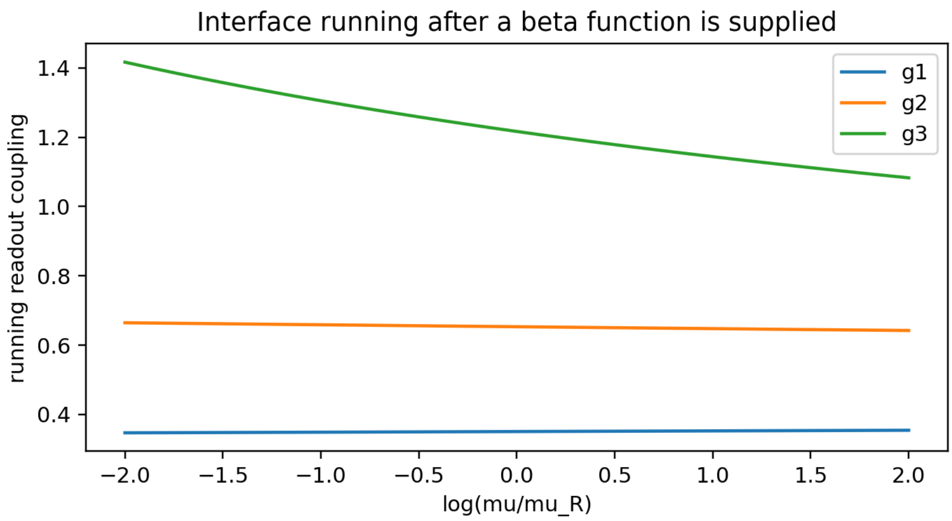

Figure 3: Interface running from readout couplings after a beta function is supplied. The figure illustrates the transport step from readout scale to comparison scale. It does not identify the readout values with measured Standard Model couplings.

This section is included to prevent a common misunderstanding. CAS may derive a set of kinetic normalizations. QFT running then tells how a coupling evolves with scale once the QFT is chosen. The two statements are logically distinct. Treating them as the same statement would erase precisely the bridge that must be tested.

7 Event-class observables and branch push-forward

The branch theory in Paper 7 describes transitions among chambers and event classes. A finite continuous-time Markov interface is sufficient to express the observable side of that construction. Let Q be the generator restricted to transient chambers and let R contain rates from transient chambers into absorbing event classes. With absorbing classes ordered as external event labels, the absorption probability matrix is

$$B = (-Q)^{-1} R, \tag{7.1}$$

and the vector of mean hitting times is

$$t = (-Q)^{-1}\mathbf{1}. \tag{7.2}$$

Proposition 7.1 (Absorption push-forward)**.** *If Q is a transient generator block, meaning all eigenvalues of Q have negative real part, then $(-Q)^{-1}$ exists and equations (7.1) and (7.2) give the event-class probabilities and mean absorption times for the finite Markov interface.*

Proof. For a transient continuous-time Markov chain, the semigroup e^{Qt} decays to zero as $t \to \infty$. Therefore

$$\int_0^\infty e^{Qt}\,\mathrm{d}t = (-Q)^{-1}. \tag{7.3}$$

The probability of eventual absorption into each absorbing class is obtained by integrating the instantaneous flux $e^{Qt}R$ over time, giving $B = \int_0^\infty e^{Qt}R\,\mathrm{d}t = (-Q)^{-1}R$. The mean time to absorption from each transient state is the integral of the survival probability, giving $t = \int_0^\infty e^{Qt}\mathbf{1}\,\mathrm{d}t = (-Q)^{-1}\mathbf{1}$. □

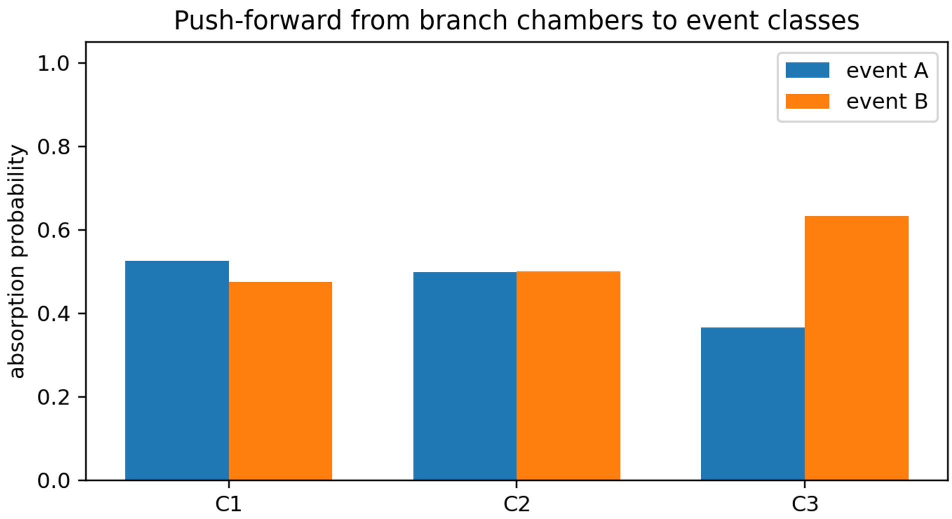

Figure 4: Finite event-class push-forward for a diagnostic three-chamber/two-event model. The bars are not cosmological data; they verify the calculation that maps branch rates to event-class probabilities.

The external criticism that CAS currently lacks direct phenomenology is correct unless calculations of this kind are tied to specific observational channels. The branch formalism gives a probability map, but the identification of absorbing event classes with survey-visible classes remains a future readout problem. The point of the present pack is to isolate exactly where that future identification must be made.

8 Quantum status and lift gates

The previous papers use operator theory, spectra, and projectors. This does not by itself make the theory quantum. Classical stability operators, semiclassical Hessians, transfer operators, and quantum Hamiltonians all have spectra. The word “spectrum” is therefore not sufficient. A quantum interpretation requires additional structure.

Definition 8.1 (Quantum lift)**.** *A quantum lift of a CAS effective sector consists of a Hilbert space of states, a positive inner product, a representation of observables as operators or a path-integral measure with specified action and contour, commutation or anticommutation rules where appropriate, and a prescription for multi-excitation sectors or second quantization when particle interpretation is intended.*

Theorem 8.2 (Operator spectrum is not enough)**.** *The existence of a spectral decomposition for an effective CAS operator does not imply that the corresponding sector is a quantum theory. A quantum interpretation requires a state space, positivity, an observable algebra, and a rule for amplitudes or probabilities.*

Proof. A finite real symmetric matrix has a spectral decomposition and can arise as the Hessian of a classical potential, the generator of small oscillations, or a quantum Hamiltonian. The spectral theorem alone does not determine which interpretation is intended. The missing data are precisely the state interpretation, positivity/probability rule, and composition law. Therefore spectral structure is necessary for many quantum models but not sufficient to define one. □

This theorem is not a retreat from the quantum problem; it is the correct opening gate. CAS should not claim to have produced quantum field theory merely because Riesz projectors and Feshbach kernels appear. The next scientific task is to determine whether the spectral-affine sectors admit a positive quantum lift and whether the resulting effective action has a controlled renormalization structure.

9 Ledger of gates and failure modes

Gate	Mathematical condition	Positive output	Failure mode
Spectral isolation	Closed contour avoids the rest of the spectrum	Riesz projector and finite carrier sector	Carrier label is unstable
Feshbach invertibility	Complement block invertible near the island	Finite pole equation	Pole collision or invalid elimination
Readout map	Map to external variables fixed before data	Observable push-forward	No observable channel
Calibration-free audit	No inverse fit from target datum	Candidate prediction	Calibration only
QFT lift	Beta function, field content, thresholds and scale fixed	Coupling comparison	Non-comparable normalization
Quantum lift	State space, positivity, amplitudes and composition supplied	Quantum observable	Semiclassical operator only

The ledger is deliberately unforgiving. It is better for a gate to fail clearly than for the theory to absorb the failure through terminology. This is also the main response to the external criticism. CAS must be judged not only by whether it constructs elegant internal mathematics, but by whether its maps to observable physics survive these gates without new free matching parameters.

10 Next calculations

The next calculations should be chosen for maximum falsifiability rather than maximum ambition. The first target is a genuine spectral carrier computation in which K, $P_\Gamma(K)$, J_V, and $F_V(z)$ are extracted from an upstream CAS kernel rather than introduced as a diagnostic finite model. The second target is a coupling-interface calculation where the readout scale, thresholds, beta coefficients, and comparison convention are locked before any numerical comparison. The third target is a branch/event calculation in which event classes are tied to a concrete observational catalogue or simulated survey statistic by a predeclared map.

A result that fails one of these gates is not useless. It identifies the exact obstruction. For a foundational theory, a clean obstruction is scientifically valuable because it prevents the framework from drifting into unfalsifiable language. The immediate program is therefore not to claim a final prediction, but to build a sequence of calculations that become progressively harder to rescue by interpretation.

11 Uncertainty propagation and sensitivity gates

A numerical comparison is only as meaningful as its propagated uncertainty. The previous sections define the push-forward at the level of measures. In many applications the upstream uncertainty is described locally by a covariance matrix rather than by a full probability measure. The standard differential push-forward then gives a first test of whether a proposed observable channel is stable enough to be worth comparing with data.

Let $\theta_0 \in \Theta$ be a nominal internal gate point and suppose that a local coordinate chart has been chosen on the finite-dimensional approximation used for calculation. Let Σ_Θ denote the covariance of the internal gate variables. If $\Phi : \Theta \to Y \subseteq \mathbb{R}^n$ is differentiable at θ_0, its Jacobian is denoted by

$$J_\Phi(\theta_0) = \left.\frac{\partial \Phi^i}{\partial \theta^\alpha}\right|_{\theta_0}. \tag{11.1}$$

The leading observable covariance is then

$$\Sigma_Y = J_\Phi(\theta_0)\,\Sigma_\Theta\, J_\Phi(\theta_0)^T. \tag{11.2}$$

Proposition 11.1 (Linear uncertainty push-forward)**.** *Assume that Φ is differentiable near θ_0 and that the internal gate variable is $\theta = \theta_0 + \delta\theta$, with $\mathbb{E}[\delta\theta] = 0$ and covariance Σ_Θ. Then, to first order in $\delta\theta$, the observable fluctuation $\delta y = \Phi(\theta) - \Phi(\theta_0)$ has covariance (11.2).*

Proof. Taylor expansion gives $\delta y = J_\Phi(\theta_0)\delta\theta + O(\|\delta\theta\|^2)$. Taking the expectation of $\delta y \delta y^T$ and retaining the leading term yields $J_\Phi \mathbb{E}[\delta\theta\delta\theta^T] J_\Phi^T$, which is (11.2). The neglected terms are higher order in the internal uncertainty scale. □

This elementary result is a practical gate. A purported sharp prediction must explain why Σ_Y is small. A broad push-forward may still be scientifically useful if it excludes regions of Y, but it should not be advertised as a precision number. Conversely, a small Σ_Y produced by a nearly singular change of variables or a hidden calibration must be rejected by the anti-fitting audit rather than celebrated.

12 Gap stability and carrier robustness

The vorton carrier gate depends on spectral isolation. This condition is not merely qualitative: it supplies a norm bound controlling the stability of the Riesz projector. Let K_0 have an isolated spectral component enclosed by Γ, and let the distance from Γ to $\mathrm{Spec}(K_0)$ be at least $\Delta > 0$. If $\|K - K_0\| < \Delta$ in a bounded-operator model, the resolvent identity

$$(z - K)^{-1} = (z - K_0)^{-1} \left[I - (K - K_0)(z - K_0)^{-1}\right]^{-1} \tag{12.1}$$

shows that the contour remains in the resolvent set of K whenever $\|(K - K_0)(z - K_0)^{-1}\| < 1$ on Γ. In particular, the projector difference satisfies the contour estimate

$$\|P_\Gamma(K) - P_\Gamma(K_0)\| \le \frac{L(\Gamma)}{2\pi} \frac{\sup_{z\in\Gamma} \|(z - K_0)^{-1}\|^2 \|K - K_0\|}{1 - \sup_{z\in\Gamma} \|(z - K_0)^{-1}\| \|K - K_0\|}, \tag{12.2}$$

where $L(\Gamma)$ is the contour length. This is the quantitative form of spectral-carrier robustness.

Corollary 12.1 (Finite-rank stability under a gap)**.** *Under the assumptions above, if $\|K - K_0\|$ is sufficiently small that Γ remains in the resolvent set of K, then* $\mathrm{rank}\, P_\Gamma(K) = \mathrm{rank}\, P_\Gamma(K_0)$.

Proof. The Riesz projector varies continuously with K as shown by (12.2). Since projections of finite rank cannot change rank under a sufficiently small norm-continuous deformation without losing idempotency or crossing a spectral singularity, the rank remains constant as long as the contour remains in the resolvent set and continues to enclose the same isolated spectral island. □

This is the point at which the carrier language becomes mathematically serious. A carrier is not stable because it has been named. It is stable because a spectral gap, a contour, and a resolvent estimate prevent its projector from changing rank under admissible perturbations.

13 Exact numerical audit of the diagnostic carrier

The diagnostic two-mode model is small enough that the complete pole data can be tabulated. For $m = 1$, $\omega = 0.12$, $M = 3.40$, and $|b| = 0.21$, the exact polynomial in (5.4) has three real roots. The two roots close to $m \pm \omega$ are carrier-like; the third is complement-like. The perturbative formula (5) approximates the carrier-like pair because the gaps $M - m \mp \omega$ are large compared with $|b|$.

Quantity	Value	Interpretation	Status
m	1.0000	carrier center	input
ω	0.1200	circulation splitting	input
M	3.4000	eliminated mode	input
$\|b\|$	0.2100	complement coupling	input
$z_-^{(2)}$	0.871250	perturbative lower carrier root	computed
$z_+^{(2)}$	1.110329	perturbative upper carrier root	computed

The exact roots are written to `tables/feshbach_poles.csv`; the purpose of the table is not numerical impressiveness but reproducibility. A later physical calculation must replace these diagnostic inputs by values extracted from an upstream CAS operator. Until that replacement is performed, this calculation demonstrates the method rather than a measured prediction.

14 Algorithmic protocol for an external observable

The interface can be implemented as a protocol. The protocol is intentionally ordered so that no target datum enters before the readout map is locked.

Step 1. Select the upstream CAS object: a reduced Hessian, spectral operator, kinetic normal-form matrix, or branch generator. Record its source paper and the assumptions under which it was constructed.

Step 2. Define the internal gate variable θ and its admissible uncertainty μ_Θ or covariance Σ_Θ. If the uncertainty is unknown, declare the output conditional rather than predictive.

Step 3. Choose the readout space X, the readout map $R : \Theta \to X$, and the observable projection $O : X \to Y$ before looking at the target datum.

Step 4. Compute the push-forward $\Phi_* \mu_\Theta$, or its linearized covariance $J_\Phi \Sigma_\Theta J_\Phi^T$, and record all numerical choices in a ledger.

Step 5. Apply the anti-fitting audit. If any coefficient in R or O was chosen using the target datum, label the result as calibrated.

Step 6. If comparison with QFT is intended, specify field content, beta functions, thresholds, renormalization scheme, and scale before comparison.

Step 7. If particle interpretation is intended, supply a quantum lift and multi-excitation rule; otherwise label the result semiclassical or spectral-effective only.

Step 8. Compare with data only after the previous steps are locked. Record both successes and failures as gate outcomes.

The protocol is deliberately procedural because external review will not be satisfied by conceptual claims alone. It must be possible for a reviewer to ask which step fixed which coefficient, where the target data entered, and which gate would fail if the result did not agree with observation.

15 Dictionary from CAS interface objects to standard language

The following dictionary is not an attempt to erase the CAS terminology. It is a translation layer that lets a physicist locate familiar structures inside the framework without assuming that the structures are identical.

CAS interface object	Closest standard-language analogue	Important caveat
Riesz spectral island	isolated effective sector or band	not a particle until quantized and coupled to an observable channel
Vorton carrier	compact circulating spectral mode	not a named elementary particle in this pack
Feshbach kernel	effective Hamiltonian/self-energy reduction	valid only off complement singularities
Readout coupling	kinetic normalization at a readout scale	not a running coupling until QFT lift is supplied

CAS interface object	Closest standard-language analogue	Important caveat
Branch chamber	metastable sector or phase-region analogue	not a cosmological epoch by itself
Event class	absorbing or detectable outcome class	requires an observational taxonomy
Gate failure	obstruction, anomaly, instability or non-identifiability	scientifically informative if declared before comparison

This translation table addresses the semantic-isolation criticism directly. The CAS terms remain useful internally, but an external reader must be able to map them to operator theory, effective field theory, dynamical systems, and stochastic-process language.

A Reproducibility notes

All numerical tables and figures in this pack are generated by `cas_observable_interface_calc.py`. The Feshbach model uses the dimensionless parameters $m = 1$, $\omega = 0.12$, $M = 3.40$, and $|b| = 0.21$. The gauge-running figure uses readout-normalization values only as a diagnostic interface example and applies a one-loop beta-function transport after beta coefficients are supplied. The Markov branch model uses a finite generator block Q and absorbing-rate block R recorded in the source script.

B Bibliographic orientation

The operator-theoretic components of the interface are standard in perturbation theory and spectral projection theory. Riesz projectors and stable spectral subspaces follow the framework of Kato. Feshbach reduction originates in the projection formalism of nuclear reaction theory and is widely used in effective Hamiltonian methods. The renormalization interface uses only the standard one-loop structure of perturbative QFT, but the document deliberately does not identify CAS readout couplings with measured couplings until the QFT lift is specified. Finite Markov absorption formulas are standard consequences of transient generator theory.

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