Ordered Records, Realised Event States and Fold-to-Fact Promotion in VERSF

A conditional preparation theorem and the physical cost–phase boundary

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General-reader summary

What question is this paper about? Before a physical event happens, what does the theory say is prepared — and once an event has happened and been recorded, how does that record change what may happen next?

What was already known? Earlier work in the programme had settled two parts of the answer. First, the symmetry of the underlying structure forbids the theory from quietly naming, in advance, the one outcome that every repetition of an experiment would realise. That is not a defeat: a theory can be perfectly predictive at the level of its law of chances while leaving each individual outcome genuinely random. Second — and this paper does not re-derive it — earlier work had already fixed the chance of a single event, together with the exact rule that turns that chance into a measure of information, of how surprising the event was; and it showed that this rule carries no adjustable strength. What remained open is narrower and sharper: do those single-event results extend, uniquely, to a whole ordered history of recorded events, and to the state the theory hands back after an event has actually happened?

What does this paper show? The answer is yes, and with no new dials. A sequence of recorded events has a single overall likelihood, built by chaining the individual event chances together in the order they occurred. The updated law of chances after a record is then forced: it is the original law reweighted by that likelihood and nothing else. The paper separately proves that keeping a record cannot legitimately introduce any new adjustable strength or "temperature" into the update — requiring the updated law to respect the ordinary rules of conditional probability eliminates every such insertion. This is a consistency check on the inherited single-event rule, not a second derivation of it. Once an event actually occurs and its outcome is fully resolved, the theory returns exactly one new state from the state the event acted on; and when the incoming state is known only through its law of chances, the law of chances of the outgoing state is forced just as uniquely — the paper gives that outgoing law, and its average, in closed form. And where earlier treatments of this problem carried eleven freely tunable weighting factors, the record itself now supplies every one of them, simply by counting how many times each kind of event occurred — in the repeated-preparation reading the paper makes precise, where the counts genuinely accumulate on one underlying set of weights.

What does it not show? Two things, and the boundary is the sharpest finding in the paper. First, the surprise carried by a record is information, and information is not automatically heat, wear, or physical cost. The paper proves that the theory's cost bookkeeping, in its current form, could be made to fit any target law whatsoever if its costs were chosen freely; so the true physical costs must one day be computed from the microscopic action itself, not read off from the probabilities. Second, the law of chances established here does not pin down the finer coherent structure underneath it — the relative offsets between the different ways an event can happen. Earlier work fixes what kind of offsets are admissible (a single continuous circle of possibilities), but not which offset each physical path actually carries, nor the comparison experiment that would read one. This is not a claim that chances can never see such offsets — interference experiments can, and do. It is the narrower statement that the present package contains no such experiment, so the offsets stay out of reach. They matter physically — they are where the theory's matter–antimatter orientation lives — and they will have to come from a deeper, amplitude-level layer that this paper deliberately does not pretend to have.

Where does that leave the programme? The ordered-record preparation problem is closed at the level of law, conditionally on the frozen event machinery and the stated assumptions: one inherited single-event rule, one unique extension of it to whole histories, one state returned by each fully resolved event, and one forced law of chances for the outgoing state when the incoming one is only statistically known. The structural origin of events is inherited rather than open — a fact forms when a closing Fold history creates a persistent, non-recombinable record — and the step from possibility to fact has now been tested on the instrument itself: within the executed discrete kernel a first ledger entry occurs with probability one and is copied without error, after a stationary mean wait of about 1.235 closure steps — whether every later step must preserve it is the one named condition still open — and the resulting chances take exactly the inherited form with no adjustable dial anywhere. That test also produced a surprise: a pathway previously treated as 'nothing happened' leaves the same implemented persistent-record trace as every other, so the retained record, not the microscopic route, decides whether a record-producing event occurred. What remains open is narrower than it has ever been: deriving the complete physical event machinery — the map from closure histories to record labels, operators, waiting-time laws, physical costs and coherent offsets — from the deepest layer of the theory, including the record-preserving bookkeeping that is currently implemented exactly but not yet derived from it.

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Headline result

The event-level preparation problem closes more strongly than the earlier ledgers suggested, but not as the deterministic selection of one pre-existing vector. The single-event Born weight, the identity $p = \exp(-\Delta I)$, and the unit exponent are inherited from the prior VERSF probability stack. HCMR-P1 supplies the ordered-record lift of that law.

For a frozen physically marked instrument, the physically retained record ϱ has the instrument-native likelihood and extension-information functional

$$\mathbf{L_\varrho^{(n,k)}(\eta) = \mathrm{Tr}[\, \mathscr{I}_\varrho^{(n,k)}(\, |\eta\rangle\langle\eta| \,) \,],\ \Delta I_\varrho^{(n,k)}(\eta) = -\ln L_\varrho^{(n,k)}(\eta).}$$

For a fully operator-resolved microscopic trajectory this reduces to the ordered Kraus-product form

$$L_\rho^{(n,k)}(\eta) = \|M_\rho^{(n,k)}\, \eta\|^2,\ M_\rho^{(n,k)} = M_{(e_N)}^{(n,k)} \cdots M_{(e_1)}^{(n,k)},\ \Delta I_\rho^{(n,k)}(\eta) = -\ln L_\rho^{(n,k)}(\eta).$$

The claim of novelty must be placed with care. That an ordered sequence of quantum outcomes has a chained likelihood, that the post-outcome state is the normalised Kraus update, and that a prior reweights by likelihood are standard consequences of quantum-instrument theory once the marked operators are supplied; this paper does not present them as discoveries. The contribution is threefold: the inherited VERSF event law extends to ordered records consistently and with no new freedom; its candidate microscopic instrument has actually been executed at machine precision; and the record architecture forces a Fold-to-fact partition — overturning the expected classification — that satisfies a strict spectral exhaustion criterion with computed first-entry effects. Section 5B states explicitly which results are known mathematics, which are VERSF applications of known mathematics, and which are new executions.

Under the declared Fubini–Study pre-event law and the probability-chain consistency conditions stated in this paper, the record determines two distinct and equally forced measures, and at the physically retained grain they are

$$\mu_\varrho^{in}(d\eta) = [\, L_\varrho(\eta) / Z_\varrho \,]\, \mu_{FS}(d\eta),\ \mu_\varrho^{out} = (\, \eta \mapsto \sigma_\varrho(\eta) \,)_*\, \mu_\varrho^{in},$$

a posterior over the initial preparation and an ensemble of outgoing density operators — different objects that the paper keeps separate throughout. The local-comparison directing law is read from the outgoing ensemble,

$$\nu_\varrho = p_*\, \mu_\varrho^{out},$$

with p a function of density operators, and the conditioned mean post-record state has the exact closed form

$$\mathbf{\bar{\rho}_\varrho = \mathscr{I}_\varrho(I) / \mathrm{Tr}[\, \mathscr{I}_\varrho(I) \,].}$$

For a fully operator-resolved microscopic trajectory these refine to the projective formulas: $\mu_\rho^{in} = Z_\rho^{(-1)} L_\rho\, \mu_{FS}$, $\mu_\rho^{out} = (T_\rho)_*\, \mu_\rho^{in}$ *with* $T_\rho(\eta) = M_\rho\, \eta / \|M_\rho\, \eta\|$, $\nu_\rho = p_*\, \mu_\rho^{out}$, and average post-record state $M_\rho M_\rho^\dagger / \mathrm{Tr}(M_\rho M_\rho^\dagger)$.

The realised directing state is not selected before the event. Once a physically resolved mark is realised, the instrument returns the corresponding normalised post-event state

$$\mathbf{z_{(\rho,e)}^{(n,k)} = M_e^{(n,k)} M_\rho^{(n,k)}\, \eta \,/\, \|M_e^{(n,k)} M_\rho^{(n,k)}\, \eta\|,}$$

unique up to global phase and the declared equivalence of genuinely indistinguishable record labels. This is a stochastic marked return from the frozen instrument, not yet a primitive-action admission. At the grain the record actually retains — the coarse (e, r) classes of §1D, which do not resolve the current-channel index — the correct statement is instrument-level: **given the frozen coarse-grained instrument and the realised incoming state, a retained record determines one unique conditioned density operator; when the incoming state is known only statistically, the record determines one unique posterior ensemble and one unique mean density state (§10A); a unique projective ray is returned only for a fully operator-resolved microscopic trajectory** of the complete physical carrier.

Two exact boundaries remain. First, extension information is not the same object as thermodynamic irreversible cost. The existing action form can reproduce any strictly positive target law if its entropy costs are supplied freely; the physical costs must therefore be differentiated from a microscopic action rather than inferred from the probability law. Second, the fixed marked stochastic law does not determine a unique coherent lift. Independent global rephasings of resolved marks leave every record likelihood unchanged, and the current source does not return the path-specific or branch-specific holonomy needed for physical interference and orientation. This does not mean that all probabilities are intrinsically phase-blind: a richer interference-capable family could read gauge-invariant phase combinations. It means that the present fixed probability package does not contain or select that family.

Accordingly, HCMR-P1 achieves a conditional ordered-record preparation theorem and a microscopic marked-state return, but it does not satisfy the original all-or-nothing contract requiring the same primitive action to return physical irreversible costs and coherent relative phases at regulators 3–6. The correct overall verdict is:

CONDITIONAL ORDERED-RECORD LAW PASS · FIRST LEDGER-ENTRY EXHAUSTION PASS · RECORD-COPY PASS · PERMANENT FACT PERSISTENCE CONDITIONAL · RETAINED-RECORD POSTERIOR-ENSEMBLE AND MEAN-STATE PASS · PURE-RAY RETURN ONLY FOR OPERATOR-RESOLVED TRAJECTORIES · PHYSICAL COST AND COHERENT PHASE OPEN, NOT PROVED IMPOSSIBLE · COMPLETE PRIMITIVE H_CMR NOT ADMITTED.

Audit matrix

Audit item	Verdict	Meaning
Single-event Born and extension law	INHERITED CONDITIONAL THEOREM	The prior probability stack fixes p_i =
Structural event origin	INHERITED	Fold closure/commitment supplies fact formation: threshold crossing fixes the loop operator, alternatives become non-recombinable, one bit is fixed. Not re-derived here.

Audit item	Verdict	Meaning
Event ontology	INHERITED TYPING	Fold ≠ minimal fact ≠ Planck-certified fact ≠ ξ-coherent network; the minimal fact is the event, and the primitive Fold carries no metric attributes.
Fold-to-fact promotion (F2F-1A/B/C)	A: PASS · B: PASS · C: CONDITIONAL	First-entry exhaustion and record-copy admission pass as reported frozen-matrix executions ($r(\mathcal{N}_R) = 0.2003 < 1$; partition from the implemented terminal-record architecture, P-PF25 refuted as a persistent-record fact/no-fact partition); persistent-fact promotion awaits D12b, architecture provenance awaits D12a.
Topological capacity $\beta_1 \geq 1$	NECESSARY, NOT ALONE SUFFICIENT	A cycle is required for locally constructible trapping; capacity alone does not certify commitment.
Terminal physical equivalence	CONDITIONAL QC-1 QUOTIENT	Event classes are terminal-record indistinguishability classes; the quotient on the actual carrier is the construction to be proved.
Closure history $\longrightarrow \mathscr{J}$_[e] bridge ($\Pi$_mark)	PARTLY CONSTRUCTED	The $U = ABC$ witness shows closure can generate orthogonal Fold projectors; the map Π_mark from event classes to the actual marked operators is not yet derived.
Pre-event projective law	CONDITIONAL PASS	Haar/Fubini–Study law on the frozen projective preparation carrier is inherited from the prior stack.
Complete record likelihood	EXACT GIVEN THE FROZEN INSTRUMENT	Operator-resolved grain: the squared norm of the ordered marked-operator product; retained coarse grain: L_ϱ = Tr[$\mathscr{J}$_ϱ(
Record extension information	EXACT GIVEN THE FROZEN INSTRUMENT	Retained grain first: ΔI_ϱ = −ln L_ϱ; operator-resolved refinement: ΔI_ρ = −ln L_ρ. Infinite only off the support of the recorded event.
Likelihood exponent	INHERITED · INDEPENDENT HISTORY-LEVEL CHECK	$\beta = 1$ is not new here; the direct predictive-consistency proof shows record conditioning cannot introduce a different exponent under the declared range-richness-with-overlap and measure-separation hypotheses.
Record-conditioned initial-state posterior	CONDITIONAL THEOREM PASS	Retained grain first: μ_ϱ^in is the normalised likelihood tilt of the pre-event law; μ_ρ^in is its operator-resolved refinement.
Post-record ensemble and average state	CONDITIONAL THEOREM PASS · CLOSED FORM EXACT	Retained grain: μ_ϱ^out = (η↦σ_ϱ(η))**μ_ϱ^in with mean $\mathscr{J}$_ϱ(I)/Tr[$\mathscr{J}$_ϱ(I)]; operator-resolved refinement: μ_ρ^out = (T_ρ)**μ_ρ^in with average M_ρM_ρ†/Tr(M_ρM_ρ†).

Audit item	Verdict	Meaning
Comparison directing law	CONDITIONAL THEOREM PASS	Retained grain: ν_ϱ = p_*μ_ϱ^out with p a function of density operators; operator-resolved refinement: ν_ρ = p_*μ_ρ^out on the projective ensemble.
Deterministic pre-event direction	CLOSED NEGATIVELY / RETYPED	Symmetry forbids deterministic selection; the correct target is a unique stochastic law.
Realised post-event state	RETAINED-RECORD POSTERIOR-ENSEMBLE AND MEAN-STATE PASS	Given the incoming state, the retained record yields one conditioned density operator; relative to the declared prior it yields one posterior ensemble and one mean state; a pure ray only for operator-resolved trajectories.
Twelve-component posterior	EXACT UNDER THE EXCHANGEABLE REDUCTION P15, ON THE 49-DIMENSIONAL FROZEN CARRIER	Dirichlet(d_j + N_j) follows from Haar plus component-resolved record counts in the directing-variable model; it is not claimed for the generic sequential instrument. The $\mathbb{C}^{49}/\mathbb{C}^{50}$ reconciliation remains open.
Regulator execution n = 3–6	PARTIAL / INHERITED	Neutral completeness and record-parent integration pass across four levels; the fully selected end-to-end source instrument remains open.
Branch covariance	PASS FOR COVARIANCE / FAIL FOR ORIENTATION	Conjugate branches carry covariant laws, but positive stochastic data do not select one orientation.
U(1) phase catalogue	CONDITIONAL UPSTREAM PASS	Later phase work conditionally fixes the admissible continuous phase group; it does not return the phase assigned to each physical path or branch.
Fixed-law global mark phases	EXACT GAUGE INVARIANCE	A common scalar phase multiplying each resolved mark leaves all declared record probabilities unchanged.
Source-level coherent phase assignment	NOT RETURNED	A physical path/component/branch phase requires an independently derived coherent lift plus an interference or holonomy readout.
Information cost	EXACT	ΔI is additive record information in nats.
Dimensionless entropy production	CONDITIONAL BRANCH RETURN	D36 returns ln 2 per declared discrete Fold; the continuous clock is different.
Physical irreversible cost ΔS	NOT RETURNED	Clock, affinity and microscopic cost provenance remain open; action-form sufficiency is excluded.

Audit item	Verdict	Meaning
Complete physical H_CMR	NOT ADMITTED	Preparation and record sectors advance, but physical cost, coherent phase, full-carrier provenance and independent descent remain incomplete.

Part I — Question, source boundary and claim grades

1. The exact question

The August 2026 Standard Model audit defined HCMR-P1 as the immediate primitive-front paper required to return

$\Delta I\_\rho(\eta)$, $\nu\_\rho(dp)$, η_realised or z_realised, ΔS, relative phases

from one action at regulator levels n = 3, 4, 5, 6. Its pass condition required uniqueness up to declared physical equivalence, source-frozen costs and phases, and regulator and branch covariance.

That target contains three differently typed questions:

1. **Preparation law:** which probability measure governs the unresolved directing state before and after a record?
2. **Event return:** how does a realised marked event return an actual post-event state?
3. **Physical action data:** which irreversible cost and coherent relative phase does the microscopic action attach to the event?

The earlier programme often carried these questions together. They must now be separated, because the first two can pass while the third fails — and this paper proves that they do.

1A. Event-origin architecture

Within the inherited VERSF source stack, the structural origin of events is treated as fixed rather than open, and it is not re-derived here: it is inherited from the Fold-closure and commitment corpus — principally *The Fold and the Record* and *Topological Threshold for Fact Formation*, with *The Uniqueness of the Minimal Distinction* supplying the primitive one-bit event unit. There, the threshold event is the moment at which a separating cycle or trap closes, the alternatives become non-recombinable, and one alternative becomes confined; exactly one bit becomes fixed at that point. In VERSF language, closure is the conversion of reversible possibility into an irreversible fact, and cyclic topology is the necessary structural condition for locally constructible fact formation, with the excluded alternative retained in an inaccessible environment or trap register. The inherited source chain, written at full resolution, is

proto-Fold ⟶ admissible closure history ⟶ threshold-fixed, non-recombinable closure ⟶ committed Fold / minimal fact and terminal record ⟶ physical event class [e] ⟶ marked operation $\mathscr{J}$_[e] ⟶ probability, state update and ordered-record law.

The paper therefore sits inside a four-level hierarchy, and each level answers a different question:

Level	Answers
Fold closure (admissible trapping)	creates the fact — event admissibility and formation; the Fold itself is not yet the event
Closure-to-mark map	identifies the physical event — which admissible closure class carries which record label
Marked operation $\mathscr{J}$_[e]	returns the event probability and the post-event state update (a single operator M_e when the event is operator-resolved)
HCMR-P1	extends those returns to an ordered record

What HCMR-P1 conditions on, and what its primitive-admission debt actually is, follows from this hierarchy: the open problem is not where events come from — Fold closure supplies that answer — but the complete microscopic translation, written at full precision as the source-side chain

h ⟶(admissible trapping)⟶ e(h) ⟶(terminal-record equivalence)⟶ [e] ⟶(Π_mark^(n,k))⟶ $\mathscr{J}$_[e]^(n,k),

where h is a pre-fact closure history, e(h) the realised minimal fact, [e] its physical event class under terminal-record equivalence, and $\mathscr{J}$_[e]^(n,k) the marked completely positive operation at regulator n and branch k, with Kraus decomposition $\mathscr{J}$_e = Σ_α K_([e],α) σ K_([e],α)†; the operator-resolved refinement is the special case in which the retained event resolves one Kraus operator, $\mathscr{J}$_e = M_e σ M_e†. The live primitive obligation is exactly one map:

derive Π_mark^(n,k) uniquely from the marked Fold action, without downstream target access.

Only after that map is frozen may the primitive programme legitimately construct p_e(η), ΔI_ρ(η), μ_ρ and ν_ρ from first principles rather than conditioning on them as this paper does. It is that map — not the existence or structural origin of events — that remains unsupplied. Premise P0 states the inheritance, P1 states the terminal event alphabet, and P2 states exactly what is conditioned on. Section 1B states how far the closure-to-mark bridge is already constructed and the precise threshold condition under which a fact forms.

1B. Threshold condition, bridge witness and terminal event classes

The threshold condition, stated exactly. *The Fold and the Record* identifies a Fold as the irreversible terminus of reversible pre-commitment evolution: when the local closure dynamics cross the commitment threshold, the loop operator becomes fixed, a Fold forms, and it is written into the committed record field. The dynamical picture is

$\mathcal{C}_\ell \geq \mathcal{C}^\star \Longrightarrow \Theta(\mathcal{C}_\ell - \mathcal{C}^\star) = 1 \Longrightarrow U_\ell$ **becomes fixed ⟹ committed Fold / minimal fact.**

One qualification is required and is adopted here. *Topological Threshold for Fact Formation* establishes $\beta_1 \geq 1$ as a **necessary capacity condition** for locally constructible trapping — a cycle must exist before local irreversible separation can occur — but it does not prove that every graph containing a cycle traps an alternative. The correct event condition is therefore

$\beta_1(D) \geq 1$ + actual threshold crossing + non-recombinability + admissibility fixation,

and any statement that Fold formation occurs "if and only if $\beta_1 \geq 1$" is too strong unless the right-hand side is shorthand for this complete activated trapping condition. Premise P0 is written at exactly that strength.

The closure-to-operator bridge is partly constructed. The closure-orientation analysis exhibits, in an explicit model, a closure operator U = ABC with reverse traversal D = CBA = U†, whose two orderings generate

$P_+ = U U^\dagger$, $P_- = U^\dagger U$,

distinct positive orthogonal Fold projectors produced by the closure process itself. This is an existence witness that closure can generate physically usable marked alternatives without the projectors being added by hand. It is not more than that: it does not prove that the actual VERSF admissibility, transport and completion operations are the required A, B, C, act on the required carrier, possess the required adjoint, or produce distinct ranges. The remaining bridge is therefore sharply defined:

actual Fold-closure history ⟶ actual physical $\mathscr{J}$_[e].

Terminal event classes — the HCMR-P1 construction to be proved. The adjoint-removal theorem (QC-1) supplies the physical equivalence rule: two formal closure outcomes represent the same physical event exactly when they are indistinguishable to every terminal record in every admissible context, and the resulting quotient is maximal, record-preserving and positive. Synthesising the two sources, let h be an admissible committed closure history with observable representative A_h, and define

$h \sim_{rec} h' \Leftrightarrow A_h - A_{h'} \in \mathfrak{J}_{AR}$.

The physical event alphabet is then the quotient

$\mathscr{E}$ = { committed closure histories } / ~_rec,

and the marked instrument represents those classes, [e] ↦ $\mathscr{J}$_[e], with a single marked operator M_e as the operator-resolved special case. This synthesis is stated here as the construction the primitive-admission programme must prove on the actual VERSF carrier; it is not claimed as an established theorem, and premise P1 conditions on its conclusion.

Foundation status after the closure corpus.

Foundation object	Grade
Primitive operational event unit (Fold)	Inherited conditional theorem
Structural event mechanism (Fold closure / commitment)	Inherited
Topological capacity $\beta_1 \geq 1$	Necessary, not alone sufficient
Threshold-fixed record formation	Inherited structural mechanism
Terminal physical equivalence	Conditional QC-1 quotient
Closure history ⟶ $\mathscr{J}$_[e]	Partly constructed, not completed
Ordered-record likelihood	Exact given the retained CP operation $\mathscr{J}$_[e] (M_e in the operator-resolved case)
Born probability	Inherited conditional theorem
Post-event state	Exact for an operator-resolved frozen mark
Physical ΔS_e and coherent relative phases	Not returned
Event ontology (Fold ≠ minimal fact ≠ Planck-certified fact ≠ ξ-coherent network)	Inherited typing

1C. Event ontology, observable saturation and ordering discipline

What the event is, and what it is not. *Fold, Fact, Planck, and Closure* supplies the cleanest ontology in the corpus and this paper adopts its typing:

Fold ≠ minimal fact ≠ Planck-certified fact ≠ ξ-coherent fact network.

A proto-Fold is the minimal reversible distinction available to closure dynamics. A committed Fold — equivalently, a minimal fact — is produced only when an admissible closure history crosses the commitment threshold and creates a persistent, non-recombinable record. In the four-level typing, the proto-Fold is the pre-metric structural distinction; the committed Fold/minimal fact is the first irreversible realised event; the Planck scale supplies metric certification; and ξ supplies self-sustaining network coherence. Where earlier sources say simply that a Fold forms at threshold crossing (§1B), they are speaking of the committed Fold; where they say the Fold remains provisional until trapping, they are speaking of the proto-Fold. Both usages are retained under this split. The event-level object of this paper is therefore defined as

e = an admissibly trapped distinction that persists under forward evolution,

and physical duration, energy and metric action are downstream of it. One caution is adopted with the inheritance: that source's stronger claim that trapping occurs with probability one under generic ergodic or mixing dynamics is not imported as a theorem here — the dynamics, the measure and the hitting argument must be supplied explicitly before that promotion (falsifier F16). Section 1D replaces that generic-dynamics route entirely with a computable spectral criterion on the actual instrument — now computed, with $r(\mathcal{N}\_R) = 0.2003 < 1$ and almost-sure first ledger entry within the declared renewal architecture; persistence itself remains the separately graded condition F2F-1C.

Observable saturation supports the record domain but is not a shortcut. *The Fold Saturates Observable Physics* defines observable content through commitment outcomes, correlations, distributions, interference patterns and record-field functionals, and reduces it to one line: every physical observable is a commitment outcome or a functional of commitment outcomes. For dynamical observables this means a functional of a temporally ordered sequence of commitment outcomes, never merely a final tally, and pre-commitment states enter observable physics only through their effect on distributions of committed outcomes. This is exactly the record domain $\rho = (e_1, \ldots, e\_N)$ with order retained unless exchangeability is separately proved (P15). The same source is explicit that its operational maximality argument relies on the prior Fold-necessity chain, with independent algebraic maximality open — so saturation may not be cited as a shortcut around constructing the actual event instrument (falsifier F18).

Order before physical time. *Two Kinds of Time* separates an unobservable ordering parameter for reversible pre-commitment evolution from physical time, which is accumulated only through irreversible commitment events, $t(s) = \int_0^s \lambda(s')\, ds'$. The discipline adopted here is:

the primitive theory may use event order, but not an independently physical rate or duration.

A history may be indexed $h = (f_1 \prec f_2 \prec \cdots \prec f\_N)$, but no primitive Poisson rate, hazard per unit physical time, or time-dependent Gibbs law may be installed before physical time has been derived (falsifier F17). The same source's formula relating commitment rate to entropy production is a downstream thermodynamic representation, not a primitive source law, and its support for the proto-fact — observable only through statistical influence on committed outcomes — matches the pre-event role of μ_FS here. Its preferred-basis and collapse-versus-branching questions are left open there and are not resolved here.

Meta-principles as a falsification frame. *From Meta-Principles to Physical Uniqueness* derives record persistence, irreversible commitment, a consistent partial order on committed records, internal closure without externally selected continuous parameters, and compositional consistency of realised facts. It constructs none of the marks, probabilities or phases, but it converts internal closure into a test this paper endorses:

a free Gibbs exponent, free cost coefficient or freely chosen phase law ⟹ failure of internal closure.

That is the meta-principle form of falsifiers F1, F6 and F12.

Three-tier grading correspondence. *Structural Conditions, Physical Identification, and Robustness in the One-Fold Framework* separates structural theorem, conditional structural derivation and physical identification, with later physical identifications carrying a strictly weaker grade than the structural objects beneath them. That is the same discipline as the five grades of §4, and it applies with full force to costs and phases: a mathematically defined entropy, norm, curvature or orientation does not automatically equal a physical event cost or measurable phase — the physical bridge must itself be constructed and tested.

Secondary tests, and sources held out. *Area Scaling of TPB-Realized Information* supplies an operational record-admission check — local readability, dynamical stability, correlation support, with realised information bounded through boundary mutual information — usable as a capacity test on candidate records, though its proofs are presently sketches and it determines no event probabilities. The gravity and cosmology papers are downstream consumers: they can later test whether an event law generates sensible memory, continuum fields and stress-energy, but they already use metric scales, physical time and thermodynamic quantities and cannot be used to manufacture a primitive ΔS_e; the extended gravity paper itself designates its shorter companion as authoritative for the core derivations, so the pair is one source, not two confirmations. *From Paths to Folds* is quarantined as a phase source: its local phases are model ingredients and its continuous-phase emergence rests on an older renormalisation construction, so it stands as an example of what an event-level phase derivation must improve upon, not as provenance.

1D. The Fold-to-fact promotion programme (F2F-1)

The Fold-to-fact step of §1C can now be reduced to one precise theorem and a finite matrix calculation, replacing any residual reliance on "a cycle exists, therefore a fact occurs". The governing correction is:

a fact is not merely a Fold with $\beta_1 \geq 1$.

A Fold supplies the possible distinction; cyclic closure supplies the capacity to trap it; a **fact occurs when the microscopic event dynamics first enter an absorbing, terminally distinguishable record class.**

Mark partition. Take the executed microscopic marked instrument $\{ M_\alpha \}$, $\alpha \in \mathcal{A}$ (§29 supplies a concrete candidate: the 319-operator XI-2 instrument with completeness, Stinespring isometry and record-copy map all passing). Divide the marks into two source-defined classes,

$\boldsymbol{\mathcal{A} = \mathcal{A}_{open} \sqcup \bigcup_a \mathcal{A}_a}$**,**

where a ranges over the implemented terminal-ledger classes. Notation: a denotes an implemented ledger class throughout this section — in the execution, a = (e, r) with e the edge and r the terminal type — and the symbol for a physically admitted event class is deliberately withheld until the QC-1 quotient of §1B has been executed, so that ledger entry and physical fact cannot be silently identified before F2F-1C and that quotient pass.

Here $\mathcal{A}\_open$ contains reversible or not-yet-committed closure moves and $\mathcal{A}_a$ contains all microscopic marks that complete the same implemented ledger class a. The classification must come from closure structure and terminal records — two marks belong to the same implemented ledger class exactly when they have the same effect on every admissible terminal record, the QC-1 principle of P1 — and never from the desired downstream physics (falsifier F19).

Promotion dynamics. Define the trace-decreasing maps

$$\mathcal{N}(\sigma) = \Sigma_{(\alpha \in \mathcal{A}\_open)} M_\alpha \sigma M_\alpha^\dagger, \quad \mathcal{J}_a(\sigma) = \Sigma_{(\alpha \in \mathcal{A}_a)} M_\alpha \sigma M_\alpha^\dagger,$$

so the full one-step evolution $\mathcal{T} = \mathcal{N} + \Sigma_a \mathcal{J}_a$ is trace-preserving by completeness. Define the promotion time

$$\boldsymbol{\tau = \inf \{ m \geq 0 : \text{the realised mark at step m belongs to some } \mathcal{A}_a \},}$$

so τ counts the open transitions preceding commitment, and the committing mark itself occurs at step index τ.

Before τ the process remains in the open Fold-closure sector; at τ it enters one implemented ledger class. That is the ledger-entry transition. The probability that the first entry lands in class a is the first-entry sum

$$P(a \mid \sigma) = \Sigma_{(m=0)}^{\infty} \mathrm{Tr}[\mathcal{J}_a \mathcal{N}^m(\sigma)] = \mathrm{Tr}(\sigma F_a), \quad F_a = \Sigma_{(m=0)}^{\infty} (\mathcal{N})^m [\mathcal{J}_a(I)].$$**

Here and throughout this section σ denotes a density operator on the carrier; ρ remains reserved for the ordered record.

The effects F_a are not fitted; they are calculated from the open-transition and closure-completion operators alone.

The decisive finite test. Promotion is exhaustive precisely when the open map cannot retain probability forever:

$$\mathbf{r(\mathcal{N}) < 1,}$$

the spectral radius of the no-fact superoperator. Then $\mathrm{Tr}\, \mathcal{N}^m(\sigma) \to 0$ geometrically, the effect series converges in norm, and $\Sigma_a F_a = \Sigma_m (\mathcal{N}^*)^m[I - \mathcal{N}^*(I)]$ telescopes to the identity, so $\Sigma_a P(a \mid \sigma) = 1$: the system cannot remain indefinitely in the open sector — it enters one implemented terminal-ledger class with probability one. The criterion is two-sided: since $\mathcal{N}$ is positive and trace-non-increasing, $r(\mathcal{N}) \leq 1$ always, and if $r(\mathcal{N}) = 1$ there exists at least one positive Perron eigenstate for which noncommitment has nonzero probability, so exhaustion fails for at least that state; the $P(a \mid \sigma)$ still exist by monotone convergence, and for initial states with no component in the nondecaying subspace commitment may still occur almost surely — the defect below one, where present, is the probability of never committing. This computable inequality on the actual Fold instrument is what replaces the unsupported generic-ergodicity trapping claim held out in §1C.

The persistence condition — what must be proved for a ledger entry to become a permanent fact. Once a is entered, the record-copy isometry of §29 writes the mark into an orthogonal record register, and the sequentially normalised updates obey the ordinary probability chain law. The absorbing requirement is that the committed class is forward-invariant — the record label remains unchanged under every later admissible evolution while the working state continues to evolve. That supplies the three required properties: non-recombinability (distinct terminal records are orthogonal), persistence (the copy map preserves a) and forward invariance (later operations cannot return a to the open sector).

Where topology enters. The topology does its work at exactly one level: a mark counts as ledger-producing only when its history carries

$\beta_1(h\_\alpha) \geq 1 \cdot \mathcal{C}\_\ell \geq \mathcal{C}\star$ · non-recombinable closure alternatives · terminal record class $[R\_\alpha] \neq 0$.

$\beta_1 \geq 1$ provides the closure route; $\mathcal{C}\_\ell \geq \mathcal{C}\star$ says the route was actually activated; the nonzero terminal record says something physically happened. This resolves the residual ambiguity between a graph capable of trapping and an event that has actually trapped.

The Tick Race is not load-bearing. The Tick Race analysis begins from proportional hazards, amplitude-squared rates and first-tick selection before arguing those assumptions are physically motivated. None of those assumptions is needed here: the probability law comes directly from the complete marked instrument and its first-entry effects, and the inherited Born theorem can then *test* whether F_a equals the required Born effect — a strictly stronger position than assuming a tick rate proportional to a squared amplitude and recovering the same number.

The F2F-1 result, split into its three separately graded propositions. Given (i) a complete primitive marked Fold instrument, (ii) a division between open and terminal closure marks derived from the implemented terminal-record architecture, and (iii) terminal-record equivalence classes:

F2F-1A — First-entry exhaustion. $r(\mathcal{N}\_R) < 1$ implies almost-sure first entry into exactly one implemented terminal-ledger class, with $P(a \mid \sigma) = \mathrm{Tr}(\sigma F\_a)$. *Status: executed pass (reported frozen-matrix execution).*

F2F-1B — Record-copy admission. The implemented isometry copies the first-entry label into the ledger without error at the commitment step. *Status: executed pass (reported frozen-matrix execution).*

F2F-1C — Persistent-fact promotion. Every subsequent admissible evolution preserves each inequivalent ledger sector ($\varepsilon\_leak = 0$). *Status: conditional theorem; execution open under D12b.*

Only the conjunction of all three yields a permanent fact, and only F2F-1A and F2F-1B are executed; calling the executed pair a persistent-fact result would overstate it. The 84 implemented classes are promoted to physical event equivalence classes only once the QC-1 quotient of §1B has been computed on the actual carrier. **Grade: F2F-1A and F2F-1B pass as reported frozen-matrix executions; F2F-1C remains a conditional theorem awaiting D12b, and the whole rests on the declared renewal architecture awaiting D12a.**

Execution (4 August 2026) — the F2F-1 calculation report. The programme above was executed on the frozen PFDMI-EX2E/EX2F matrices only, with no downstream HCMR or Standard Model target consumed. Its principal returns:

The record decides the partition, and it overturned the expected one. The implemented retained-ledger alphabet is $(e, r) \in \{1,\ldots,12\} \times \{1,\ldots,7\}$ — twelve edges by seven terminal types, 84 classes — and the current-channel label $\alpha \in \{0,\ldots,12\}$ is not retained in the persistent ledger. The stored terminal effects agree at machine zero (residual 0.0 at the declared precision) with the aggregation $E_{(e,r)} = \Sigma_\alpha C_{(e,\alpha)}^\dagger P_r C_{(e,\alpha)}$ — a positive terminal effect, deliberately not written M since it is not a Kraus operator — and the channel previously classified as the open, no-fact channel (C_0 under the P-PF25 split) contributes nonzero effect to all 84 record classes, with total endpoint probability between 0.4591 and 0.4712 per edge. C_0 therefore cannot mean "no persistent fact": **P-PF25 is refuted as a persistent-record fact/no-fact partition.** It is not necessarily refuted as a microscopic current-channel classification — it may still label a finer current jump/no-jump distinction — but that label cannot decide whether a fact occurred. The partition the implemented record architecture forces is instead — no retained ledger entry: the seven self-history marks; ledger-producing: every nonself history transition, all thirteen current channels coarsened into (e, r). At the 319-mark grain this is 7 no-record and 312 record-producing marks. The current channels describe microscopic *ways* of producing a ledger entry; they do not decide *whether* a retained ledger entry occurred — the retained record decides that. The arithmetic relating the grains: 31 history marks split as 7 self and 24 nonself; each nonself history mark carries 13 current channels, giving $24 \times 13 = 312$ record-producing marks, which with the 7 self marks yields the 319-mark grain; the persistent ledger coarsens those 312 into the 84 retained classes (12 edges × 7 terminal types), and it is these 84 labels that the rank-84 renewal isometry copies. This is falsifier F19 operating as designed: the classification the record forces displaced the classification a prior label suggested.

The spectral test passes decisively (reported frozen-matrix execution). The no-record map is the seven self-history marks tensored with the identity on the internal carrier, so on the full 350-dimensional carrier

$$\mathbf{r(\mathcal{N}\_R) = 0.200305886206958 < 1,}$$

and the probability of never entering the ledger is zero for every initial internal state: one and only one first ledger entry occurs almost surely — a statement conditional throughout on the declared renewal architecture, the implemented mark partition, the finite executed instrument and the terminal-ledger interpretation, with the derivation of that architecture from the master action still open (D12a). Mean waiting counts are 7/6 closure steps from the first history state and 1.250478130015 from the others, with stationary mean **$\mathbb{E}\_\pi$[N_fact] = 1.234602249934960**

closure steps (renewal opportunities — the unit is deliberately not called a Fold, since Fold now names the committed fact itself) — shorter than the earlier 2.3096-step accepted-current wait, which had wrongly excluded the C_0 branches even though they produce persistent records.

The first ledger entry is returned by POVM-form first-entry effects constructed from the frozen marked instrument (reported frozen-matrix execution). Because the no-record map acts trivially on the internal carrier, the waiting is exactly geometric and the first-record effect separates in closed form,

$$\mathbf{F_{(x;e,r)} = [\, p_{(x\to y(e))} / (1 - p_{(x\to x)}) \,]\, E_{(e,r)},}$$

with per-edge terminal completeness $\Sigma_r E_{(e,r)} = I_{50}$ (residual $\leq 1.93e{-14}$) making the family complete: maximum completeness residual 1.28e−14 across sources, minimum eigenvalue −8.5e−16 (positivity at machine precision), factorisation residual 5.55e−17, and probability sums equal to one from every history source. The first ledger entry is returned as $P(e, r \mid \sigma, x) = \mathrm{Tr}(\sigma\, F_{(x;e,r)})$. This constructs the first-entry effects in exact Born trace form from the frozen instrument, without an additional Gibbs tilt or externally inserted hazard. It is a construction identity relative to that instrument, not an independent derivation or corroboration of the inherited Born theorem — the effects are generated from the same Kraus family whose probabilities they return, so citing the agreement as confirmation would breach the paper's own reproduction rule.

Persistence is implemented at machine zero but not yet derived — and copying is not yet absorption. The 84-record renewal map has rank 84 with isometry residual 0.0 at the declared precision, and neutral completeness holds at n = 3–6 (residuals $\leq 1.1e{-15}$): at the moment of commitment, $|e, r\rangle \mapsto |e, r\rangle_{active} \otimes |e, r\rangle_{ledger}$ exactly. Two distinct things must be kept apart here. The execution certifies the copy map; the theorem's absorbing requirement is the stronger later-time condition that every future admissible channel Φ preserves each ledger sector,

$$\Phi^*(I_{active} \otimes \Pi_{(e,r)}) = I_{active} \otimes \Pi_{(e,r)},$$

equivalently a zero-leakage functional taken over every state,

$$\varepsilon_{leak} = \max_{((e,r) \neq (e',r'))} \sup_{(\sigma \geq 0,\ \mathrm{Tr}\,\sigma = 1)} \| \Pi_{(e',r')}\, \Phi(\Pi_{(e,r)}\, \sigma\, \Pi_{(e,r)})\, \Pi_{(e',r')} \|_1,$$

with the absorbing-ledger condition

$$\varepsilon_{leak} = 0.$$

The supremum over normalised σ makes the statement state-independent, and the trace norm gives the leaked weight its operational meaning as transferred probability. Until that invariance is proved across the admissible channel family, the correct wording is **persistent-record implementation**, not yet an unconditional absorbing fact theorem. The ledger architecture also remains a declared design until derived from the master action. These are debts D12b and D12a respectively.

Status after execution.

Component	Status
Fold/fact distinction	Closed conceptually (§1C)
Microscopic marked instrument	Executed
Mark partition	**Executed — derived from the implemented terminal-record architecture; P-PF25 refuted as a persistent-record fact/no-fact partition; self/nonself split forced**
$r(\mathcal{N}) < 1$	**Computed: 0.200305886206958 on the full 350-dimensional carrier**
First-entry effects (POVM form)	**Constructed exactly in Born trace form from the frozen instrument — a construction identity, not independent corroboration**
Record persistence	**Copy isometry exact; absorbing-ledger invariance unproved (D12b); derivation from the master action open (D12a)**
Regulator/branch sweep of $r(\mathcal{N}\_R)$	Copy-map implementation certified at n = 3–6; the radius itself reported at the executed level — sweep outstanding
Reproducibility package (Appendix E)	Specified but not yet supplied — all F2F-1 results remain graded executed but not yet independently rerunnable

The strict verdict of the report, restated in the three-proposition grading: **first ledger-entry exhaustion PASS · record-copy admission PASS · persistent-fact promotion CONDITIONAL (D12b) · architecture provenance OPEN (D12a); the fully primitive Fold-to-fact theorem remains conditional.**

2. Source stack consumed

The construction layer separates controlling theorem sources, microscopic execution sources and historical background.

2.1 Controlling probability and phase sources

- *Probability as Consistency* supplies the single-event Born weight, the identity $\Delta I\_i = -\ln |c\_i|^2$, and the unit exponent in the extension-information representation. Its stated scope is a single commitment event; the ordered-history lift is the task undertaken here.
- *Probability as Admissible Measure on the VERSF Operational Hilbert Geometry* and *Operational Distinguishability Geometry as the Primitive Probability Object* supply conditional operational-measure uniqueness routes. They strengthen the inherited Born layer but do not derive the full primitive marked action.
- *The Double Square Rule* supplies the pairwise-kernel route to the quadratic probability core. Its downstream bilinear result is consumed only together with *The Connection Construction and the Shared Phase Obligation*, which corrects the claim that arg det(dT) constructs a continuous phase from a real metric.

- *Physical Necessity of Quantum Probability Structure* supplies admissibility arguments for pairwise rather than higher-order selection, equal path weighting, the fundamental phase representation, factorisation and $p = 2$.
- *Why Finite Distinguishability Forces Continuous U(1) Phase* supplies the current conditional phase-catalogue result. It fixes the admissible value group, not the source-level assignment of a phase to every path, mark or branch.
- *Born Rule as Entropic Unfolding* supplies an apparatus-level Gibbs-cost model and operational proposals for measuring outcome-conditioned heat, work and erasure. Because its Maximum-Caliber step is explicitly an inference principle used when microscopic dynamics are incomplete, it is treated as a cost target and test model, not as primitive cost provenance.

2.2 Microscopic and Standard Model closure sources

- *The Fold and the Record* supplies the structural commitment event: the threshold-crossing dynamics under which a loop operator becomes fixed and a Fold is written into the committed record field.
- *Topological Threshold for Fact Formation* supplies the $\beta_1 \geq 1$ capacity condition for locally constructible trapping, used here at necessary-condition strength only.
- *The Uniqueness of the Minimal Distinction* supplies the Fold as the unique minimal one-bit operational distinction, factoring finite measurements through binary Fold questions without forcing binary state spaces.
- The closure-orientation analysis supplies the $U = ABC$ bridge witness of §1B: closure-generated orthogonal Fold projectors $P_+ = UU^\dagger$, $P_- = U^\dagger U$.
- The adjoint-removal theorem (QC-1) supplies the terminal-record physical-equivalence quotient used to define event classes.
- *The W_7 Fold Carrier and the Readout Domain* supplies the fact / tally / ordered-history typing: a final order-blind tally cannot carry reversal-odd information, while an ordered commitment history can.
- *From Overdetermination to Inevitability* supplies the inherited kinematic stack — complex Hilbert-space kinematics, norm-preserving reversible evolution, the Born rule and the trace rule — as conditional consequences of the fact-producing admissibility framework, while explicitly leaving the post-measurement state rule separate.
- *The Price of Copies* supplies the global-versus-sector phase boundary: one global U(1) phase for the unique Fold does not produce independent relative phases between internal closure sectors.
- The $K = 7$ wheel supplies the seven-state graph, its exact harmonic sectors and the canonical transition architecture.
- D36-R1 supplies the fully specified row-normalised discrete-Fold kernel, its stationary law and the distinction between discrete and continuous clock conventions.
- PFDMI-1 supplies the field-dependent marked-instrument architecture, the physically resolved record labels, the faithful source carrier and the regulator/branch discipline.
- PFHBA-7 supplies the exact warning that an inverse Fisher lift is not primitive provenance and that an unmarked kernel does not determine a coherent marked lift.
- HCMR-MR1 supplies the four-regulator candidate parent and the physical-admission boundary.

- The consolidated GSJB preparation sequence supplies the Haar/Fubini–Study base, the Gibbs–Haar typing, the deterministic first-direction no-go, the action-form no-go and the shared-face record results.
- HCMR-XI-1 and HCMR-XI-2 supply the record-sufficient law candidate and its microscopic marked-instrument execution.

2.3 Historical-source firewall

The earlier *Pre-Entropic and Entropic Domains*, *Entropy-Momentum Foundations* and related framework papers are not load-bearing theorem sources for HCMR-P1. They may supply motivation or historical ancestry, but later probability, phase and source-provenance papers control the claim grades used here.

The charged-flavour and neutral-sector outputs are not construction inputs. CKP-2.4 is used only after the theorem is graded, to state the downstream consequence of leaving physical phases and the full carrier open.

3. Non-insertion boundary

No observed mass, coupling, mixing angle, CKM entry, PMNS entry or CP phase is used to choose any preparation factor, event probability, entropy cost or relative phase in this paper.

The law-level construction is allowed to consume:

- the frozen marked operations and their operator-resolved refinements, with their physical labels;
- the Fubini–Study base measure on the declared preparation carrier;
- the exact event probabilities returned by the instrument;
- the append-only committed record;
- declared conjugation and blocking maps.

It is forbidden to consume:

- the desired HCMR Hessian as a source for the field-to-mark derivative;
- the favourable CKM axle phase or coefficient;
- a neutral mass matrix or measured oscillation data;
- entropy costs chosen to reproduce a target distribution;
- a phase convention selected because it improves a downstream comparison.

4. Claim grades

This paper uses five grades.

1. **Exact theorem:** follows algebraically from the declared mathematical objects.

2. **Generic machine certificate:** numerical verification of an exact law on an independently generated finite instrument; useful as a code check, not VERSF physical evidence.
3. **Imported VERSF machine return:** a frozen execution result from the cited calculation package.
4. **Conditional physical theorem:** follows after named source and interpretation premises are granted.
5. **Primitive physical admission:** the complete source action returns the object without target access and survives all regulator, branch, readout and independent-route tests.

These grades align with the corpus-level three-tier discipline of structural theorem, conditional structural derivation and physical identification (§1C): a physical identification always carries a strictly weaker grade than the structural object beneath it. No result may move between these grades by rhetorical proximity. In particular, a machine-zero numerical agreement between two quantities is graded a reproduction, not a corroboration, unless the two quantities are shown to have disjoint derivation chains; the burden of exhibiting both chains lies with the party citing the agreement.

5. Premises

P0 — Fold-closure origin of physical events. A physical event is the irreversible completion of an admissible Fold-closure history on the commitment interface: an admissibly trapped distinction that persists under forward evolution. The Fold in its uncommitted form — the proto-Fold — is a pre-metric, provisional and reversible distinction and is not yet the event; the minimal fact — the first irreversible realised event — occurs when closure-capable topology is present and the actual dynamics cross the commitment threshold, producing a non-recombinable, admissibility-fixed record. No length, duration, energy or mass is attributed to the primitive Fold before the metric bridge is crossed. The condition $\beta_1 \geq 1$ supplies the required topological capacity but does not by itself certify that commitment has occurred.

P1 — Terminal event classes. Committed closure histories represent the same physical event when their observable representatives are indistinguishable to every terminal record in every admissible context. The physical event alphabet consists of the resulting terminal-record equivalence classes.

P2 — Frozen marked representation. At regulator n and branch k, each physical closure-event class [e] is represented by a marked completely positive operation $\mathcal{J}_{[e]}^{(n,k)}$ with Kraus decomposition $\mathcal{J}_e = \Sigma_\alpha K_{([e],\alpha)}\, \sigma\, K_{([e],\alpha)}^\dagger$, the family obeying the declared completeness relation; the operator-resolved refinement is the special case in which the retained event resolves one Kraus operator, $\mathcal{J}_e = M_e\, \sigma\, M_e^\dagger$. HCMR-P1 conditions on this frozen representation. Primitive admission requires a forward derivation of the complete map from closure histories and their terminal-record classes to these marked operations, without target access.

P3 — Pre-event base law. Before a committed record breaks the symmetry, the unresolved directing state is distributed by the Fubini–Study measure on the frozen projective preparation carrier.

P4 — Record sufficiency. The preparation update may depend on the completed record only through the instrument-native likelihood of that record and its physically retained mark labels. Primitive-action provenance of the instrument is a later admission gate.

P5 — Probability-chain consistency. Posterior predictive probabilities must agree with joint probabilities divided by the probability of the existing record.

P6 — No independent Gibbs tilts. No coefficient may enter the record-conditioned law unless it is returned by a recorded event multiplicity or by the microscopic action.

P7 — Physical mark resolution. Distinct labels in the preparation law correspond to orthogonal or otherwise operationally distinguishable record events. A unitary reshuffling of unresolved Kraus operators is not a new physical event alphabet.

P8 — Branch covariance. The two retained branches are related by the frozen conjugation/reflection law unless an independently derived orientation-odd action term breaks the relation. In the frozen-basis convention, C_n is unitary and K is entrywise complex conjugation, so $\Theta_n = C_n \circ K$ is the corresponding antiunitary, norm-preserving branch map. The Fubini–Study pre-event law is invariant under Θ_n.

P9 — Regulator currency. Levels 3–6 are nested realisations of one declared source law; a single-level success is not a primitive certificate.

P10 — Cost typing. Extension information, stochastic entropy production, thermodynamic entropy and action are distinct quantities and may not be identified without a derived bridge.

P11 — Phase typing. A relative phase is physical only if it affects an interference-capable amplitude or a comparison holonomy. A phase invisible to all declared events is gauge.

P12 — Carrier scope. The twelve-component Dirichlet corollary is stated on the frozen 49-dimensional projective preparation carrier. It is not silently promoted to the full 50-dimensional internal carrier.

P13 — Downstream firewall. Charged and neutral observables are opened only after the preparation result and its failures are sealed.

P14 — Operator-resolved richness and separation. The attainable nonconstant operator-resolved likelihoods satisfy the range-richness-with-overlap condition of Theorem 2, and the family of subsequent operator-resolved event functions separates probability measures on the support of the existing record. The executed PFDMI candidate has a full-rank 72-dimensional local physical score, which supports local non-degeneracy but does not by itself prove global measure separation; neither the richness half nor the separation half has been separately certified globally, and both remain explicit premises until informational completeness is demonstrated.

P14R — Retained-record richness and separation. The attainable retained-record likelihoods have essential ranges satisfying the range-richness-with-overlap condition of Theorem 2, and the family of subsequent retained-event functions separates probability measures on the support of the retained record.

P15 — Exchangeable component-count reduction. Conditional on a fixed latent component-weight vector w, component-resolved opportunities are independent draws with likelihood $\prod_j w_j^{N_j}$; the individual observations do not dynamically transform w except through Bayesian conditioning. This is a replicated-preparation, directing-variable model, not the generic sequential marked instrument, whose ordered likelihood is Theorem 1 and is generally not multinomial.

5A. Inherited single-event law and revised novelty

The upstream VERSF probability stack conditionally establishes, for one admitted outcome i,

$$p_i = |c_i|^2,$$

$$\Delta I_i = -\ln p_i,$$

$$p_i = \exp(-\Delta I_i),$$

with the exponent fixed to one. HCMR-P1 does not reopen that single-event theorem and does not claim the exponent as a new discovery.

The new obligation is the history lift: given a physically ordered record $\rho = (e_1, \ldots, e_N)$, determine whether one and only one record likelihood, extension-information functional, conditioned directing measure and marked post-event state follow from the frozen instrument without inserting new record-dependent tilts. Theorems 1–5 together with Theorem 3A answer that history-level question.

One boundary inside the inheritance must be kept explicit. *From Overdetermination to Inevitability* derives complex Hilbert-space kinematics, norm-preserving reversible evolution, the Born rule and the trace rule as conditional consequences of the fact-producing admissibility framework, but it states equally explicitly that fixing the Born rule does not fix the post-measurement state rule: the Lüders/Kraus update is a separate question. The division of labour in this paper is therefore

Born probability: inherited · Kraus state update: conditional on the frozen event instrument,

and nothing in the inherited Born theorem is treated as deriving the physical marks M_e.

5B. Relation to established results

Several of this paper's working objects are standard mathematics, and presenting them otherwise would invite the correct criticism that known results have been renamed. The table below states, for each principal object, the established framework it belongs to and what — if anything — is new here. External works are cited as E1–E11 in the references.

Object in this paper	Established framework	Status here
Ordered Kraus-product likelihood; instrument composition (Theorem 1)	Operational quantum instruments (E2, E3, E4)	Known mathematics, applied
Normalised post-outcome state (Theorem 5)	Lüders/Kraus update rule (E1, E3)	Known mathematics, applied
Likelihood reweighting of a prior over states (Theorem 3)	Bayesian quantum-state inference (E8)	Known framework; the VERSF content is the no-tilt discipline and the in/out split as applied here
Haar prior inducing Dirichlet block weights (Theorem 4)	Induced measures on state spaces (E7)	Known mathematics; applied to the frozen twelve-block carrier under P15
First-entry effects; exhaustion via a spectral condition (§1D)	Quantum trajectories and repeated measurement; absorbing completely positive maps and hitting probabilities (E5, E6)	Known framework; the executed partition, the computed radius and waiting numbers, and the overturned classification are new
Record-level exponent theorem (Theorem 2)	Coherence arguments for Bayesian updating	Known in spirit; the predictive-consistency/range-overlap/measure-separation formulation at record level is specific to this programme
Information versus thermodynamic cost typing (Part V)	Stochastic thermodynamics; Landauer and measurement thermodynamics (E9, E10, E11)	Known typing; the action-form non-identifiability theorem is the programme-specific statement
Mark-phase invariance (Theorem 8)	Unitary freedom of Kraus representations (E3, E4)	Known mathematics; used here to type the phase refusal, not presented as new
Retained-record coarse-grained CP instrument, conditioned density state and mean-state closed form (§10A)	Coarse-grained quantum instruments (E2, E3, E4)	Known framework; the retained-grain preparation law and its no-tilt and covariance corollaries are the VERSF application
Fold-to-fact partition, $r(\mathcal{N}_R) = 0.2003$, stationary mean 1.235, POVM-form first-entry effects on the executed 350-dimensional instrument	—	New execution

Object in this paper	Established framework	Status here
Inheritance, reproduction-versus-corroboration and non-insertion grading discipline	—	Programme-specific methodology

The paper's claims should be read at exactly this resolution: the instrument-theoretic layer is inherited mathematics; the preparation-law layer is a disciplined application; the executions and the refusal theorems are where the new content lives.

Part II — The marked record and extension information

6. Marked instrument and record likelihood

Scope of Part II: sections 6–10 are written at the operator-resolved microscopic grain, where each realised mark corresponds to one Kraus operator. Section 10A supplies the retained coarse-grained formulation that the physically kept record actually supports, and P2 conditions on the CP-map representation with the single-operator form as its special case.

Fix regulator n and branch k. Let

$$\mathbb{I}_n^{(k)} = \{ M_{(n,e)}^{(k)} : e \in \mathscr{E}_n \}$$

be the frozen marked instrument, with completeness

$$\Sigma_{(e \in \mathscr{E}_n)} M_{(n,e)}^{(k)\dagger} M_{(n,e)}^{(k)} = I.$$

For a normalised directing state η, the probability of mark e is

$$p_{(n,e)}^{(k)}(\eta) = \|M_{(n,e)}^{(k)} \eta\|^2.$$

For an ordered record $\rho = (e_1, \ldots, e_N)$, define

$$M_{(n,\rho)}^{(k)} = M_{(n,e_N)}^{(k)} \cdots M_{(n,e_1)}^{(k)},$$

$$L_{(n,\rho)}^{(k)}(\eta) = \|M_{(n,\rho)}^{(k)} \eta\|^2.$$

The likelihood is defined by the instrument itself. It is not an inverse construction from a supplied HCMR matrix.

7. The ordered-record identity

Theorem 1 — Microscopic ordered-record likelihood. For every record with nonzero support,

$$L_{(n,\rho)}^{(k)}(\eta) = \prod_{j=1}^{N} p_{(n,e_j)}^{(k)}(\eta_{j-1}),$$

where $\eta_0 = \eta$ and

$$\eta_j = M_{(n,e_j)}^{(k)} \eta_{j-1} / \|M_{(n,e_j)}^{(k)} \eta_{j-1}\|.$$

Proof. At the first step, $\|M_{e_1} \eta\|^2 = p_{e_1}(\eta)$. Writing $M_{e_1} \eta = \sqrt{p_{e_1}}\, \eta_1$ and iterating gives

$$M_{e_N} \cdots M_{e_1} \eta = \left(\prod_j \sqrt{p_{e_j}(\eta_{j-1})} \right) \eta_N.$$

Taking the squared norm proves the result. ■

The HCMR-XI-2 execution tested this identity in the actual PFDMI marked carrier. Direct two-step descent and sequential normalisation agreed at 5.678e−16 in state norm, and the probability-chain identity agreed at 1.388e−17.

8. Extension information

Definition 1 — Event-level extension information.

$$\boldsymbol{\Delta I_{(n,\rho)}^{(k)}(\eta) = -\ln L_{(n,\rho)}^{(k)}(\eta),}$$

with $\Delta I = +\infty$ when the record has zero likelihood.

By Theorem 1,

$$\Delta I_{(n,\rho)}^{(k)}(\eta) = -\Sigma_{j=1}^{N} \ln p_{(n,e_j)}^{(k)}(\eta_{j-1}).$$

In the directing-variable reduction in which primitive opportunities are conditionally independent given η, the η_j dependence is absorbed into the fixed directing variable and the earlier GSJB expression is recovered:

$$\Delta I_\rho(\eta) = -\Sigma_{e \in \rho} \ln p_e(\eta).$$

This is a typing relation, not a claim that every microscopic instrument is iid.

9. History-level compatibility of the inherited exponent

The single-event exponent $\beta = 1$ is inherited from the prior probability-consistency and operational-measure results. The theorem below is an independent history-level compatibility check. It asks whether record conditioning could introduce a new power even though the one-event law is already fixed. The answer is no under the declared probability-chain and measure-separation premises.

Theorem 2 — Record-level no-additional-tilt (likelihood-update uniqueness) theorem. Assume P3–P6 and P14. Suppose the conditioned measure has Radon–Nikodym derivative

$$d\mu_\rho / d\mu_\emptyset \propto F(L_\rho),$$

where F is positive and continuous on (0, 1]. For the evolving instrument the ordered likelihood factorises exactly as

$$L_{(\rho_1 \oplus \rho_2)}(\eta) = L_{(\rho_1)}(\eta) \cdot L_{(\rho_2|\rho_1)}(\eta),\ L_{(\rho_2|\rho_1)}(\eta) = \|M_{(\rho_2)}\, T_{(\rho_1)}(\eta)\|^2,$$

where $T_{(\rho_1)}(\eta) = M_{(\rho_1)}\, \eta / \|M_{(\rho_1)}\, \eta\|$ is the record map: concatenation multiplies the record likelihood by a conditional likelihood evaluated on the transformed state, not by an independent copy of a static function. Assume additionally:

(a) **range richness with overlap** — the essential ranges of the attainable nonconstant likelihood functions overlap pairwise along a chain and, together with the value 1 attained by trivial records, cover a dense subset of (0, 1]; (b) **measure separation** — the family of subsequent event functions, each written explicitly as $q \circ T_\rho$ when evaluated as a function of the initial state, separates probability measures on the support of the existing record, i.e. where $L_\rho > 0$ (P14).

Then, in the normalisation $F(1) = 1$,

$$\mathbf{F(x) = x \text{ on } (0, 1],}$$

so the update exponent is one.

Proof. The proof acts directly through the probability chain; no multiplicative functional equation is required. Let p be any attainable nonconstant likelihood under the prior μ. Predictive consistency requires, for every subsequent event function q,

$$\int q\, F(p)\, d\mu / \int F(p)\, d\mu = \int q\, p\, d\mu / \int p\, d\mu.$$

By separation (b), the two normalised measures coincide, so

$$F(p) / \int F(p)\, d\mu = p / \int p\, d\mu \quad \mu\text{-a.e.},$$

that is, $F(p(\eta)) = c_p \cdot p(\eta)$ with the constant $c_p = \int F(p)d\mu / \int p\, d\mu$ depending only on p. Since F is one fixed function on (0, 1], this says $F(x) = c_p\, x$ for μ-almost every value of p; to pass from almost-everywhere equality to the whole essential range, note that every x in the essential range is by definition a limit of values x′ where the equality holds (each neighbourhood of x carries positive measure, hence contains such x′), and continuity of F transfers the identity to the limit, giving $F(x) = c_p\, x$ for every x in the essential range of p. Whenever two attainable likelihoods have overlapping ranges the constants agree on the overlap, so by the overlap chain in (a) all the c_p are equal to one universal constant c; continuity extends $F(x) = c x$ from the covered dense subset to (0, 1], and $F(1) = 1$ gives $c = 1$. ■

Remark — the multiplicative-power route and its cocycle. One can also argue through record concatenation: because each update is a normalised reweighting, associativity gives only $F(x)F(y) = C(\rho_1, \rho_2) F(xy)$ on attainable pairs, with a record-pair-dependent constant. Evaluating on (x, 1) pairs proves $C(\rho_1, \text{trivial}) = 1$ but not $C(\rho_1, \rho_2) = 1$ for arbitrary ρ_2, so the multiplicative route needs an additional universal-cocycle-triviality hypothesis that would be assumed rather than derived. The direct measure argument above avoids the cocycle entirely; the power-law form $F(x) = x^\beta$ under a trivialised cocycle survives only as a corollary (Appendix A.1) and does not carry the proof. Specialising the direct argument to $F(x) = x^\beta$ recovers the familiar statement: $p^{(\beta-1)}$ must be constant almost everywhere on the support of every attainable nonconstant likelihood, which forces $\beta = 1$. That calculation is now a consequence of the theorem, not its proof.

Corollary 2.1 — Retained-record no-additional-tilt theorem. The physically retained record acts through the density-operator-valued map $\eta \mapsto \sigma_\varrho(\eta)$ of §10A, and the theorem must hold at that grain to protect the record the theory actually keeps. For a subsequent retained event b, define the retained event function

$$q_b(\sigma) = \mathrm{Tr}\, \mathscr{I}_b(\sigma).$$

Predictive consistency at the retained grain requires

$$\int q_b(\sigma_\varrho(\eta))\, F(L_\varrho(\eta))\, \mu_{FS}(d\eta) \,/ \int F(L_\varrho(\eta))\, \mu_{FS}(d\eta) = \int q_b(\sigma_\varrho(\eta))\, L_\varrho(\eta)\, \mu_{FS}(d\eta) \,/ \int L_\varrho(\eta)\, \mu_{FS}(d\eta),$$

and under the retained-grain analogues of both Theorem 2(a) and 2(b) — range richness with overlap for the retained likelihoods and separation by the retained-event functions $\{ q_b \circ (\eta \mapsto \sigma_\varrho(\eta)) \}$, stated together as premise P14R — the proof of Theorem 2 applies verbatim and gives $F(x) = x$ at the retained grain as well. No extra temperature can enter through the coarse record any more than through the microscopic one.

This theorem is a consistency and uniqueness result, not an independent physical derivation of the exponent: P5 already imposes ordinary conditional-probability consistency, and the theorem proves that once that rule is granted an ordered record cannot introduce a second Gibbs exponent or effective temperature — exactly under hypotheses (a)–(b), and not more strongly. The hypotheses remain live: a full-rank local score supports non-degeneracy but not global measure separation, and the range richness and pairwise overlap of the executed instrument's attainable likelihoods, while plausible from its 72-dimensional physical score, have not been separately certified. The theorem is graded exact under the declared range-richness-with-overlap and separation hypotheses.

10. Unique record-conditioned measure

Theorem 3 — Record-sufficient directing measures. Under P2–P6 and the inherited unit-exponent single-event law, the record determines two distinct measures, each unique up to μ_{FS}-null sets and neither containing an independent record-conditioned tilt.

(i) Initial-state posterior.

$$\boldsymbol{\mu_{(n,\rho)}^{(k,in)}(d\eta) = [\, L_{(n,\rho)}^{(k)}(\eta) / Z_{(n,\rho)}^{(k)} \,]\, \mu_{FS}(d\eta)}, \quad Z_{(n,\rho)}^{(k)} = \int L_{(n,\rho)}^{(k)}(\eta)\, \mu_{FS}(d\eta).$$

This is the conditional law of the pre-event directing state given that record ρ occurred. It is not the distribution of the current state.

(ii) Post-record ensemble. Let $T_{(n,\rho)}^{(k)}(\eta) = M_{(n,\rho)}^{(k)} \eta / \|M_{(n,\rho)}^{(k)} \eta\|$ be the nonlinear record map, defined on the support of the likelihood. The distribution of the current post-record state is the pushforward

$$\mu_{(n,\rho)}^{(k,out)} = (T_{(n,\rho)}^{(k)})_* \, \mu_{(n,\rho)}^{(k,in)}.$$

Physical consumers of the post-record state read μ^{out}; inference about the preparation reads μ^{in}. Conflating the two is falsifier F14.

Corollary 3.1 — Associativity. For records ρ_1 and ρ_2,

$$U_{\rho_2}(U_{\rho_1}(\mu)) = U_{\rho_1 \oplus \rho_2}(\mu),$$

provided the ordered likelihood is used; the update acts on the initial-state posterior μ^{in}. The generic verification package supplied with this paper returns a maximum discrete-posterior residual of 1.63e−19.

Corollary 3.2 — Exact average post-record state. On the d-dimensional frozen carrier the Fubini–Study prior satisfies $\int |\eta\rangle\langle\eta|\, \mu_{FS}(d\eta) = I/d$, and therefore

$$\boldsymbol{\bar{\rho}_{(n,\rho)}^{(k)} = \int |z\rangle\langle z|\, \mu_{(n,\rho)}^{(k,out)}(dz) = M_{(n,\rho)}^{(k)} M_{(n,\rho)}^{(k)\dagger} / \mathrm{Tr}(\, M_{(n,\rho)}^{(k)} M_{(n,\rho)}^{(k)\dagger} \,)}.$$

Proof. On the support, $|T(\eta)\rangle\langle T(\eta)| = M_\rho |\eta\rangle\langle\eta| M_\rho^\dagger / \|M_\rho \eta\|^2$, so the likelihood weight cancels pointwise:

$$\int |T(\eta)\rangle\langle T(\eta)|\, [\, L_\rho(\eta) / Z_\rho \,]\, \mu_{FS}(d\eta) = Z_\rho^{-1} M_\rho \left(\int |\eta\rangle\langle\eta|\, \mu_{FS}(d\eta) \right) M_\rho^\dagger = M_\rho M_\rho^\dagger / (d\, Z_\rho),$$

and $Z_\rho = \int \|M_\rho \eta\|^2 \mu_{FS}(d\eta) = \mathrm{Tr}(M_\rho^\dagger M_\rho)/d$. ■

The average post-record state is thus returned in closed form directly from the ordered mark product, with no free coefficient.

10A. The retained-record coarse-grained instrument

The F2F-1 execution establishes that the physically retained record label is the coarse pair $a = (e, r)$, which does not resolve the current-channel index α. Theorem 3 and Corollary 3.2 as written above therefore describe the operator-resolved microscopic trajectory; the retained record requires the instrument-level formulation, and the two must not be conflated.

For each retained event a, define the trace-decreasing coarse-grained operation

$$\mathscr{I}_a(\sigma) = \Sigma_{(\alpha\in\mathcal{A}_a)} K_{(a,\alpha)}\, \sigma\, K_{(a,\alpha)}^\dagger,$$

summing the unresolved Kraus operators that share the retained label. For an ordered retained record $\varrho = (a_1, \ldots, a_N)$ — the symbol ϱ distinguishes the retained coarse record from the fully resolved record ρ — define

$$\mathscr{I}_\varrho = \mathscr{I}_{(a_N)} \circ \cdots \circ \mathscr{I}_{(a_1)},\quad L_\varrho(\eta) = \mathrm{Tr}[\ \mathscr{I}_\varrho(\ |\eta\rangle\langle\eta|\ )\ ].$$

Theorem 3A — Retained-record conditioned state. Given the realised incoming state η, the retained record determines one unique conditioned current state,

$$\boldsymbol{\sigma_\varrho(\eta) = \mathscr{I}_\varrho(\ |\eta\rangle\langle\eta|\ )\ /\ L_\varrho(\eta),}$$

which is unique as a density operator but need not be pure. Under the Fubini–Study prior, the conditioned average post-record state has the exact closed form

$$\boldsymbol{\bar{\rho}_\varrho = \mathscr{I}_\varrho(I)\ /\ \mathrm{Tr}[\ \mathscr{I}_\varrho(I)\ ].}$$

Proof. Uniqueness of σ_ϱ is the uniqueness of the coarse-grained instrument's output on the realised label sequence. For the average, the likelihood weight cancels pointwise exactly as in Corollary 3.2: $\int \sigma_\varrho(\eta)\ [L_\varrho(\eta)/Z_\varrho]\ \mu_{FS}(d\eta) = Z_\varrho^{(-1)}\ \mathscr{I}_\varrho(\ \int|\eta\rangle\langle\eta|\ \mu_{FS}(d\eta)\ ) = \mathscr{I}_\varrho(I)/(d\ Z_\varrho)$, and $Z_\varrho = \mathrm{Tr}\ \mathscr{I}_\varrho(I)/d$. ■

The two central measures also have retained-record versions, and these are the physically primary ones. The initial-state posterior is

$$\boldsymbol{\mu_\varrho^{in}(d\eta) = [\ L_\varrho(\eta)\ /\ Z_\varrho\ ]\ \mu_{FS}(d\eta),\quad Z_\varrho = \int L_\varrho(\eta)\ \mu_{FS}(d\eta),}$$

and the post-record ensemble is the pushforward of that posterior under the state map,

$$\mu_\varrho^{out} = (\ \eta \mapsto \sigma_\varrho(\eta)\ )_*\ \mu_\varrho^{in},$$

a measure on density operators, not on projective rays. The comparison directing law is then

$$\nu_\varrho = p_*\ \mu_\varrho^{out},$$

with p explicitly a function of a density operator. The Bayesian mean of μ_ϱ^{out} is the $\bar{\rho}_\varrho$ of Theorem 3A.

One justification must be explicit, or the incoherent sum in $\mathcal{J}_a$ is open to challenge: the coarse-graining is incoherent because the 319-mark Stinespring construction first correlates the microscopic alternatives α with orthogonal fine-grained record states, and discarding — or, as here, failing to retain — that fine label traces those orthogonal states out, producing the CP sum $\Sigma_\alpha K_{(a,\alpha)} \sigma K_{(a,\alpha)}^\dagger$ rather than a coherent amplitude sum. A coherent sum would be correct only if the α alternatives fed one common fine record, which the executed instrument's copy structure excludes. The orthogonality of the fine record states is itself part of the reported frozen execution: until it is demonstrated symbolically from the construction, or the Appendix E package allows independent verification, this justification carries the reported-execution grade, not an algebraic one.

When every retained label happens to resolve a single Kraus operator, $\mathcal{J}_\varrho(\sigma) = M_\varrho \sigma M_\varrho^\dagger$ and Theorem 3A reduces to Theorem 3 and Corollary 3.2; the pure-Kraus formulas are the operator-resolved special case, not the general law of the retained record. The correct headline is therefore: given the frozen coarse-grained instrument and the realised incoming state, a retained record determines one unique conditioned density operator; when the incoming state is known only statistically, the record determines one unique posterior ensemble and one unique mean density state; the record label by itself determines neither. A unique projective ray is returned only for a fully operator-resolved microscopic trajectory.

Part III — Directing laws, component weights and the realised state

11. The comparison directing law

Let p map a current state to the complete local-comparison probability or to the complete directing variable needed by the renewal law. The comparison map acts on the current post-record state, so the comparison directing law is read from the post-record ensemble and is not an additional measure:

$\nu_{(n,\rho)}^{(k)} = p_{\ } \mu_{(n,\rho)}^{(k,out)}$.*

For any measurable set B,

$$\nu_{(n,\rho)}^{(k)}(B) = \mu_{(n,\rho)}^{(k,out)}(\{ z : p(z) \in B \}).$$

Equivalently, ν may be written as a pushforward of the initial-state posterior under the composite $p \circ T_{(n,\rho)}^{(k)}$; the two readings must not be mixed, and a comparison functional evaluated on the initial state is a different object. This section is written at the operator-resolved grain; the physically retained comparison law is $\nu_\varrho = p_* \mu_\varrho^{out}$ of §10A, with p a function of density operators, and the projective version here is its operator-resolved special case.

This closes the formal relation between ΔI and ν. It does not select a special scalar p unless the source instrument makes p_ρ one-dimensional.

12. Twelve-component posterior

On the frozen projective carrier used by the GSJB preparation line, the twelve component dimensions are

$d = (1, 2, 2, 2, 4, 2, 3, 6, 3, 6, 6, 12), \Sigma_j d_j = 49.$

Let $w_j = \|P_j \eta\|^2$ be the component weights. Haar/Fubini–Study measure implies

$w \sim \mathrm{Dirichlet}(d_1, \ldots, d_{12}).$

Under the exchangeable component-count reduction P15, a record containing N_j component-resolved events has likelihood $\prod_j w_j^{(N_j)}$ in the latent weights. Therefore:

Theorem 4 — Component-count posterior under the exchangeable directing-variable reduction.

$\mathbf{w \mid \rho \sim \mathrm{Dirichlet}(d_1 + N_1, \ldots, d_{12} + N_{12})}$

and

$\mathbf{\mathbb{E}[w_j \mid \rho] = (d_j + N_j) / (49 + \Sigma_l N_l).}$

This is the precise sense in which the eleven normalisation-free Gibbs tilts become record multiplicities rather than free coefficients. The reduction P15 is doing real work: for a generic sequential marked record the state evolves between events and the likelihood is the ordered product of Theorem 1, not a multinomial in fixed weights, and Theorem 4 is not claimed there. Quoting the Dirichlet posterior without P15 is falsifier F15. *The W_7 Fold Carrier and the Readout Domain* sharpens the same point from the commitment side: it separates the single committed fact, the final order-blind tally and the ordered commitment history, and proves that the tally cannot carry reversal-odd information while an ordered-history functional can — two histories with identical counts may differ under reversal-sensitive readout. The multinomial reduction is therefore not merely unproved for the general Fold history; it discards exactly the order information in which orientation or phase memory would reside.

Scope firewall. The full PFDMI internal carrier is $\mathbb{C}^{50}$. The later audit identifies a 49-versus-50 reconciliation debt associated with the trivial neutral-singlet component. Theorem 4 is therefore exact on the frozen 49-dimensional preparation carrier and is not yet a full-carrier census theorem.

13. The realised directing state

A stochastic law does not preselect a unique outcome. Once mark e is realised, however, the instrument returns a unique conditioned ray.

Theorem 5 — Marked realised-state theorem (operator-resolved mark, pure incoming state). Let the existing normalised post-record state be η_ρ and let e be an operator-resolved mark — a physical outcome that resolves one Kraus operator, not merely an outcome label — with nonzero probability. Then

$$z_{(\rho,e)}^{(n,k)} = M_{(n,e)}^{(k)} \eta_\rho / \sqrt{ p_{(n,e)}^{(k)}(\eta_\rho) }$$

is the unique post-event projective state associated with that mark, up to global phase. If a completed outcome is represented by an orthogonal record projector, its record label is copied without changing this state update.

Proof. The numerator is the amplitude returned by the frozen mark. Normalisation fixes its norm, and projective equivalence removes only a common phase. Any different ray would fail to reproduce the action of that operator-resolved mark. ■

Remark — unresolved outcome labels return mixed states. If a macroscopic outcome label e aggregates several unresolved Kraus operators $M_{(e,\alpha)}$, the conditioned return on an incoming state ρ_{in} is generally mixed:

$$\rho_e = \Sigma_\alpha M_{(e,\alpha)} \rho_{in} M_{(e,\alpha)}^\dagger / \Sigma_\alpha \mathrm{Tr}(M_{(e,\alpha)} \rho_{in} M_{(e,\alpha)}^\dagger),$$

and no unique post-event ray exists. P7 excludes silent reshuffling of the unresolved list, but the pure-state uniqueness claim of this theorem is made only for operator-resolved marks. Likewise, the record alone does not determine a unique ray when the incoming state is itself distributed; what the record then determines uniquely is the post-record ensemble μ^{out} of Theorem 3.

The HCMR-XI-2 execution constructs 319 physically labelled marked operators on $\mathbb{C}^7 \otimes \mathbb{C}^{50}$, with completeness residual 2.471e−14. Its record alphabet is copied by a 101761-by-319 isometry with $\|C^\dagger C - I\| = 0.0$ at the declared precision. Two different copy maps appear in this paper and must not be conflated; the chain is

319 microscopic marks ⟶ 319-label fine record ⟶ coarse-graining ⟶ 84-label retained ledger.

The 101761-by-319 isometry above copies the fine 319-label record at the microscopic grain; the rank-84 renewal isometry of §1D copies the retained (e, r) ledger label, and it is the 84-label map — not this one — that F2F-1B certifies. These are microscopic returns of the event map and the committed classical label.

14. Deterministic selection is not the pass condition

The earlier first-differentiation theorem excludes a deterministic, symmetry-preserving selection of one nonzero pre-fact direction. HCMR-P1 therefore rejects the following false requirement:

Before the event, the action must name one deterministic η that every repetition will realise.

The physically meaningful requirement is instead:

Before the event, the action must return one unique probability law. After a retained coarse-grained event, the frozen instrument returns one conditioned density operator for a specified incoming state. After a fully operator-resolved event on a pure incoming state, it returns one projective ray.

The first is Theorem 3, the second is Theorem 3A, and the third is Theorem 5. Randomness of the mark is not residual parameter freedom.

15. Physical equivalence

The preparation result is unique modulo:

- global phase of η and z;
- changes on μ_FS-null sets;
- exact relabelling of record outcomes proved operationally indistinguishable — with terminal-record indistinguishability in every admissible context (the QC-1 quotient of §1B) as the declared standard of proof once executed on the actual carrier;
- exact gauge transformations acting trivially on all declared record probabilities;
- conjugate-branch identification only if a separate theorem declares the two branches physically equivalent.

A continuous family that changes any marked probability, record label, downstream interference or physical branch is not gauge and is not quotiented.

Part IV — Regulator and branch statement

16. Four-regulator evidence

The current source stack contains several relevant but differently graded regulator returns.

Object	n = 3–6 status	HCMR-P1 use
PFDMI stagewise instrument	Stagewise regulator and branch certificates pass; full end-to-end D6 remains open	Supplies the candidate marked source and blocking discipline.

Object	n = 3–6 status	HCMR-P1 use
HCMR-MR1 parent	Second-order convergence at four levels	Supplies a stable consumer target, not preparation provenance.
HCMR-XI-2 neutral instrument	Completeness residual at or below 1.11e−15 at all four levels	Supports marked preparation compatibility across levels.
HCMR-XI-2 record-completed parent	Rank 101 with one stable normalisation null; positive eigenvalue converges toward 1.818e−3	Supports regulator-stable record integration.
F2F-1 record promotion (§1D)	Radius $r(\mathcal{N}\_R) = 0.2003$ computed at the executed level; copy-map implementation certified at all four levels; a regulator/branch sweep of the radius itself is outstanding	Supports almost-sure first ledger entry within the declared renewal architecture; persistence remains conditional (F2F-1C/D12b).
Full preparation-to-all-sectors action	Not executed as one independently derived source	Prevents primitive admission.

The preparation law is algebraic once the regulator-specific marks are supplied. The remaining four-regulator task is not to rediscover Theorem 3 at each level, but to prove that the marks themselves descend from one source and that the resulting measures converge under the declared blocking maps.

17. Branch covariance

Assume the marked branches obey

$$M\_(n,\bar{e})\^(6) = C\_n\ M\_(n,e)\^(1)^* \ C\_n\^(-1)$$

for the frozen conjugation map C_n and corresponding mark relabelling $e \mapsto \bar{e}$. To forestall a double-conjugation reading: in this convention C_n is a linear unitary matrix and $*$ denotes entrywise complex conjugation in the frozen basis, so the branch relation applies conjugation exactly once; equivalently, defining the single antiunitary map Θ_n = C_n ∘ K with K the frozen-basis conjugation, the relation reads M_ē^(6) = Θ_n M_e^(1) Θ_n^(−1). Assume, per P8, that Θ_n is antiunitary — hence norm-preserving — and that the Fubini–Study prior is invariant under it, as it is under every unitary or antiunitary transformation of the frozen carrier, being the unique such invariant measure on its projective space.

Theorem 6 — Preparation branch covariance.

$$L\_(n,\bar{\rho})\^(6)(C\_n\ \eta^*) = L\_(n,\rho)\^(1)(\eta),$$

and therefore

$(C_n \circ)_{\_}\ \mu_{(n,\rho)}^{(1)} = \mu_{(n,\bar{\rho})}^{(6)}$.

The comparison directing measures obey the corresponding pushforward relation.

Proof. Conjugating the ordered mark product conjugates its output vector, and norms are preserved because C_n is norm-preserving. The posterior identity follows from uniqueness of the likelihood update together with the $C_n \circ *$-invariance of the prior. ■

Corollary 6.1 — Retained-record branch covariance. Because the retained CP instrument is the physically primary object, the covariance must also be stated at its grain. On density operators, define the branch-symmetry map

$$\vartheta_n(\sigma) = C_n \sigma^* C_n^\dagger.$$

This map is conjugate-linear on the full operator space and real-linear on Hermitian operators; it is positive and trace-preserving; like transposition, it is not completely positive in dimensions greater than one; and if the declared antiunitary branch symmetry obeys $\Theta_n^2 = e^{i\varphi} I$ it is involutive on density operators. It is a symmetry transformation, not a completely positive physical channel — which is exactly why it is written as a separate map rather than treating the antiunitary Θ_n as a linear matrix acting on density operators. Under the retained-label relabelling $a \mapsto \bar{a}$,

$$\mathscr{J}_{\bar{a}}^{(6)}(\vartheta_n(\sigma)) = \vartheta_n(\mathscr{J}_a^{(1)}(\sigma)),$$

which follows by applying the operator-level relation to each Kraus term of $\mathscr{J}_a$ and re-summing. Consequently

$$L_{\bar{\varrho}}^{(6)}(\Theta_n \eta) = L_\varrho^{(1)}(\eta),$$

and the retained posterior measure μ_ϱ^{in}, the density-state ensemble μ_ϱ^{out}, the mean state $\bar{\rho}_\varrho$ and the comparison law ν_ϱ all transform covariantly under the symmetry map ϑ_n.

Corollary 6.2 — Covariance is not orientation selection. If the two branches are exact conjugates and the action contains no orientation-odd term, the preparation law returns a conjugate pair or a branch-symmetric stochastic law. It does not select one global CP orientation.

This matches the HCMR-MR1 and PFHBA results: positive quadratic data preserve the $k = 1$ / $k = 6$ pair exactly.

18. Regulator pass condition

A future primitive admission package must publish, for $n = 3, 4, 5, 6$ and both branches:

1. exact source and mark hashes;
2. completeness and completeness-derivative residuals;
3. blocked likelihood and posterior residuals;

4. a metric for convergence of μ_ρ or of a complete finite sufficient-statistic representation;
5. branch covariance residuals;
6. the physical-equivalence rule or the action-derived branch gap;
7. a revision-currency registry and non-insertion seal.

HCMR-P1 proves the law that must be tested. It does not manufacture the missing full-source arrays.

Part V — Information cost and irreversible physical cost

19. Four quantities that must not be conflated

Quantity	Definition	Dimension	Status
Extension information	−ln L_ϱ (retained grain); −ln L_ρ (operator-resolved)	dimensionless nats	Derived in this paper
Stochastic path entropy	ln(P_F[path] / P_R[reverse path])	dimensionless	Defined once forward and reverse laws are fixed
Thermodynamic entropy	k_B times stochastic entropy, with physical coarse graining	entropy	Conditional
Action cost	time integral of energy, or A⋆ times a dimensionless action	action	Physical normalisation open

A record may carry large extension information while producing no dissipative heat in a reversible inference update. Conversely, irreversible dynamics may produce entropy that is not equal to the surprisal of one recorded outcome.

20. D36 and the clock boundary

D36-R1 proves that two formerly conflicting entropy numbers belong to two different clocks.

- The row-normalised discrete-Fold law gives ln 2 per declared Fold at $\alpha = 0.959001109719975$.
- The continuous-rate frozen-conductance law gives 0.184903137785088 at the same numerical coordinate.

Both are correct for their own generators. The substrate has not yet selected the step type, the full affinity normalisation or the absolute attempt rate. The ordering discipline of §1C applies here with full force: the record supplies event order, and no primitive Poisson rate, hazard per unit physical time or time-dependent Gibbs law may be installed before physical time is itself derived from commitment accumulation. Therefore the dimensionless D36 entropy branch cannot yet be promoted to the unique physical ΔS required by the original HCMR-P1 contract.

21. Action-form non-identifiability

The prior local action has the form

$$\mathcal{M}_i = -\ln a_i + \lambda\, \Delta S_i,$$

with event law

$$P_i \propto a_i\, e^{(-\lambda\, \Delta S_i)}.$$

Theorem 7 — Physical-cost non-identifiability from action form. For every strictly positive target law q_i, every strictly positive readiness law a_i and every $\lambda > 0$, there exists a nonnegative cost vector, after adding one common constant, such that the action form reproduces q exactly:

$$\Delta S_i = -(1/\lambda) \ln(q_i / a_i) + C.$$

Therefore the functional form alone does not derive the physical costs.

Proof. Substitution gives $a_i\, e^{(-\lambda\, \Delta S_i)} = e^{(-\lambda C)}\, q_i$. The common factor cancels on normalisation. Choose C large enough to make all ΔS_i nonnegative. ■

Corollary 7.1. A cost vector chosen because it reproduces a desired preparation law is an inverse fit, even if every cost is positive and the resulting distribution is regulator stable.

21A. What Entropic Unfolding contributes — and what it does not

The earlier Entropic Unfolding paper proposes the apparatus-level model

$$P_i \propto a_i \exp(-\lambda\Delta S_i)$$

and supplies an operational interpretation of ΔS_i through outcome-conditioned heat, dissipated work and erasure in a measurement chain. It also proposes calorimetric and digital-erasure tests.

That work is useful here in two restricted ways:

1. it specifies what a physically meaningful cost should eventually connect to experimentally;
2. it supplies a falsifiable phenomenological model for testing whether apparatus asymmetry biases observed frequencies.

It does not close the HCMR-P1 cost gate. Its Maximum-Caliber step is explicitly an inference rule for incomplete microscopic dynamics, and the numerical ΔS_i are not returned by the primitive VERSF action. Theorem 7 shows why the functional form alone cannot provide that provenance. HCMR-P1 therefore treats Entropic Unfolding as an operational target and test model, not as the source of the physical costs.

22. What is actually returned

HCMR-P1 returns

$$\Delta I_\varrho(\eta) = -\ln L_\varrho(\eta)$$

at the physically retained grain, and $\Delta I_\rho(\eta) = -\ln L_\rho(\eta)$ for the operator-resolved refinement, as instrument-native information functionals relative to the frozen marked instrument; primitive source provenance of that instrument remains a later admission gate.

It does not return:

- a unique reverse process for every physical mark;
- a substrate-selected affinity normalisation;
- the map from discrete Fold or accepted mark to physical duration;
- the absolute action unit;
- branch-resolved thermodynamic costs;
- the microscopic dissipation associated with maintenance and copying.

The original irreversible-cost gate therefore fails.

23. Cost release condition

A future pass must differentiate a microscopic path action and return

$$\Sigma_\rho = \ln(\mathbb{P}_F(\rho \mid \eta) / \mathbb{P}_R(\tilde{\rho} \mid \Theta z)),$$

then prove:

- finite mean and regulator convergence;
- compatibility with the selected physical clock;
- local detailed balance or its declared replacement;
- an independently normalised action or entropy unit;
- no cost chosen from downstream flavour or neutral data.

Until that execution exists, ΔI is derived and ΔS remains open.

Part VI — Relative phases and the amplitude boundary

23A. Inherited phase catalogue and remaining assignment debt

The phase corpus now distinguishes three different questions.

1. **Does an admissible continuous phase value space exist?** The later phase paper gives a conditional positive answer: under its inherited reversibility, closure and single-Fold premises, the minimal admissible continuous catalogue is U(1).
2. **Did the original Double Square connection formula construct that phase from a real metric?** No. The correction addendum proves that arg det(dT) is at most $\mathbb{Z}_2$-valued on a real orthogonal tangent map and vanishes on the orientation-preserving sector. It is motivation, not a construction of continuous phase.
3. **Which U(1) value is assigned to each physical path, mark or branch?** This remains open. A value catalogue does not determine the source-level assignment $\theta : \text{paths} \to U(1)$, nor the comparison observable that reads its gauge-invariant differences.

HCMR-P1 consumes the conditional U(1) catalogue but does not treat it as a returned physical phase assignment.

The Price of Copies confirms the placement of this boundary from the commitment side: deriving one global U(1) phase for the unique Fold does not automatically produce independent relative phases between internal closure sectors, and sector-resolved relative phase is there treated explicitly as an additional import or open obligation. The grade adopted here is therefore: global U(1) phase structure — conditional inherited pass; phase attached to each closure history or sector — open; interference readout of those phases — open.

24. Resolved-mark global-rephasing invariance

For arbitrary real functions θ_e, transform each physically resolved marked operator by

$$M_e \mapsto M'_e = e^{i\theta_e} M_e.$$

Theorem 8 — Global mark-rephasing invariance. For every η and ordered record ρ,

$$p'_e(\eta) = p_e(\eta), \quad L'_\rho(\eta) = L_\rho(\eta),$$

and therefore

$$\Delta I'_\rho = \Delta I_\rho, \quad \mu'_\rho = \mu_\rho, \quad \nu'_\rho = \nu_\rho.$$

Proof. A scalar phase cancels in $M_e^\dagger M_e$. An ordered record acquires only the common scalar phase $e^{(i\Sigma\theta_{(e_j)})}$, which cancels in the squared norm. ■

The generic machine certificate accompanying this paper verifies the record-likelihood invariance at residual 1.73e−18.

This theorem concerns one global scalar phase per resolved mark. Such phases are gauge for the declared stochastic record law unless a separate coherent operation superposes the marks and makes a relative combination observable.

25. Fixed stochastic law does not determine a unique coherent lift

The phase debt is larger than the scalar gauge in Theorem 8. An unmarked completely positive channel admits Kraus representations related by unitary mixing among unresolved outcomes. More generally, distinct coherent path decompositions can induce the same declared marked probabilities and record law.

PFHBA-7 therefore correctly separates:

- the unmarked population kernel;
- the physically resolved marked decomposition;
- the partial isometries, coherent amplitudes and comparison holonomies.

The first does not determine the latter two. Even a full set of probabilities for the present fixed instrument determines only the equivalence class read by that instrument; it does not manufacture a unique source-level path decomposition by inversion.

26. Physical phases require an interference-capable comparison

A relative phase becomes physical when coherent alternatives feed one common physical outcome or when a comparison loop returns a gauge-invariant holonomy. Internal path phases can therefore affect probabilities in an interference-capable experiment. HCMR-P1 does not deny that fact.

The present preparation law lacks the independently derived source-native object needed to perform that comparison. A phase completion must supply at least one of:

- a coherent marked-amplitude decomposition with source-fixed relative phases;
- a comparison-loop holonomy evaluated on a realised record;
- an orientation-odd action term;
- an independently derived family of interference-capable readouts that separates the candidate coherent lifts.

The current local completion metric is phase-isotropic, the physical curvature readout is unreturned, and the positive HCMR branch pair remains conjugate. The preparation law therefore cannot decide among the physically different CKP phase readings.

27. Exact scope of the phase refusal

Theorem 8 does not prove that probabilities can never contain phase information. Interference probabilities plainly can. Nor does it prove that the full VERSF action can never derive a phase assignment.

It proves the narrower statement needed here:

The present fixed marked stochastic law, its ordered-record likelihoods, posterior measures, Fisher objects and positive quadratic pullbacks do not select a unique coherent source lift beyond transformations invisible to all declared record probabilities.

A future amplitude-level action or independently derived interference family may distinguish the surviving coherent lifts. The current probability package does not contain that additional return.

28. Phase release condition

A phase pass requires one frozen identity of the form

$$\mathcal{A}_{(\rho,e)}^{(n,k)} = |\mathcal{A}_{(\rho,e)}^{(n,k)}|\, e^{i\varphi_{(\rho,e)}^{(n,k)}},$$

with:

1. φ returned before downstream comparison;
2. a clearly stated gauge quotient under allowed mark rephasings and basis changes;
3. regulator convergence;
4. branch covariance or a nonzero branch gap;
5. a declared interference or holonomy observable that reads a gauge-invariant phase difference;
6. no phase selected from CKM, PMNS or strong-phase targets.

The conditional existence of the U(1) catalogue is not sufficient. The original relative-phase gate fails until the assignment and its readout are returned.

Part VII — Microscopic execution and full-carrier boundary

29. Imported microscopic preparation execution

HCMR-XI-2 moved the record-sufficient law into the actual PFDMI matrices. Its principal returns were:

Object	Return
Microscopic carrier	$\mathbb{C}^7 \otimes \mathbb{C}^{50}$, dimension 350
Marked operators	319
Kraus completeness residual	2.471e−14
Full marked probability normalisation	2.220e−16
Sequential state-update residual	5.678e−16
Probability-chain residual	1.388e−17
Copy-isometry residual	0
Wilson physical score	rank 72
Record-completed HCMR parent	rank 101, one normalisation null

These residuals certify that the preparation and record-update identities are implemented consistently in the frozen matrices. They do not, by themselves, establish primitive physical provenance.

30. Why this does not complete H_CMR

The same execution compared its source-native Wilson Fisher matrix with the HM4 gauge Hessian on the same 72-dimensional carrier. The best scaled comparison returned

$\varepsilon_{\text{gauge-shape}} = 0.993353598040$, $\cos_F = 0.115102690068$.

This was a failure of eigenstructure, not an overall coefficient: the Frobenius cosine is invariant under any positive rescaling of either form, so no adjustment of overall stiffness can raise the observed eleven-percent alignment.

A later structural instrument, HCMR-XI-3, reports an exact Fisher identity and a machine-zero gauge-shape match (residual 4.485e−16, Frobenius cosine 1.000000000000000). Under the reproduction rule of §4, that agreement is not yet a corroboration: the matrix Z used by the construction is on record as a Schur reduction of a gauge quadratic form, and if that form is the one the HM4 array stores, the pullback reconstructs the HM4 Hessian by construction. The existing firewall certifies that the HM4 array was not opened during construction; it does not certify that Z is independent of that array's contents. The settling condition is exact: Z is an independent return if and only if it is produced by a calculation that never differentiates, inverts or Schur-reduces the HM4 gauge quadratic form. Until one of the two derivation chains is exhibited as disjoint, the gauge-shape agreement remains graded a candidate reproduction, and the primitive-derivation reading remains conditional.

HCMR-XI-4 further narrows the neutral and charged amplitude alphabets, but it does not return the physical entropy costs or relative phases required here. The absolute action unit also remains open.

31. PFHBA and the prohibition on inverse completion

PFHBA-7 proves that the recurrent Fisher law can exactly support the 102-dimensional HCMR candidate at all four regulators, but the broadly typed lift family has dimension 34,152. Two exact lifts reproduce the same parent while giving nearly orthogonal marked responses.

Therefore:

- exact $H = J^T I J$ is an embeddability theorem;
- it is not a derivation of J;
- no choice of a convenient lift may be used to populate ΔS or the phase carrier;
- the preparation law must be differentiated forward from the marked action.

32. HCMR-MR1 boundary

HCMR-MR1 supplies a stable four-regulator candidate but refuses physical admission because the oriented branch is not selected, the full history provenance is conditional, P_Y is nonselective, the independent CY3′ route fails and Z_{comp} is absent.

HCMR-P1 removes part of the preparation ambiguity. It does not repair these independent gates.

Part VIII — Main theorem, verdict and programme consequence

33. HCMR-P1 theorem

Theorem HCMR-P1 — Event-level preparation, extension-information and realised directing-state theorem. Fix the frozen source stack and premises P0–P15 together with P14R. Then:

1. **Record likelihood — exact given the frozen instrument.** Every fully operator-resolved record ρ has instrument-native likelihood $L_\rho(\eta) = \|M_\rho \eta\|^2$. The physically retained coarse record ϱ has the instrument-level likelihood $L_\varrho(\eta) = \mathrm{Tr}[\mathscr{J}_\varrho(|\eta\rangle\langle\eta|)]$ of §10A, of which the Kraus-product form is the operator-resolved special case.
2. **Extension information — exact.** At the retained grain, $\Delta I_\varrho(\eta) = -\ln L_\varrho(\eta)$; at the operator-resolved refinement, $\Delta I_\rho(\eta) = -\ln L_\rho(\eta)$.

3. **Likelihood update — inherited and independently checked at history level.** The prior probability stack fixes the unit exponent for one event. At record level, predictive consistency, continuity, range richness with overlap and measure separation force the reweighting function to be $F(L_\varrho) = L_\varrho$ at the retained grain (Corollary 2.1) and $F(L_\rho) = L_\rho$ at the operator-resolved refinement. An ordered record therefore cannot introduce a second exponent, effective temperature or Gibbs power at either grain.
4. **Conditioned directing measures — conditional theorem pass.** At the retained grain — the physically primary one — the record forces $\mu_\varrho^{in} = Z_\varrho^{(-1)} L_\varrho \mu_{FS}$, $\mu_\varrho^{out} = (\eta \mapsto \sigma_\varrho(\eta))^* \mu_\varrho^{in}$, *a posterior over preparations and an ensemble of density operators, with mean state* $\mathcal{J}_\varrho(I) / Tr[\mathcal{J}_\varrho(I)]$ *(Theorem 3A). The operator-resolved refinement is* $\mu_\rho^{in} = Z_\rho^{(-1)} L_\rho \mu_{FS}$, $\mu_\rho^{out} = (T_\rho)^* \mu_\rho^{in}$, with average post-record state $M_\rho M_\rho^\dagger / Tr(M_\rho M_\rho^\dagger)$.
5. **Comparison directing law — conditional theorem pass.** At the retained grain, $\nu_\varrho = p_* \mu_\varrho^{out}$ with p a function of density operators; the operator-resolved refinement is $\nu_\rho = p_* \mu_\rho^{out}$ on the projective ensemble.
6. **Realised state — unique retained-record density-state pass; pure-ray return only for operator-resolved trajectories.** Given the realised incoming state, a retained record determines one unique conditioned density operator; when the incoming state is known only statistically, it determines one unique posterior ensemble and one unique mean density state (Theorem 3A); the record label alone determines neither. A unique projective ray is returned only when an operator-resolved physical mark occurs on a realised pure incoming state, in which case the normalised Kraus update supplies it up to declared physical equivalence; when the incoming state is distributed, the record determines the post-record ensemble rather than a single ray.
7. **Deterministic preselection — closed negatively and unnecessary.** The law is unique; the individual event may remain stochastic.
8. **Regulator and branch statement — partial pass.** The algebra is regulator-local and branch covariant; imported executions support four-level record integration, but one fully selected source instrument has not yet passed the complete n = 3–6 programme.
9. **Physical irreversible costs — not returned.** Extension information and a conditional D36 entropy branch do not supply the unique microscopic ΔS.
10. **Coherent phase assignment — not returned.** The U(1) phase catalogue is inherited conditionally, but the source-level path/branch assignment and its interference or holonomy readout are absent. The fixed marked stochastic law is invariant under global rephasing of each resolved mark.
11. **Complete physical H_CMR — not admitted.** Preparation-law closure does not repair the full-carrier provenance, physical readout, independent descent, orientation and normalisation gates.

34. Original contract grade

The original HCMR-P1 contract required all of

$\{ \Delta I_\rho, \nu_\rho, \eta_{realised}$ or $z_{realised}, \Delta S$, relative phases $\}$

from one action at n = 3–6.

The returned grade is:

Required object	HCMR-P1 result
$\Delta I\_\rho(\eta)$	PASS — exact record likelihood
$\nu\_\rho(dp)$	PASS conditionally — unique pushforward law
realised η or z	Retained coarse record: unique conditioned density state given the incoming state — PASS; unique pure ray for operator-resolved trajectories only; deterministic preselection rejected
irreversible ΔS	FAIL / NOT IDENTIFIABLE from current source
coherent relative phases	FAIL / NOT RETURNED — U(1) catalogue inherited conditionally, but source-level assignment and readout remain open
full n = 3–6 one-action certificate	PARTIAL / NOT COMPLETE

Therefore:

HCMR-P1 ORIGINAL ALL-OBJECT PASS: NO

but

EVENT-LEVEL PREPARATION LAW AND MARKED-STATE RETURN: PASS CONDITIONALLY

and

PHYSICAL COST–PHASE COMPLETION: NOT RETURNED BY THE CURRENT FIXED STOCHASTIC LAYER.

35. Consequence for the old Standard Model gates

- **SM-4 ordered readout:** advanced from an unspecified readback to an explicit record-conditioned law; physical amplitude phase remains open.
- **SM-12 occupancy:** the law and event-state map are typed; realised topology still depends on the directing law and the physical mark history.
- **SM-13 frame firewall:** deterministic preparation is excluded; branch and amplitude phase require an orientation-sensitive source.
- **SM-22 flavour preparation:** the event law is no longer a free Gibbs family, but the generation-sensitive coupling and CKM axle installation remain open.
- **SM-26 whole-action provenance:** not closed; the full source must still reproduce all sectors independently.

36. Consequence for charged flavour

The paper does not admit the CKP quadratic axle. It improves the upstream preparation status by lifting the inherited single-event law to an ordered record, eliminating new record-conditioned tilts and clarifying how a realised mark returns a state. It does not return the role-sensitive source-level phase, its interference readout or the generation-sensitive completion coupling. CKP-2.4 therefore remains correctly graded: the quadratic form is exact, while its physical coefficient, readout and phase are open.

37. What should be calculated next

The first-entry and record-copy components of F2F-1 (§1D) have been executed; what stands first in the queue is the remainder — the derivation of the renewal architecture from the master action (D12a), the absorbing-ledger invariance proof (D12b), and the regulator/branch sweep of $r(\mathcal{N}\_R)$. Beyond that, the successor calculation is not another posterior derivation. It is an amplitude-and-cost execution:

1. derive the microscopic reverse law and branch-resolved entropy production;
2. return the physical clock and affinity normalisation entering that law;
3. derive a coherent marked-amplitude decomposition whose relative phases survive all gauge equivalences;
4. identify the interference or comparison-holonomy observable that reads those phases;
5. execute the complete source at $n = 3$–6 and both branches;
6. only after freezing, compare the returned cost and phase with charged and neutral consumers.

This work may be combined with PFDMI-R1 only if the source-jet, cost and phase pass conditions remain separately reported.

Falsifier ledger

F1 — Posterior insertion. A record-conditioned coefficient not equal to a record multiplicity or a microscopic action return is inserted.

F2 — Exponent ambiguity hidden. The unit exponent is claimed from composition or associativity alone — the record-pair cocycle $C(\rho_1, \rho_2)$ silently trivialised — instead of through the predictive-consistency and measure-separation proof of Theorem 2 with its range-richness-with-overlap hypothesis.

F3 — Deterministic-outcome overclaim. One sampled η is presented as a pre-event deterministic prediction.

F4 — $\mathbb{C}^{49}/\mathbb{C}^{50}$ conflation. The twelve-component Dirichlet theorem is quoted as a full $\mathbb{C}^{50}$ carrier theorem without resolving the trivial-singlet component.

F5 — Information/entropy conflation. $-\ln L$ is labelled physical thermodynamic entropy or action without the reverse law, clock and normalisation.

F6 — Cost inversion. ΔS is chosen to reproduce a desired distribution and then described as derived.

F7 — Fixed-law phase overclaim. A unique coherent source lift is claimed from the present fixed probabilities, record likelihoods, Fisher matrix or positive Hessian without an independently derived interference or holonomy readout.

F8 — Kraus-list gauge confusion. A unitary change of unresolved Kraus representation is treated as a new physical marked law.

F9 — Covariance called selection. Exact conjugate-branch covariance is presented as an oriented branch prediction.

F10 — Inverse Fisher provenance. An exact pullback of a supplied HCMR matrix is presented as the primitive field-to-mark derivative.

F11 — Regulator rhetoric. Stagewise or consumer convergence is presented as the complete source-action $n = 3$–6 certificate.

F12 — Downstream selection. CKM, PMNS or other observed targets are used to choose a preparation cost, phase, branch or readout.

F13 — Reproduction cited as corroboration. A machine-zero agreement between two quantities is cited as evidence without exhibiting disjoint derivation chains for the two quantities. Certifying that one array was unopened while a quantity derived from it was used does not discharge the burden.

F14 — Posterior/ensemble conflation. The initial-state posterior μ^{in} is quoted as the distribution of the current post-record state, or a comparison functional whose argument is the current state is evaluated against μ^{in}, without the record-map pushforward.

F15 — Exchangeability suppressed. The Dirichlet component-count posterior is quoted for a generic sequential marked record without the P15 reduction.

F16 — Ergodic trapping imported as theorem. Probability-one trapping under generic ergodic or mixing dynamics is cited as established without the explicit dynamics, invariant measure and hitting argument.

F17 — Primitive rate insertion. A Poisson rate, hazard per unit physical time or time-dependent Gibbs law is installed before physical time has been derived from commitment accumulation.

F18 — Saturation shortcut. Observable saturation is cited to bypass constructing the actual event instrument, despite the maximality argument's dependence on the prior Fold-necessity chain.

F19 — Partition fitted downstream. The open/terminal mark classification of §1D is chosen using desired downstream physics rather than derived from closure structure and terminal-record equivalence.

Debt ledger

Debt	Required return	Current grade
D1	Reconcile the 49-dimensional preparation carrier with the full $\mathbb{C}^{50}$ internal carrier	OPEN
D2	Derive Π_mark^(n,k) — the map from realised minimal facts and their terminal-record classes to the complete marked instrument (record labels, operators, waiting-time laws) — uniquely from the marked Fold action at n = 3–6 and both branches, without downstream target access	OPEN
D3	Derive the physical reverse process and stochastic entropy production	OPEN
D4	Select the physical clock, affinity normalisation and attempt rate	OPEN
D5	Return branch-resolved physical irreversible costs ΔS_e from the action — not imported as k_B ln 2 per Fold or fitted to a target law	OPEN
D6	Return a coherent amplitude-level relative-phase carrier	OPEN
D7	Derive an interference or holonomy readout for that phase	OPEN
D8	Break or quotient the exact conjugate branch pair physically	OPEN
D9	Settle the independence of the XI-3 gauge form and XI-4 neutral selector	OPEN
D10	Complete the independent source-to-HCMR descent and full regulator certificate	OPEN

Debt	Required return	Current grade
D11	Execute F2F-1: the mark partition, the spectral test and the first-entry effects	SUBSTANTIALLY DISCHARGED (4 Aug 2026): partition executed from the implemented terminal-record architecture, $r(\mathcal{N}\_R) = 0.2003 < 1$ computed, first-entry effects constructed exactly in Born trace form (construction identity, not independent corroboration); the regulator/branch sweep of the radius remains outstanding
D12a	Renewal provenance: derive the record-copy isometry and ledger architecture from the master action (the report's D-PF33)	OPEN
D12b	Absorbing-ledger invariance: prove that every later admissible evolution preserves each terminal record sector, with zero transition amplitude between inequivalent ledger labels ($\varepsilon\_leak = 0$ across the admissible channel family)	OPEN

Appendix A — Proof notes

A.1 Power-law corollary under a trivial cocycle

Corollary. Let F be positive and continuous on (0, 1] and multiplicative — $F(x)F(y) = F(xy)$ — on a set of pairs whose values generate a dense subinterval of (0, 1]. Then $F(x) = x^\beta$ for some real β.

Proof. Write $x = e^t$ and $g(t) = \ln F(e^t)$; multiplicativity becomes the additive Cauchy equation $g(t + s) = g(t) + g(s)$ on a dense generating subset of an interval of $\mathbb{R}_-$. A continuous solution extends uniquely to the interval and is linear, $g(t) = \beta t$; hence $F(x) = x^\beta$. ■

Scope note. Sequential associativity of normalised updates supplies multiplicativity only up to a record-pair cocycle, $F(x)F(y) = C(\rho_1, \rho_2)F(xy)$, and evaluating on trivial second records fixes only $C(\rho_1, \text{trivial}) = 1$. Multiplicativity as assumed above therefore corresponds to a universal-cocycle-triviality hypothesis that Theorem 2 neither needs nor assumes: the theorem's proof runs directly through predictive consistency and measure separation, and this corollary records the power-law route only for comparison with older presentations.

A.2 Why predictive consistency fixes β

The proof of Theorem 2 does not require a continuum of experimental states. It is enough that the preparation carrier admits one nonconstant likelihood p and enough subsequent event functions q to separate probability measures — the content of P14. The marked PFDMI carrier has a full-rank 72-dimensional local physical score, which supports local non-degeneracy but is not by itself a proof of global measure separation. Without a measure-determining family the theorem's displayed equality constrains nothing; this is why P14 remains a named premise until informational completeness is demonstrated.

A.3 Global phase and projective state

The state z and $e^{i\theta} z$ are one projective point. Relative phases between physically distinct coherent components are not removed by this equivalence. They remain open here because the present fixed marked law does not uniquely determine the coherent lift or provide the interference/holonomy family needed to read its gauge-invariant differences.

Appendix B — Numerical law-level certificate

The companion JSON file performs generic checks on an independently generated finite completely positive instrument. It is not a VERSF physical source execution.

Check	Return
Kraus completeness	2.20e−15
Ordered-record chain identity	3.47e−18
Independent mark-phase invariance	1.73e−18
Conjugate-branch probability covariance	0
Posterior associativity	1.63e−19
Exponent scan minimiser	$\beta = 1.0000$
Twelve-component posterior-mean Monte Carlo residual	6.89e−5

The exact theorems, not these numerical values, carry the proof.

Appendix C — Imported VERSF machine certificate

The following returns are imported from the frozen HCMR-XI-2 execution and later audit.

Item	Value
Marked carrier	$\mathbb{C}^7 \otimes \mathbb{C}^{50}$
Mark count	319
Completeness residual	2.471e−14
RSU chain residual	1.388e−17
Copy isometry	machine zero, residual 0.0 at declared precision
Wilson physical score	rank 72
Record-completed parent	rank 101, one normalisation null
Four-level record minimum eigenvalues	1.7593e−3, 1.8037e−3, 1.8150e−3, 1.8179e−3
XI-2 same-action gauge shape	FAIL, residual 0.99335
XI-3 reported gauge shape	4.485e−16, independence still audited under F13

Appendix D — Source-currency registry

Source	Role in HCMR-P1	Currency note
Probability as Consistency	Inherited single-event Born law, $\Delta I_i = -\ln p_i$, unit exponent	Controlling single-event probability source; multi-time histories explicitly left to companion work
Probability as Admissible Measure on the VERSF Operational Hilbert Geometry	Conditional operational-measure uniqueness	Controlling support source; inherits operational Hilbert geometry and one cross-channel bridge
Operational Distinguishability Geometry as the Primitive Probability Object	ODG-invariance route to the Born measure	Controlling conceptual support source; substrate origin of ODG remains open
The Double Square Rule	Pairwise-kernel route to the quadratic core	Consumed only with the connection-construction correction below
The Connection Construction and the Shared Phase Obligation	Corrects arg det(dT) as a phase construction and isolates the phase-assignment debt	Controlling correction to the earlier phase provenance claim
Physical Necessity of Quantum Probability Structure	Admissibility arguments for pairwise selection, equal weights, $n = 1$, factorisation and $p = 2$	Supporting structural source; its phase-continuity layer is superseded in currency by the dedicated phase paper
Why Finite Distinguishability Forces Continuous U(1) Phase	Conditional phase-catalogue theorem	Fixes the admissible catalogue; path-by-path holonomy assignment remains open

Source	Role in HCMR-P1	Currency note
Born Rule as Entropic Unfolding — A First-Principles Derivation	Apparatus-level cost model and experimental definition of ΔS_i	Cost target/test model only; Maximum Caliber is an inference principle, not primitive dynamics
The Primitive Field-Dependent Marked Instrument Programme in VERSF: Identity-Field No-Go, Typed-Carrier Construction and Native Score Closure (PFDMI-1)	Marked source, roles, score and regulator discipline	Website PDF uploaded 3 August 2026
The Four-Regulator Commitment-Maintenance Execution and Physical-Admission No-Go Theorem in VERSF (HCMR-MR1)	Four-level consumer and admission boundary	Website PDF uploaded 3 August 2026
The Primitive Full-Carrier Provenance, Recurrent Fisher Pullback, Source-Projected Bath Factorisation and Conditional Doob–Kraus Descent Theorem in VERSF (PFHBA-7)	Capacity/non-identifiability and coherent-lift boundary	Website PDF uploaded 3 August 2026
The D36 Clock-Convention, Reproducibility and Manifest-Currency Theorem in VERSF (D36-R1)	Clock and entropy-convention typing	Website PDF uploaded 3 August 2026
The Absolute-Scale, Action-Normalisation and Closure-Clock Conditional Theorem in VERSF (ASAC-1)	Action/cost normalisation boundary	Website PDF uploaded 3 August 2026
Explicit Construction and Spectral Analysis of the K=7 Closure-Transition Graph	Wheel and harmonic preparation carrier	Website PDF uploaded 3 August 2026
The Conditional Derivation of Charged Flavour and the Unique Lowest-Order Quadratic CP Axle in VERSF (CKP-2.4 / RRHF-FD1)	Sealed downstream consequence and later audit of HCMR-XI results	Website PDF uploaded 3 August 2026
VERSF Standard Model Derivation Audit — August 2026	HCMR-P1 contract and programme ordering	Current audit supplied in conversation/library
Consolidated GSJB preparation sequence	Haar/Gibbs typing, first-direction and cost no-goes	Latest consolidated source used for prior-result currency
The Fold and the Record	Structural commitment event: threshold crossing fixes the loop operator and	Load-bearing for P0 and §1B; its "if and only if $\beta_1 \geq 1$" phrasing is used here only as

Source	Role in HCMR-P1	Currency note
	writes the Fold into the committed record field	shorthand for the complete activated trapping condition
Topological Threshold for Fact Formation	$\beta_1 \geq 1$ as necessary capacity condition for locally constructible trapping	Load-bearing at necessary-condition strength only
The Uniqueness of the Minimal Distinction	Fold as the unique minimal one-bit operational distinction	Supports the primitive event alphabet; does not force binary state spaces
Closure-orientation analysis (U = ABC bridge witness)	Closure-generated orthogonal Fold projectors $P_+ = UU^\dagger$, $P_- = U^\dagger U$	Existence witness only; the actual VERSF operations, carrier and ranges are debt D2
The Adjoint-Removal Positivity and Microcausality Theorem (QC-1)	Terminal-record physical-equivalence quotient defining event classes	Load-bearing for P1; execution on the actual carrier is part of the construction to be proved
The W_7 Fold Carrier and the Readout Domain	Fact / tally / ordered-history typing; tallies carry no reversal-odd information	Load-bearing for the ordered-record framing and the P15 caveat
From Overdetermination to Inevitability	Inherited Hilbert/Born/trace stack; Born does not fix the post-measurement rule	Load-bearing for §5A's division of labour
The Price of Copies	Global U(1) versus sector-resolved relative phase boundary	Confirms the §23A phase grades
Fold, Fact, Planck, and Closure	Event ontology: Fold ≠ minimal fact ≠ Planck-certified fact ≠ ξ-coherent network	Load-bearing for P0 and §1C; its probability-one ergodic trapping claim is NOT imported (F16)
The Fold Saturates Observable Physics	Observables as commitment outcomes or functionals of ordered commitment sequences	Supports the record domain; maximality depends on the prior necessity chain, so no saturation shortcut (F18)
From Meta-Principles to Physical Uniqueness	Record persistence, partial order, internal closure without external continuous parameters, compositional consistency	Falsification frame only; constructs no marks, probabilities or phases
Two Kinds of Time	Ordering parameter versus commitment-accumulated physical time	Load-bearing for the §1C ordering discipline; its rate–entropy formula is downstream, not primitive

Source	Role in HCMR-P1	Currency note
Structural Conditions, Physical Identification, and Robustness in the One-Fold Framework	Structural theorem / conditional derivation / physical identification tiers	Grading discipline aligned with §4
Area Scaling of TPB-Realized Information	Boundary mutual-information capacity check for realised records	Secondary record-admission test; proofs presently sketches, no event probabilities
From Paths to Folds	Local-phase model with renormalisation-based continuous-phase emergence	QUARANTINED as phase provenance; example to improve upon only
The Tick Race analysis	First-tick selection with proportional amplitude-squared hazards	Intuition only, not load-bearing; §1D derives the first-entry law without its rate assumptions
F2F-1 calculation report and test report (4 August 2026)	Fold-to-fact record-promotion execution on the frozen PFDMI-EX2E/EX2F matrices	Load-bearing for §1D's execution results; sourced without downstream target access
Gravity and cosmology consumer papers	Downstream tests of memory, continuum fields and stress-energy	Consumers only; cannot manufacture primitive ΔS_e; extended paper and its shorter companion count as one source
One Fold manuscript and Void/Fold synthesis	Provenance records	Later dedicated audited papers control wherever they overlap
HCMR-XI-1 and HCMR-XI-2 calculation reports	RSU/CPR law and microscopic execution	Internal calculation reports, not presented as website paper titles
Pre-Entropic and Entropic Domains, *Entropy-Momentum Foundations* and related early framework papers	Historical motivation only	Not load-bearing sources for the theorem grades in this paper

Appendix E — Reproducibility package specification

The F2F-1 execution is the paper's most valuable computational result, and the reproduction-versus-corroboration rule of §4 binds the paper's own packages as much as anyone else's. The publication package for F2F-1 and for every successor execution must therefore include:

1. the exact marked operators (all 319) or an unambiguous construction script that regenerates them;
2. array and source hashes for every frozen input;
3. the mark-partition code implementing the terminal-record classification;
4. the superoperator construction for $\mathcal{N}$_R, $\mathcal{J}$_a and $\mathcal{T}$;
5. the spectral-radius computation with method and tolerances;
6. the first-entry-effect computation and its completeness, positivity and factorisation checks;
7. declared tolerances and floating-point precision for every reported residual;
8. an independent test script that reruns all checks from the frozen inputs alone;
9. a compact machine-readable results manifest mirroring every number quoted in §1D.

Until this package accompanies the F2F-1 report, its results are graded executed but not yet independently rerunnable, and citations of them should carry that qualifier.

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25. K. Taylor, *The W_7 Fold Carrier and the Readout Domain*.
26. K. Taylor, *From Overdetermination to Inevitability*.
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34. K. Taylor, *From Paths to Folds*.
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36. F2F-1 calculation report and *F2F-1 — Fold-to-Fact Record-Promotion and First-Entry Test*, 4 August 2026.

External literature

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Final scientific verdict

Object	Grade
Single-event Born and extension law	**INHERITED CONDITIONAL THEOREM**
Ordered-record likelihood	**EXACT GIVEN THE FROZEN INSTRUMENT**
Record extension information	**EXACT GIVEN THE FROZEN INSTRUMENT**
Likelihood exponent $\beta = 1$	**INHERITED · CHECKED AT HISTORY LEVEL UNDER RANGE-RICHNESS AND SEPARATION**
Record-conditioned initial-state posterior	**CONDITIONAL PASS**
Post-record ensemble and average state	**CONDITIONAL PASS · CLOSED FORM EXACT**
Comparison directing law	**CONDITIONAL PASS**
Retained-record conditioned density state	**UNIQUE GIVEN THE INCOMING STATE — CONDITIONAL PASS (Theorem 3A)**
Pure-ray realised state	**OPERATOR-RESOLVED TRAJECTORIES ONLY**
Fold-to-fact promotion	**F2F-1A FIRST-ENTRY PASS · F2F-1B RECORD-COPY PASS · F2F-1C PERSISTENCE CONDITIONAL (D12b; architecture D12a)**
Deterministic pre-event vector	**NOT REQUIRED / CLOSED NEGATIVELY**
Four-regulator complete source certificate	**PARTIAL / OPEN**
Physical irreversible costs	**NOT RETURNED**
U(1) phase catalogue	**INHERITED CONDITIONAL PASS**
Source-level coherent phase assignment and readout	**NOT RETURNED**
Complete physical H_CMR	**NOT ADMITTED**

The attempt therefore succeeds in lifting the inherited single-event probability law to one retained ordered-record likelihood, one record-conditioned posterior over incoming preparations, one conditioned ensemble of outgoing density states with an exact mean, and — only at the fully operator-resolved grain — one stochastic projective post-state. Beneath it, the first-entry and record-copy components of the Fold-to-fact programme have been executed: the partition forced by the implemented record architecture, the strict spectral inequality and the complete POVM-form first-entry effects constructed from the frozen instrument all hold on the actual matrices as reported frozen-matrix executions, not independently rerunnable until the complete Appendix E reproduction package is supplied. Persistent-fact promotion itself remains conditional: absorbing-ledger invariance is unproved and the renewal architecture is not yet derived from the master action — the ledger's two newest debts. It does not derive the Born rule anew, and it does not promote the frozen marked instrument to primitive-action status. Physical irreversible costs are separate action returns. The admissible U(1) catalogue is conditionally inherited, but the path-by-path or branch-by-branch phase assignment and the comparison observable that reads it remain open. The next calculation must derive those objects directly, together with the complete source provenance, or accept that the physical HCMR boundary remains open.