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VII-E-ST: Observation boundaries and finite hybrid feedback on a prescribed conical spacetime

Record compatibility, residual separation, certified markings, and causal transport

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Abstract

We construct a supported local spacetime adaptation of the observation-boundary contract of VII-E and the finite hybrid-channel contract of VII-G. The two contracts are proved independently within one laboratory on I-B's prescribed conical Lorentzian product. For the observation boundary, we prove the effect-pullback criterion, its reference-stable form, the exact sharp-measurement coherence criterion, and a qubit separation of trace distance 1/2 between ideal residual targets with identical records. For hybrid evolution, we prove a complete branch representation, history-sensitive observation closure, spectator consistency, and the exact recovery–constant-complement criterion. An informative classical record consequently excludes recovery of every unknown quantum input, even when the declared residual is also available.

The additional contribution is an end-to-end finite observation package that keeps these distinctions visible in supplied spacetime. We provide a compactly supported 3 + 1-dimensional lift of a four-face transverse adjacency exchange, an exact guarded reversible encoding, and a separately constructed qubit instrument selecting strictly ordered slices without changing the conical metric. A two-step specialization has two histories with the same terminal slice but different conditional residuals. After coarse aggregation, the record remains unchanged while two complete residual targets have the exact half-diamond gap $4(1 - 1/\sqrt{2})/25$. An explicit residual audit enlarges

the required input observation space from the diagonal algebra to the full qubit algebra.

A destructive finite clock, complete-channel approximation bounds, and a causal route for both payload and classical control complete the local Grade S construction. The package may serve as a precise testbed for distinguishing record-level claims from instrument-level claims in geometric feedback models. The channel and recovery principles themselves are established finite-dimensional facts; the claimed contribution is their supported assembly and the explicit certificates and separations. No metric emergence, gravitational dynamics, field instrument, radiative coefficient, or quantum Ward identity is constructed.

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par **Two contracts, one laboratory** par The VII-E contract concerns what a declared observation boundary can distinguish. The VII-G contract concerns a state-independent finite completely positive hybrid evolution. Neither contract derives the cone, and neither is a premise supplying the other.

The four-face exchange is an illustration, not an assumption of the general channel theorems. Matter-controlled slicing is not matter-driven gravitational dynamics. par

Introduction, provenance, and the Enter philosophy

A probability law for a classical record does not specify the selective transformation of the surviving quantum system. Likewise, preservation of one named expectation does not imply recovery of every input. These distinctions are basic to the instrument formulation of quantum measurement [1, 2, 3].

This paper places two source contracts in a common supported spacetime presentation:

1. VII-E's observation boundary, residual separation, spectator condition, and four-face certificate [4];

2. VII-G's finite direct-sum channel, branchwise observation criterion, recovery obstruction, and ordered-slice model [5]. Their mathematical statements are reproved below. Citation does not replace a proof, identify two models, or provide missing geometric dynamics.

Enter and its spacetime interface

In Cheung's Enter calculus, runtime quantum names are access rights to tensor factors. Destructive computational-basis readout consumes the measured names and returns classical records. Unmeasured factors can remain available [6, 7]. The characterization of the Born strategy in Manuscript I concerns its explicitly specified class and five requirements. We use a specified Born instrument and prove its channel formula; we do not rederive that characterization or extend it to quantum fields.

The accompanying philosophy distinguishes:

destructive readout, quantum-return recovery, physical implementation, geometric interpretation.

An output type does not determine the fate of all physical degrees of freedom used by an apparatus, and a channel does not specify a thermal machine [8].

I-B supplies a finite operational interface on a prescribed conical spacetime [9]. A finite clock can be calibrated to its time coordinate, destructively read, and used for causal control. The geometric time axis, defect worldsheet, and future cone remain after that clock is consumed.

Definition (Local Grade S). A local Grade S observation package specifies and proves:

1. a prescribed Lorentzian background and a supported regular laboratory;

2. named observation and evolution contracts, with their mathematical domains;

3. a complete finite destructive-clock instrument;

4. a declared finite encoding of labels and selected residual observations;

5. reference-preserving transport with complete dependencies embedded in the supplied causal relation. Grade E would additionally require a construction deriving the geometric data from operational records. It is not claimed.

Novelty boundary. Direct-sum state spaces, Kraus representations, deferred readout, and exact quantum error correction are not new general theorems [2, 10, 11]. The contribution here is a supported assembly with explicit geometric and finite-channel witnesses, including the equal-slice residual separation proved in Section .

Prescribed conical geometry and supported presentation

Fix

$$c > 0, \qquad 0 < \mu < 2\pi, \qquad \alpha = 1 - \frac{\mu}{2\pi}.$$

The physical smooth background is

$$M = \mathbb{R}_T \times C_\mu^\circ \times \mathbb{R}_z, \qquad \bar{g} = -c^2 \mathrm{d}T^2 + \mathrm{d}r^2 + \alpha^2 r^2 \mathrm{d}\varphi^2 + \mathrm{d}z^2,$$

where $r > 0$ and φ is periodic with period 2π. Its completion has the conical worldsheet

$$\mathscr{W} = \mathbb{R}_T \times \{o\} \times \mathbb{R}_z.$$

No smooth Einstein tensor is assigned on $\mathscr{W}$.

Proposition (Geometry and local rods). *The metric has signature* $(-,+,+,+)$. *Choose* ∂_T *as future directed. A nonzero future-causal vector* $a\partial_T + w$ *satisfies*

$$a > 0, \qquad |w|_{\text{spatial}} \le ca.$$

Static observers have proper time $\mathrm{d}\tau = \mathrm{d}T$*, so the proper-time lapse is one.*

On a sufficiently small lifted angular interval,

$$\mathrm{dev}\,(T, r, \varphi, z) = (c(T - T_*), r\cos(\alpha\varphi), r\sin(\alpha\varphi), z)$$

is a local isometry to Minkowski space. Its spatial coordinates give three local rods.

In the inverse-deck convention the peripheral affine gluing is

$$J_\mu = (\mathrm{diag}\,(1, R(\mu), 1), 0).$$

It has neither time nor axial translation.

Proof. The signature and causal inequality follow from the diagonal metric. Setting $w = 0$ proves the proper-time statement. The local-isometry identity is

$$\mathrm{d}x^2 + \mathrm{d}y^2 = \mathrm{d}r^2 + \alpha^2 r^2 \mathrm{d}\varphi^2.$$

A positive angular lift around the apex advances through $2\pi - \mu$; the inverse deck map closes it by rotation through μ. Its time and axial coordinates do not change.

Proposition (Failure of global hyperbolicity). *The regular product M is not globally hyperbolic.*

Proof. Fix $r_0 > 0$, an angle, and $z = 0$. Let p, q have that spatial position and times $-2r_0/c$ and $2r_0/c$. For $r_n \mathrm{downarrow}\, 0$, the events $(0, r_n, \varphi, 0)$ lie in $J^+(p) \cap J^-(q)$, by radial causal travel. They have no convergent subsequence in M. Thus this causal diamond is not compact.

Definition (Supported laboratory). A supported presentation consists of:

1. a regular developing chart and a relatively compact laboratory region with closure disjoint from $\mathscr{W}$;

2. compact spatial collars, finite marked cells, and compactly supported tests used by the declared observations;

3. finite quantum and classical registers, their locations, and every controller variable inspected by an operation;

4. a finite schedule with explicit input and output ports and no undeclared incoming boundary inputs. Any

background exterior labels are fixed metadata. No global Cauchy theorem, Green operator, or intrinsic conical field theory is part of this presentation.

All matrix theorems below are independent of a field equation. Developed charts, polygonal markings, and collars pull back through the stated local isometry. They are not declarations that the physical spacetime is global Minkowski space.

Contract E: readout, records, and residuals

For a finite-dimensional Hilbert space H, write $\mathscr{B}(H)$ for its operators. A channel is a completely positive, trace-preserving linear map. Adjoint maps use the pairing

$$\operatorname{Tr}(B\Phi(X)) = \operatorname{Tr}(\Phi^{*}(B)X).$$

We use

$$d_{\mathrm{tr}}(\rho,\sigma) = \frac{1}{2}\|\rho-\sigma\|_{1}, \qquad d_{\diamond}(\Phi,\Psi) = \frac{1}{2}\|\Phi-\Psi\|_{\diamond}.$$

A classical register is jointly block diagonal in its designated basis, including its correlations with all other registers. A diagonal marginal alone does not establish classicality.

Distinct interfaces

Definition (Destructive readout). Let S have computational basis $\{|z\rangle\}$, with unmeasured complement B. Put $D_z = \langle z|_S \otimes I_B$. Destructive readout is

$$\mathscr{M}_S(X) = \sum_z \operatorname{proj} z_R \otimes D_z X D_z^{\dagger}.$$

Its quantum output contains B, not S. The measured names are consumed.

Definition (Coherent recording). A fresh quantum carrier A can record the computational basis through

$$V(|z\rangle_S \otimes \psi_B) = |z\rangle_S|z\rangle_A \otimes \psi_B.$$

The channel $X \mapsto VXV^{\dagger}$ returns S, A, B. It is not destructive readout and not cloning: $V|+\rangle = (|00\rangle + |11\rangle)/\sqrt{2}$.

Definition (Represented instrument and external labels). With $P_z = \operatorname{proj} z_S \otimes I_B$, the represented nondestructive sharp instrument is

$$X \operatorname{longmapsto} \sum_z \operatorname{proj} z_R \otimes P_z X P_z.$$

It can be implemented using a fresh pointer and destructive readout of that pointer. The original S is returned.

An external geometric label is classical metadata describing a marking, chart, certificate, or location. A dictionary from measurement outcomes to such labels is an additional input. It is not one of the preceding quantum maps.

These distinctions prevent a represented residual qubit from being described as the return of a consumed quantum name.

Exact record and instrument criteria

Let $\{P_z\}$ be a finite projective resolution of I_H, let $q : Z \to W$ aggregate fine outcomes, and put

$$\Pi_w = \sum_{q(z) = w} P_z, \qquad \Delta_w(X) = \sum_{q(z) = w} P_z X P_z.$$

Let $T : \mathscr{B}(H) \to \mathscr{B}(K)$ be a channel and $\{\mathscr{I}_w\}_{w \in W}$ an instrument on K, with $E_w = \mathscr{I}_w^*(I_K)$. Compare

$$\mathscr{F}(X) = \sum_w \operatorname{proj} w_R \otimes T(\Delta_w(X)),$$

$$\mathscr{G}(X) = \sum_w \operatorname{proj} w_R \otimes \mathscr{I}_w(T(X)).$$

This comparison uses represented fine projections on a common input space. For a genuinely destructive protocol, any subsequent removal or identification of S must be included explicitly in T; it is not hidden in Δ_w.

Theorem (Effect pullback and the full residual criterion). *The record marginals of $\mathscr{F}$ and $\mathscr{G}$ agree for every input state if and only if*

$$T^*(E_w) = \Pi_w \qquad (w \in W).$$

For an observation space $\mathscr{O} \subseteq \mathscr{B}(K)$, agreement on every observable $\sum_w \operatorname{proj} w_R \otimes B_w$, $B_w \in \mathscr{O}$, is equivalent to

$$\sum_{q(z) = w} P_z T^*(B) P_z = T^*(\mathscr{I}_w^*(B)) \qquad (w \in W,\ B \in \mathscr{O}).$$

Both are equalities of linear maps on the declared observation spaces and remain valid after tensoring with any untouched reference identity.

Proof. The fine aggregated probability is

$$\mathrm{Tr}\, T(\Delta_w(\rho)) = \mathrm{Tr}\,(\rho \Pi_w),$$

while the coarse probability is $\mathrm{Tr}\,(\rho T^*(E_w))$. Equality against all states is equality of Hermitian effects.

The two w-conditioned expectations of B pull back to the two sides of . States separate Hermitian matrices, and complex linearity gives the general equality. Tensoring an equality of linear maps with a reference identity preserves it.

The following useful error formula is record-only and unassisted:

$$\sup_\rho d_{\mathrm{TV}}(p_\rho^{\mathscr{G}}, p_\rho^{\mathscr{F}}) = \max_{A \subseteq W} \Big\| \sum_{w \in A} (T^*(E_w) - \Pi_w) \Big\|_\infty .$$

Indeed, total variation is the maximum absolute difference on an outcome event. Interchange the finite maximum with the state supremum and use $\sup_\rho |\mathrm{Tr}\,(H\rho)| = \|H\|_\infty$ for Hermitian H. No equality with an assisted channel error is inferred.

Theorem (Residual obstruction and its robust form). *Record compatibility does not determine a residual instrument. There are ideal targets with identical records on every input whose outputs have trace distance* 1/2 *on one qubit input.*

If implemented versions have errors at most $\varepsilon_{\mathscr{F}}, \varepsilon_{\mathscr{G}}$ *on that input, their mutual distance is at least*

$$\frac{1}{2} - \varepsilon_{\mathscr{F}} - \varepsilon_{\mathscr{G}}.$$

Proof. Take $H = K = \mathbb{C}^2$, $T =$ id, the computational projectors, and one coarse outcome * with $\mathscr{I}_* =$ id. Both record effects are I. For $\rho_+ =$ proj +,

$$\mathscr{G}(\rho_+) = \mathrm{proj}\,*_R \otimes \rho_+, \qquad \mathscr{F}(\rho_+) = \mathrm{proj}\,*_R \otimes I_2/2.$$

Their difference has residual block

$$\frac{1}{2}X, \qquad X = \mathrm{kb}\,01 + \mathrm{kb}\,10,$$

with eigenvalues $1/2, -1/2$. Its trace norm is one. The robust bound is the triangle inequality.

The fine residual is realized by a pointer measurement returning the qubit; it is not primitive destructive readout of that qubit. Improving implementations cannot make distinct ideal target channels equal.

The exact sharp-measurement criterion

Suppose now that $\{E_w\}$ is projective and that the coarse instrument is Lüders:

$$\mathscr{I}_w(Y) = E_w Y E_w.$$

Define the two pinching maps

$$\mathscr{D}_{\Pi}(X) = \sum_w \Pi_w X \Pi_w, \qquad \mathscr{D}_P(X) = \sum_z P_z X P_z.$$

Lemma (Sharp-sector intertwining). *Under , every Kraus operator A_v of T satisfies*

$$E_w A_v = A_v \Pi_w.$$

Consequently

$$E_w T(X) E_v = T(\Pi_w X \Pi_v).$$

Proof. For $\psi \in \operatorname{im} \Pi_w$,

$$\sum_v \|(I - E_w) A_v \psi\|^2 = \langle \psi, T^*(I - E_w)\psi \rangle = 0.$$

Thus $A_v \Pi_w = E_w A_v \Pi_w$. For $\psi \in \ker \Pi_w$, the same calculation with E_w gives $E_w A_v \psi = 0$. Combine the two identities.

Theorem (Lüders compatibility). *Under the sharp hypotheses and record compatibility, the following are equivalent:*

1. $\mathscr{T} = \mathscr{G}$ *as complete recorded residual channels;*

2. $T\mathscr{D}_{\Pi} = T\mathscr{D}_{P}$*;*

3.

$$T(P_z X P_{z'}) = 0 \quad \text{whenever} z \neq z', \quad q(z) = q(z'), \quad X \in \mathscr{B}(H).$$

Thus full compatibility removes fine coherence within each coarse outcome. It need not remove coherence between different coarse outcomes.

Proof. By Lemma , the w-block of $\mathscr{G}(X)$ is $T(\Pi_w X \Pi_w)$. Its difference from the corresponding $\mathscr{F}$-block consists exactly of the fine off-diagonal corners within Π_w.

Summing the w-blocks gives (ii). Conversely, their output supports lie in orthogonal E_w-corners, so a zero sum makes each corner zero. Testing a single $P_z X P_{z'}$ proves necessity of (iii), and expansion into corners proves sufficiency.

For injective q, record compatibility already suffices. For one coarse outcome, the criterion is $T = T\mathscr{D}_P$. These are finite instrument identities, not field-instrument constructions.

Continuations, deferred readout, and spectator blindness

An observation space is a complex linear, adjoint-closed subspace containing the identity. It need not be an algebra. Write $\rho \equiv_{\mathscr{O}} \sigma$ when the two states agree against every element of $\mathscr{O}$.

Theorem (Compositional observation boundary). *For a channel Φ and observation spaces $\mathscr{O}_{\text{in}}, \mathscr{O}_{\text{out}}$, the following are equivalent:*

$$\rho \equiv_{\mathscr{O}_{\text{in}}} \sigma \Rightarrow \Phi(\rho) \equiv_{\mathscr{O}_{\text{out}}} \Phi(\sigma) \quad \text{for all states} \rho, \sigma,$$

and

$$\Phi^{*}(\mathscr{O}_{\text{out}}) \subseteq \mathscr{O}_{\text{in}}.$$

If this inclusion holds successively, compatible continuations preserve the declared agreement.

The reference-stable comparison of two extended inputs requires agreement on $\mathcal{O}_{\text{in}} \otimes \mathcal{B}(E)$*, not merely agreement of their unreferenced marginals.*

Proof. Sufficiency follows by pulling each output observable back. For necessity, take a Hermitian matrix H annihilating $\mathcal{O}_{\text{in}}$ under the trace pairing. Since $I \in \mathcal{O}_{\text{in}}$, $\operatorname{Tr} H = 0$. For a faithful state ω, both $\omega + \varepsilon H$ and $\omega - \varepsilon H$ are states for sufficiently small $\varepsilon > 0$. They agree on $\mathcal{O}_{\text{in}}$, hence

$$\operatorname{Tr}(\Phi^{*}(B)H) = 0 \quad (B = B^{\dagger} \in \mathcal{O}_{\text{out}}).$$

Finite-dimensional double orthogonal complementation gives the inclusion. Complex linearity completes the proof. Tensoring the inclusion proves the reference statement.

Theorem (Restricted deferred readout). *Let* $\{K_a\}$ *be a complete Kraus family and* $\{U_a\}$ *unitaries on the surviving system. Immediate pointer readout followed by* U_a*, and coherent controlled* U_a *followed by pointer readout, implement the same recorded instrument:*

$$X\text{longmapsto} \sum_{a} \operatorname{proj} a_R \otimes U_a K_a X K_a^{\dagger} U_a^{\dagger}.$$

This identity is complete under references.

For coherent copying of an original computational register, agreement with destructive readout holds only after both outputs are restricted to the same record–matter interface. A retained coherent carrier is not an additional common output.

Proof. The isometry

$$W\psi = \sum_{a} |a\rangle_A \otimes K_a \psi$$

satisfies $W^{\dagger}W = I$. Controlled feedback changes it to $\sum_a |a\rangle_A \otimes U_a K_a \psi$. Destructive readout of A gives . The immediate implementation has the same selective maps.

For computational copying, write $X = \sum_{z,z'} \text{kb}\, zz' \otimes X_{zz'}$. After coherent copying and label-preserving controlled operations, final readout and restriction to the common interface retain precisely the diagonal blocks X_{zz}. If both

copied measured registers are consumed, the duplicate classical outcome can be explicitly forgotten. No quantum return of a consumed register is involved.

A continuation that reads a phase-sensitive observable of the coherent carrier, or rewrites the controller using that carrier, is outside this equivalence. Deferred-measurement principles require the corresponding interface and control hypotheses [10]. They do not make remote control instantaneous or preserve an implementation's storage cost automatically.

The first spectator theorem

For Contract E, allow a classical configuration

$$(g, \Gamma, \rho, \mathrm{loc}, h),$$

where g is a geometric label, Γ the original accessible interface, h a controller state, and loc assigns abstract cell labels to names. A geometric rule changes declared geometric data and location labels. A matter rule applies a declared channel. A coupling rule may inspect a declared state functional $\rho|_{\mathcal{A}_v}$ and update a classical label.

Such a coupling function need not be affine. Contract E's equal-input comparison does not by itself make it a quantum channel.

Assumption (Complete spectator blindness). Adding inaccessible spectator names does not alter: the chosen rule or channel, exact guards, capacity checks, certificates, successor labels, controller updates, or transport of original names. Spectator storage and any required spectator location history are reserved separately. The controller does not inspect spectator outcomes or spectator cardinality.

Theorem (Spectator consistency for Contract E). *Under Assumption , compare a finite execution with an extension satisfying* $\mathrm{Tr}_N \hat{\rho} = \rho$ *on the original accessible interface. Use the same initial geometric and control labels and original-name locations.*

At every step the executions have the same geometric trace, the same accessible reduced matter state, and the same original-name locations. The spectator extension may initially be entangled.

Proof. For any linear map Φ,

$$\mathrm{Tr}_N[(\Phi \otimes \mathrm{id}_N)(X)] = \Phi(\mathrm{Tr}_N X).$$

This follows by expansion in matrix units on N. A matter step therefore preserves equality of accessible reductions. Equal reductions give equal declared state functionals, so geometric and coupling steps choose the same successors. Blindness makes guards, certificates, and resource checks identical, and the same fixed location maps apply. Induction proves the assertion.

This compares an extension with its restriction. It does not assert that all extensions with one marginal have identical joint reference correlations, or that selective conditioning cannot steer an untouched spectator.

A four-face certificate and its supported 3 + 1 lift

This section supplies an illustration independently of the general observation proofs. The numerical transverse family is the one recorded in VII-E [4]; its required properties are proved here.

Specialize the prescribed deficit to $\mu = \pi/2$. Use a regular developed patch in the first quadrant, centered at developed spatial coordinates $(20, 20)$, and write its local coordinates as (x, y, z). Set $t = c(T - T_*)$. Numerical lengths below use one fixed length unit.

Transverse faces, edge laws, and affine charts

Put

$$p = \frac{3}{5}, \quad q = \frac{5}{13}, \quad a = \frac{4}{5}, \quad b = \frac{12}{13}, \quad d = b - a = \frac{8}{65}.$$

For $-1 \le s \le 1$, define

$$F_s(x, y) = \max\{px + as, -px + as, qy + bs, -qy + bs\}.$$

Label the four affine dominance regions E, W, N, S.

Lemma (Central exchange). *The graph $t = F_s(x, y)$ is piecewise spacelike and p-Lipschitz. For $s_2 > s_1$,*

$$F_{s_2} - F_{s_1} \geq a(s_2 - s_1).$$

Its central edge is

$$s < 0: \quad x = 0, \quad |y| \leq d(-s)/q, \quad t = as, \quad \ell_-(s) = \frac{16}{25}(-s),$$

$$s > 0: \quad y = 0, \quad |x| \leq ds/p, \quad t = bs, \quad \ell_+(s) = \frac{16}{39}s.$$

At $s = 0$ the central edge becomes one four-face junction. No transverse face disappears there.

Proof. Each affine spatial gradient has norm at most $p < 1$. Their maximum has the same Lipschitz bound. A tangent to a face of slope v has squared norm

$$|u|^2 - (v \cdot u)^2 > 0.$$

All four functions increase with s at rate at least a.

For $E = W$, equality forces $x = 0$, and dominance over N, S is $q|y| \leq -ds$, possible precisely on the incoming side. For $N = S$, equality forces $y = 0$, with $p|x| \leq ds$. The edge tangents have constant t, so their lengths are the displayed Euclidean coordinate intervals. At $s = 0$, each strict-dominance region contains an open cone.

The rates

$$\dot{\ell}_-(0^-) = -\frac{16}{25}, \qquad \dot{\ell}_+(0^+) = \frac{16}{39}$$

show transversality. The four mixed adjacencies persist and satisfy $p|x| - q|y| = ds$ in their respective quadrants.

Use the following 2 + 1-dimensional Lorentz matrices, extended by the identity on z:

$$C_E = \begin{pmatrix} 5/4 & -3/4 & 0 \\ -3/4 & 5/4 & 0 \\ 0 & 0 & 1 \end{pmatrix}, \quad C_W = \begin{pmatrix} 5/4 & 3/4 & 0 \\ 3/4 & 5/4 & 0 \\ 0 & 0 & 1 \end{pmatrix},$$

$$C_N = \begin{pmatrix} 13/12 & 0 & -5/12 \\ 0 & 1 & 0 \\ -5/12 & 0 & 13/12 \end{pmatrix}, \quad C_S = \begin{pmatrix} 13/12 & 0 & 5/12 \\ 0 & 1 & 0 \\ 5/12 & 0 & 13/12 \end{pmatrix}.$$

Direct multiplication verifies Lorentz orthogonality, determinant one, and future orientation. On each

corresponding plane the transformed time coordinate is s.

Set $\Lambda_{i\leftarrow j} = C_i C_j^{-1}$. Every closed ordered core word is the identity, since

$$(C_{i_0} C_{i_1}^{-1})(C_{i_1} C_{i_2}^{-1})\cdots(C_{i_m} C_{i_0}^{-1}) = I.$$

This proves the incoming triple, outgoing triple, and event word identities without interpreting the nontrivial frame changes as curvature.

Compact transverse collar

Let

$$f_s(x,y) = \min\{F_s(x,y), 2+s\}.$$

The nonhorizontal region is

$$R_s = [-X_s, X_s] \times [-Y_s, Y_s], \qquad X_s = \frac{10+s}{3}, \quad Y_s = \frac{26+s}{5}.$$

Take

$$K = [-14/3, 14/3] \times [-6, 6].$$

The collar margins are

$$\frac{14}{3} - X_s = \frac{4-s}{3}, \qquad 6 - Y_s = \frac{4-s}{5}.$$

They are strictly positive throughout the parameter window.

The northeast resting collar polygon has spatial vertices

$$(X_s, 0),\ (14/3, 0),\ (14/3, 6), ?(0, 6),\ (0, Y_s),\ (X_s, Y_s).$$

Reflections give the other three. They partition $K \setminus R_s$ and lie at $t = 2 + s$. The collar chart is

$$A_0(t,x,y) = (t-2, x, y),$$

and the core charts are $A_{i} = C_{i}$. Thus all transitions are $A_{i}A_{j}^{-1}$, including their translations. Closed mixed words telescope in the full affine group.

Proposition (Complete transverse noncentral data). *The capped transverse patch has eight two-dimensional faces and 25 actual edges on either regular epoch. Its noncentral edge classes are:*

$l\|c\|c$class	number	length
hline mixed arms	4	$\begin{cases} (10+s)\sqrt{1921}/75, & s \le 0, \\ (26+s)\sqrt{1921}/195, & s \ge 0; \end{cases}$
horizontal inner half-sides	4	X_{s}
vertical inner half-sides	4	Y_{s}
horizontal collar joins	2	$(4-s)/3$
vertical collar joins	2	$(4-s)/5$
outer horizontal half-sides	4	$14/3$
outer vertical half-sides	4	6

Every noncentral edge has length greater than $1/2$*. The only transverse incidence change is the central exchange.*

Proof. The vertices are the two central endpoints, four inner corners, four inner side midpoints, four outer corners, and four outer side midpoints. The central edge and four mixed arms, followed by the listed collar edges, exhaust their incidences.

For the incoming northeast arm, the displacement is $X_{s}(p, 1, p/q)$ in (t, x, y). Its squared norm is $X_{s}^{2}\,1921/625$. For the outgoing arm use $Y_{s}(q, q/p, 1)$, with squared norm $Y_{s}^{2}\,1921/1521$. These give the arm formulas, which agree at zero. All remaining edges are horizontal and have the listed Euclidean lengths.

The smallest collar-join length is $3/5$; the arms exceed $3\sqrt{1921}/25$. All faces have open interiors: core faces near their inner side midpoints and collar faces by the strict margins. The central dominance calculation then isolates the only transverse incidence change.

A genuinely supported 3 + 1-dimensional marking

A transverse 2 + 1 picture alone is not a compactly supported hypersurface marking in 3 + 1 dimensions. Define

$$L_{s}(z) = s - 4 + \frac{1}{2}\max\{|z| - 1, 0\},$$

$$\hat{f}_{s}(x, y, z) = \min\{2 + s, \max\{F_{s}(x, y), L_{s}(z)\}\}.$$

Use the spatial box

$$\widehat{K} = K \times [-14, 14].$$

Proposition (Supported lift). *The graphs $t = \hat{f}_s$ are continuous piecewise spacelike hypersurface markings with spatial Lipschitz constant at most* 3/5. *They are strictly ordered:*

$$\hat{f}_{s_2} - \hat{f}_{s_1} \geq \frac{4}{5}(s_2 - s_1).$$

They equal $t = 2 + s$ near $\partial\widehat{K}$, and coincide with the transverse capped family for $|z| \leq 1$.

They extend by the horizontal marking outside $\widehat{K}$ on the regular conical product. The modification has compact spatial support disjoint from $\mathscr{W}$.

Proof. The affine pieces have spatial gradients among

$$(\pm p, 0, 0), \quad (0, \pm q, 0), \quad (0, 0, \pm 1/2), \quad 0.$$

Minima and maxima preserve the common Lipschitz bound. Their parameter slopes are at least $a = 4/5$, proving strict ordering.

For $|z| \leq 1$, $L_s = s - 4 < -3$, while $F_s \geq -4/5$. Thus the lift agrees with . For $|z| \geq 13$, $L_s \geq 2 + s$, and the graph is horizontal. Near the lateral boundary of K, the transverse collar already has height $2 + s$. This proves boundary matching and compact support.

Translation by $(20, 20)$ places the entire box in a regular first-quadrant chart of the $\mu = \pi/2$ cone. The local isometry pulls the construction back. Outside the box the marking is unchanged.

For an affine piece $t = v \cdot x + \beta(s)$, a fully specified adapted chart is the standard Lorentz boost

$$B_v^0 = \gamma_v(t - v \cdot x), \qquad B_v^{\mathrm{sp}} = x + \left[\frac{\gamma_v - 1}{|v|^2}(v \cdot x) - \gamma_v t\right] v, \quad \gamma_v = (1 - |v|^2)^{-1/2},$$

followed by time translation $(s - \gamma_v \beta(s))e_0$. For $v = 0$, use its continuous identity-boost value. Thus every lifted piece has an explicit affine chart, and all closed transition products still telescope.

The four-face statement concerns the transverse section $|z| \le 1$. In the full lift its junction is extended in the axial direction. We do not relabel it as an isolated 3 + 1-dimensional particle event, nor claim a catalogue of all additional taper incidences.

Intrinsic angle defect is not ambient curvature

Let

$$A = \arccos(-1121/1921), \qquad B = \arccos(671/1921).$$

At the transverse central event, dot products of the two boundary rays within an E-face give cosine $-1121/1921$; within an N-face they give $671/1921$. The other two faces are reflections. Hence

$$\kappa_0 = 2\pi - 2A - 2B < 0.$$

To check the sign, $A > \pi/2$, and

$$\cos(\pi - A) = 1121/1921 > 671/1921 = \cos B.$$

Thus $B > \pi - A$.

At an incoming triple junction, the two equal face angles have sum $\pi + A$, and the remaining angle is B. For example the equal-angle cosine is $-39/\sqrt{1921}$, and the double-angle identity gives that sum. The defect is $\pi - A - B = \kappa_0/2$. The outgoing calculation interchanges the two pairs and has the same result.

The marking therefore redistributes a transverse intrinsic angle defect while the ambient metric remains fixed and locally flat. This is not a bounce or the creation of spacetime curvature.

Exact guard, locations, and finite reversible encoding

Let Q_-, Q_+ denote the two regular transverse epochs and Q_{0^-}, Q_{0^+} their event germs. At the event, retained central edge slots have zero length and realize the same junction; they are metadata, not regular embedded one-cells.

The forward event rule has guard

$$s = 0, \qquad \text{mode} = 0, \qquad \text{permission} \geq 1.$$

It changes the mode to one, spends one permission, and chooses the outgoing germ without advancing s. A fixed abstract location map sends the incoming central slot and its endpoint labels to the outgoing event-junction slot; persistent labels are unchanged. No physical matter is transported through the patch by this metadata rule. If a spectator has an abstract location there, its location history is separately reserved.

Fix a finite parameter grid

$$s = j2^{-d_0}, \qquad -2^{d_0} \leq j \leq 2^{d_0},$$

stored exactly. Store rounded length reports only as reports. A rounded zero length cannot replace the exact guard: if $\ell = v(-s)$, floor quantization at resolution ε reports zero for $0 \leq -s < \varepsilon/v$.

Let x be a tuple of valid location words and $\tau(x)$ its fixed event transport. On valid forward codewords prescribe

$$(0, k, j = 0, \text{reports}, x, 0_{\text{hist}}) \text{longmapsto} (1, k - 1, j = 0, \text{reports}, \tau(x), x_{\text{hist}}).$$

At zero, both central reports are zero and all common noncentral formulas agree, so the report words remain valid.

Lemma (Decoder-correct reversible implementation). *The finite map has a permutation extension to the complete binary code space. That permutation has an exact NOT–CNOT–Toffoli implementation with clean work uncomputed. It acts as the identity on internal matter.*

Proof. The output history determines x, and its permission determines k, so the forward map is injective. Input and output sets are disjoint because their modes differ. Exchange each valid input with its designated output, and fix all other strings. The exchanges are disjoint transpositions. The decoder reads exactly the outgoing germ, spent permission, and transported locations.

For completeness, any transposition of two N-bit strings can be synthesized along a Gray path between them. The symmetric sequence of adjacent transpositions exchanges the endpoints and fixes intermediate strings. An adjacent transposition is a NOT on the differing bit, controlled on all other bits. Negative controls are converted by NOT

gates; the conjunction of positive controls is computed with Toffoli gates into clean work, used once, and uncomputed. Apply this construction to the finite transposition list. History is deliberately retained; it is not clean work.

If the code has N_E bits, at most $\max\{N_E - 2, 0\}$ clean conjunction bits suffice for this construction. This is a finite reversible existence proof, not a reported compilation.

Theorem (One supported four-face certificate). *The preceding family supplies a local certificate containing:*

1. *piecewise spacelike ordered markings and transverse incoming/outgoing central edge laws;*

2. *complete transverse edge data, affine charts, and exact ordered products;*

3. *a compact transverse collar and a compactly supported* 3 + 1*-dimensional lift matching a fixed horizontal exterior;*

4. *a transition stratum with exact guard and fixed abstract location transport;*

5. *a decoder-correct reversible finite event implementation, with separately charged history and spectator reserves. It is a type-A transverse incidence illustration only. It changes neither* μ*,* $\mathscr{W}$*, nor* J_μ*.*

Proof. Lemma supplies (i). The explicit charts and Proposition supply (ii). The collar construction and Proposition supply (iii). The event definitions and Lemma supply (iv)–(v). The construction lies in one regular developing patch and is horizontal near its boundary. It changes no global gluing map or worldsheet data.

The connection with polygonal descriptions of 2 + 1 gravity is contextual [13, 4]. No polygon Hamiltonian, particle hop, field equation, or global transition catalogue is deduced.

Contract G: finite completely positive hybrid evolution

Let G be a finite classical label set. Each label contains every variable used by the controller: geometric marking, permission, relevant records, and control memory. Matter occupies a fixed d-dimensional space H. Set

$$\mathscr{X}_{\mathrm{G}} = \mathrm{bigoplus}_{g \in \mathrm{G}} \mathscr{B}(H), \qquad \langle B, X\rangle = \sum_g \mathrm{Tr}\,(B_g X_g).$$

States have $X_g \geq 0$ and $\sum_g \operatorname{Tr} X_g = 1$. The blocks are subnormalized; their normalization is not part of the unconditional evolution.

A certified edge $g \to h$ includes all changed classical data, exact guards, geometric matching, and location maps. No edge certificate is inferred from its probability alone.

Theorem (Finite hybrid structure). *A linear map between finite direct sums is completely positive and trace preserving exactly when it has branch form*

$$(\mathscr{F}X)_h = \sum_g \Psi_{h|g}(X_g), \qquad \Psi_{h|g}(X) = \sum_v K_{h|g,v} X K_{h|g,v}^\dagger,$$

with

$$\sum_{h,v} K_{h|g,v}^\dagger K_{h|g,v} = I_H \quad \text{for every} g.$$

Its adjoint is

$$(\mathscr{F}^* B)_g = \sum_h \Psi_{h|g}^*(B_h).$$

A canonical channel on the full matrix space has Kraus operators

$$|h\rangle\langle g| \otimes K_{h|g,v}.$$

It discards off-diagonal input label blocks and produces block-diagonal output. It is a specified lift, not a reconstruction of quantum geometric coherences.

Proof. After adjoining any matrix ancilla, a positive direct-sum input has positive blocks. Complete positivity of the branches and summation prove complete positivity of $\mathscr{F}$. Equation gives trace preservation.

Conversely, compose a given completely positive map with injection into input block g and projection onto output block h. These maps give completely positive branches. For a map between matrix algebras, its Choi matrix is positive; diagonalizing that matrix and unvectorizing its rank-one terms gives the displayed Kraus representation [2]. Trace preservation on each input block gives .

The adjoint follows by pairing. Multiplication of the lifted Kraus operators gives the full identity as their sum of squared moduli, and their action uses only diagonal input blocks.

The table $\Psi_{h|g}$ is fixed independently of the current unknown density operator. Matter dependence enters through Born probabilities

$$p(h|g,\rho) = \mathrm{Tr}\,(E_{h|g}\rho), \qquad E_{h|g} = \Psi^{*}_{h|g}(I).$$

An undeclared state-dependent compiler is not part of this law.

Composition is explicit:

$$(\Lambda \circ \Psi)_{k|g} = \sum_{h} \Lambda_{k|h} \circ \Psi_{h|g}.$$

Completeness follows by summing its adjoint effects. Certificates concatenate along the declared paths; this does not create a certificate for a previously uncertified edge.

Intrinsic observation and histories

Theorem (Hybrid observation criterion). *For observation spaces in finite direct sums, preservation of agreement for all states is equivalent to*

$$\mathscr{F}^{*}(\mathscr{O}_{\mathrm{out}}) \subseteq \mathscr{O}_{\mathrm{in}}.$$

For $\mathscr{O}_{\mathrm{in}} = \mathrm{bigoplus}_{g} \mathscr{A}_{g}$ *and* $\mathscr{O}_{\mathrm{out}} = \mathrm{bigoplus}_{h} \mathscr{B}_{h}$*, this is equivalent to*

$$\Psi^{*}_{h|g}(\mathscr{B}_{h}) \subseteq \mathscr{A}_{g} \qquad (g,h).$$

In particular, successor probabilities depend only on $\rho|_{\mathscr{A}_{g}}$ *exactly when* $E_{h|g} \in \mathscr{A}_{g}$ *for every h.*

Proof. Use the faithful-state perturbation argument of Theorem within the direct-sum algebra. An output observable can have just one nonzero block, proving necessity of every branch inclusion. Summation proves sufficiency. Apply the same argument to the single effect $E_{h|g}$ for the final statement.

This is the direct-sum specialization of a general adjoint criterion, not a new general channel theorem.

For a finite sequence of fixed tables and a history $\gamma = (g_0, \ldots, g_n)$, define

$$X_\gamma = \Psi^{(n)}_{g_n|g_{n-1}} \cdots \Psi^{(1)}_{g_1|g_0}(X_{g_0}), \qquad \mathscr{H}_n(X) = \operatorname{bigoplus}_\gamma X_\gamma.$$

The history map is a channel: each path map is completely positive, and summing the last successor, then the preceding ones, proves trace preservation.

Theorem (History-sensitive observation). *Suppose observation spaces satisfy the branchwise closure*

$$\Psi^{(t)*}_{h|g}(\mathscr{O}_{t,h}) \subseteq \mathscr{O}_{t-1,g}.$$

Initial agreement on $\operatorname{bigoplus}_g \mathscr{O}_{0,g}$ *implies:*

1. *equality of all geometric history probabilities;*

2. *agreement of every unnormalized history block on its declared terminal observation space;*

3. *agreement of normalized conditional expectations on every positive-probability history.*

Proof. Pull a terminal $B \in \mathscr{O}_{n,g_n}$ backward along its fixed history. Repeated application of places the pullback in $\mathscr{O}_{0,g_0}$. Pairing proves (ii); $B = I$ proves (i). Divide by the same positive probability for (iii).

Branch closure is necessary for the corresponding universal one-step comparison at every node, by Theorem . It is not asserted necessary for accidental agreement on one input or one terminal test.

Example (An aggregate continuation can hide branch failure). Let the input observation algebra be span $\{I, Z\}$. Let

$$\Psi_+(X) = \tfrac{1}{2}HXH, \qquad \Psi_-(X) = \tfrac{1}{2}HZXZH,$$

where H is the Hadamard matrix. The summed channel has zero output Z-expectation on every input, so it preserves agreement for that terminal observation. But

$$\Psi^*_+(Z) = X/2, \qquad \Psi^*_-(Z) = -X/2.$$

The inputs proj + and proj − agree on the input diagonal algebra and have the same outcome probabilities, yet their

conditioned Z-expectations differ.

Proposition (Minimal backward boundary). *For a fixed horizon and terminal observation spaces, define*

$$\mathscr{O}_{t-1,g} = \operatorname{span}_{\mathbb{C}}\Big(\{I\} \cup \bigcup_{h} \Psi^{(t)*}_{h|g}(\mathscr{O}_{t,h})\Big).$$

These are the smallest observation spaces satisfying . Agreement on their initial direct sum is equivalent to agreement of all complete history-conditioned terminal expectations.

For a stationary table and geometry-only reports, iteration from $\mathscr{O}^{(0)}_{g} = \mathbb{C}I$ *stabilizes after at most* $|\mathrm{G}|(d^2-1)$ *strict enlargements. The stable space characterizes agreement of all finite geometric history laws.*

Proof. Adjoints preserve adjoints, so the recursively defined spans are observation spaces. Any closed family must contain these spans, proving minimality. The recursively generated elements are precisely spans of pathwise pullbacks. The inserted identity contributes no independent condition because $\sum_h \Psi^{*}_{h|g}(I) = I$.

For stationary iteration, the sum of dimensions starts at $|\mathrm{G}|$ and is at most $|\mathrm{G}|d^2$. An iteration without enlargement is already fixed. Path effects generate exactly the stable space.

No multiplicative closure is required. Replacing the minimal space by its generated algebra may expose more information than the chosen histories need.

Theorem (Spectator consistency for Contract G). *Assume complete spectator blindness and an initial extension with* $\mathrm{Tr}_N \widetilde{X}_g = X_g$ *for every g. For every complete history,*

$$\mathrm{Tr}_N \widetilde{X}_\gamma = X_\gamma.$$

Thus all history laws, restricted unnormalized residual blocks, certificates, and original-name locations agree.

Proof. Equation applies to each selective branch. Induction along a path proves the block identity. The hypotheses retain the same path labels, exact guards, controller tables, and certificates. The assertion includes zero-probability paths as zero blocks.

Recovery obstruction, deterministic packets, and balance

The recovery theorem in this section concerns the entire quantum input algebra $\mathscr{B}(H)$, not merely one observable or a classical subset of states.

Theorem (Exact recovery and a constant complement). *Let $\mathscr{N}: \mathscr{B}(H) \to \mathscr{B}(K)$ be a finite-dimensional channel. The following are equivalent:*

1. *a channel $\mathscr{R}$ satisfies $\mathscr{R}\mathscr{N} = \mathrm{id}_{\mathscr{B}(H)}$;*

2. *a complementary channel is constant: $\mathscr{N}^c(X) = \mathrm{Tr}\,(X)\sigma$;*

3. *its Kraus operators satisfy*

$$A_\alpha^\dagger A_\beta = \lambda_{\alpha\beta} I_H$$

for a positive matrix λ;

4. *after unitary mixing of Kraus operators,*

$$\mathscr{N}(X) = \sum_j p_j V_j X V_j^\dagger, \qquad V_i^\dagger V_j = \delta_{ij} I_H, \qquad p_j > 0, \quad \sum_j p_j = 1.$$

All recovery identities hold completely under references.

Proof. A Kraus dilation gives

$$(\mathscr{N}^c(X))_{\alpha\beta} = \mathrm{Tr}\,(A_\beta^\dagger A_\alpha X),$$

so (ii) and (iii) are equivalent.

Suppose $\mathscr{R}$ has Kraus operators B_ν. The composed Kraus operators $B_\nu A_\alpha$ represent the identity channel. Its Choi matrix has rank one, so every $B_\nu A_\alpha = c_{\nu\alpha} I$. Consequently

$$A_\alpha^\dagger A_\beta = \sum_\nu A_\alpha^\dagger B_\nu^\dagger B_\nu A_\beta = \sum_\nu \overline{c_{\nu\alpha}} c_{\nu\beta} I.$$

This proves (i)⇒(iii).

Diagonalize the positive matrix λ by a unitary mixing of the Kraus operators. Nonzero transformed operators have products $L_i^\dagger L_j = p_i \delta_{ij} I$. Set $V_i = L_i/\sqrt{p_i}$, obtaining (iv). Their range projections are orthogonal. With $P = \sum_i V_i V_i^\dagger$, the map

$$\mathscr{R}(Y) = \sum_i V_i^\dagger Y V_i + \mathrm{Tr}\,((I - P)Y)\tau_H$$

is completely positive and trace preserving for any fixed state τ_H. It recovers every matrix unit and hence every operator. Tensoring the identity proves complete recovery.

This is the full-input form of the standard error-correction and information–disturbance structure [11, 12]; the explicit proof fixes our domain.

Corollary (An informative classical record prevents full recovery). *For an instrument with recorded channel*

$$\mathscr{N}(X) = \sum_w \mathrm{proj}\, w_R \otimes \Psi_w(X),$$

if some effect $E_w = \Psi_w^*(I)$ is not scalar, no channel recovers every input from the entire recorded output, including its residual.

Proof. Choose branch Kraus operators $K_{w,v}$. A dilation can duplicate the classical outcome into its environment:

$$V\psi = \sum_{w,v} |w\rangle_R \otimes K_{w,v}\psi \otimes |w, v\rangle_E.$$

The environmental marginal has outcome-w probability $\mathrm{Tr}\,(E_w \rho)$. A constant complement would make this probability independent of every input, requiring $E_w = p_w I$. Apply Theorem .

A constant record law is necessary, not sufficient, for full recovery. A replacement channel has a constant record and is not reversible. Conversely, random unitary branches with input-independent recorded probabilities can be corrected using the record.

The corollary does not prohibit copying already classical data. It also does not preclude recovery on a proper code subspace or preservation of a named commutative algebra.

Proposition (Deterministic packet selection). *Let a convex domain of states be mapped affinely to classical*

probability distributions. If every output is a point mass, the output label is constant.

Proof. If ρ_0, ρ_1 have different point-mass outputs, an interior convex combination has the corresponding nontrivial mixture, not a point mass.

Thus a nonconstant deterministic expectation-to-packet rule, such as the comparison called Option N, cannot be promoted unchanged to the unconditional classical output of an affine channel. Such a nonlinear rule may be studied under a different contract. A supplied source token is not a measurement extracting an expectation from unknown matter.

Proposition (Operator balance and resource balance). *For declared Hermitian observables H_g, preservation of their expected value for every hybrid input is equivalent to*

$$\sum_h \Psi^*_{h|g}(H_h) = H_g \qquad (g \in \mathrm{G}).$$

The branch intertwinings $H_h K_{h|g,v} = K_{h|g,v} H_g$ are sufficient. A uniform operator defect at most ε gives a one-step expectation error at most ε, and at most nε after n steps for one common observable.

Separately, if a permission function and edge costs satisfy

$$r(h) + c_{h|g} = r(g)$$

on every supported branch, then each history obeys

$$r(g_n) + \sum_{j=1}^{n} c_{g_j|g_{j-1}} = r(g_0).$$

Proof. Pair $\mathscr{F}^* H - H$ with every state supported in one block. The branch sufficiency follows by summing $K^\dagger H_h K = K^\dagger K H_g$. For a normalized hybrid state, the absolute defect expectation is bounded by the largest block operator norm. Iteration proves the accumulated bound. The resource identity telescopes pathwise.

Calling H ``energy'' does not provide a physical Hamiltonian, reservoir, work budget, or Einstein equation. Permission costs are not automatically physical energies.

A finite model selecting ordered slices

This construction does not use the four-face family or its event rule. It uses only the prescribed conical product and finite matrices, adapting the ordered-slice example of VII-G [5].

Fix an integer $B \geq 1$, physical times $\tau > 0$ and $0 < \delta < \tau$, and define

$$\mathrm{G}_B = \{(k, q) : 0 \leq k \leq B,\ |q| \leq k,\ q \equiv k \bmod 2\}.$$

A label denotes the horizontal regular marking

$$T(k, q) = T_0 + k\tau + \delta q, \qquad r(k, q) = B - k.$$

The nominal controller tick $k\tau$, selected slice time $T(k, q)$, and physical times of local gate implementations are different declared quantities.

For $k < B$, set

$$\Gamma_a(k, q) = (k + 1, q + a), \qquad a = \pm 1.$$

At $k = B$, use an absorbing identity branch.

Lemma (Certificate for every successor). *Every successor is an admitted label and advances the selected slice time by $\tau + a\delta > 0$. Each marking is embedded and spacelike on the regular product. The same spatial cells and any fixed compact regular collar are used on every label. Original-name cell transport is the identity, permission decreases by one, and the complete peripheral affine word remains J_μ.*

Proof. The bounds and parity in are preserved. A horizontal slice has induced metric equal to the spatial metric of . Formula gives the positive increment. Horizontal time translation commutes with J_μ; it creates no time or axial shift in the peripheral word. No spatial cell or conical parameter changes.

Only compact regular portions are used by the operations. The extension of a marking toward the completion is background metadata, not an interaction with $\mathscr{W}$ and not a claim that these slices are global Cauchy surfaces.

Let matter be one qubit. Set

$$P_j = \mathrm{proj}\, j, \qquad Q = P_1 - P_0, \qquad E_a = \frac{1}{2}(I + a\eta Q), \qquad M_a = E_a^{1/2}, \quad 0 \le \eta \le 1,$$

and

$$U_{k,q} = e^{-i\theta_{k,q}Q}, \qquad \theta_{k,q} = \frac{\pi q}{8}.$$

For an active input g,

$$\Psi_{\Gamma_a(g)|g}(X) = U_{\Gamma_a(g)} M_a X M_a U_{\Gamma_a(g)}^{\dagger}.$$

Proposition (Source, observation, and coherence). *The branches are complete and their probabilities are*

$$p_a(\rho) = \frac{1}{2}(1 + a\eta \mathrm{Tr}\,(Q\rho)).$$

The diagonal algebra $\mathcal{A}_Z = \mathrm{span}_{\mathbb{C}}\{P_0, P_1\}$ *is branchwise invariant under the adjoints. All geometric history laws therefore depend only on the initial populations.*

Before feedback, the summed source channel preserves populations and multiplies off-diagonal entries by

$$r_\eta = \sqrt{1 - \eta^2}.$$

For $x = \delta q$*, one active increment has*

$$\mathbb{E}[\Delta x|\rho] = \delta\eta \mathrm{Tr}\,(Q\rho), \qquad \mathrm{Var}\,(\Delta x|\rho) = \delta^2(1 - \eta^2 \mathrm{Tr}\,(Q\rho)^2).$$

Also the unconditional observable identity is

$$\sum_a M_a U_{\Gamma_a(g)}^{\dagger} Q U_{\Gamma_a(g)} M_a = Q.$$

Proof. The effects are positive and sum to the identity, proving completeness and the probabilities. All branch matrices are diagonal, proving adjoint closure. Their two eigenvalue cross products each equal $r_\eta/2$; their squared eigenvalues sum to one on each sector. This gives the coherence factor.

The increment is δa; its second moment is δ^2, proving the moment formulas. Finally, Q commutes with every branch matrix and $\sum_a M_a^2 = I$, giving the operator identity.

Conservation of this named observable is compatible with information acquisition and failure of universal recovery. It is not conservation of an unspecified physical energy. Normalized postselected branches need not preserve its unconditional input mean.

For a length-n active history, all branch matrices commute. On a sector P_j, the outcome probabilities are

$$p_a(j) = \frac{1}{2}(1 + a\eta(2j - 1)).$$

Thus diagonal inputs give a classical chain with fixed hidden sector j. General inputs give the mixture of the two sector history laws, weighted by their initial populations. The outcomes are independent conditional on j, not generally after mixing the sectors.

Proposition (Exact finite diagonal comparison). *For a start at one label and $n \le B - k_0$, let $\Delta_Z\rho = P_0\rho P_0 + P_1\rho P_1$. Then*

$$d_{\mathrm{tr}}(\mathscr{H}_n(\rho), \mathscr{H}_n(\Delta_Z\rho)) = |\rho_{01}|\, r_\eta^n.$$

The geometric history laws agree exactly.

Proof. In each history block the difference is a Hermitian off-diagonal pair. Its trace-distance contribution is the absolute value of one off-diagonal entry. Each source step multiplies that entry by $r_\eta/2$; feedback changes only its phase. There are 2^n active histories. Summing gives . Off-diagonal entries have zero trace in every history.

A fresh pointer qubit implements each source isometry

$$\psi \mathrm{longmapsto} |+\rangle_A M_+\psi + |-\rangle_A M_-\psi.$$

It extends to a unitary on pointer plus matter by completing orthonormal bases. Readout consumes the pointer, returns the matter, and writes one classical history bit. Immediate and locally deferred feedback give identical full instruments by Theorem .

The classical successor is chosen only after its required record is available. The local deferral identity does not replace the intermediate geometric label by a coherent superposition of geometries.

Theorem (Finite observation-compatible model). *The model – has:*

1. *state-independent completely positive trace-preserving hybrid evolution;*

2. *a certificate for every nonzero branch, without postselection;*

3. *source-sensitive successor probabilities for* $\eta > 0$ *and nontrivial coherent feedback for* $0 < \eta < 1$*;*

4. *branchwise population-observation closure, complete history laws, and spectator consistency;*

5. *full-instrument-equivalent immediate and locally deferred implementations;*

6. *exactly* $\min\{n, B - k_0\}$ *source attempts after n hybrid ticks, one permission per attempt, and at most* $B - k_0$ *retained outcome bits. The cone, deficit, worldsheet, and peripheral affine gluing are unchanged.*

Proof. Completeness and Theorem prove (i). Lemma proves (ii). The explicit effect and phase formulas prove (iii). Theorems and apply to the diagonal branch matrices and blind fixed controller, proving (iv). The pointer calculation proves (v). The resource $B - k$ decreases once per active branch and no attempt is made at $k = B$, proving (vi).

There is no changing deficit, moving singular source, field equation, or matter-driven gravitational dynamics. The source and feedback are finite operational prescriptions.

Equal terminal slices with unequal residuals

The following exact specialization connects the two contracts without identifying them.

Take $B = 2$, start at $(0, 0)$, and choose $\eta = 3/5$. Then

$$M_{+} = \operatorname{diag}(1, 2)/\sqrt{5}, \qquad M_{-} = \operatorname{diag}(2, 1)/\sqrt{5}.$$

The two-step path Kraus operators are

$$\begin{array}{ccc} c|c|ch = (a_1, a_2) & q_2 & L_h \\ \text{hline} + + & 2 & e^{-3\pi iQ/8}\operatorname{diag}(1,4)/5 \\ + - & 0 & (2/5)e^{-\pi iQ/8} \\ - + & 0 & (2/5)e^{+\pi iQ/8} \\ - - & -2 & e^{+3\pi iQ/8}\operatorname{diag}(4,1)/5 \end{array}$$

Their effects sum to I: the two outer effects are $\operatorname{diag}(1,16)/25$, $\operatorname{diag}(16,1)/25$, and each middle effect is $4I/25$.

Proposition (A finite equal-slice residual separation). *For input $\rho_+ = \operatorname{proj} +$, the histories $+-$ and $-+$:*

1. *have equal probability* $4/25$*;*

2. *select the same terminal marking $T = T_0 + 2\tau$;*

3. *have conditional residual states of trace distance* $1/\sqrt{2}$*. Nevertheless the complete geometric history law is identical for ρ_+ and $I_2/2$.*

Proof. The two middle effects give (i), and their terminal $q_2 = 0$ gives (ii). Their normalized residuals are

$$e^{-\pi iQ/8}\rho_+ e^{+\pi iQ/8}, \qquad e^{+\pi iQ/8}\rho_+ e^{-\pi iQ/8}.$$

For equatorial qubit pure states with these relative phases, their overlap has modulus $1/\sqrt{2}$; their trace distance is $\sqrt{1 - 1/2} = 1/\sqrt{2}$. Equivalently, subtract their 2×2 matrices. The final assertion follows from their equal input populations.

Now retain only the coarse terminal label $q_2 \in \{-2, 0, 2\}$. Let $\mathscr{F}_{\text{coarse}}$ aggregate the actual middle path maps. Define a second complete instrument $\mathscr{G}_{\text{coarse}}$ with the same two outer branches, but middle branch

$$\widetilde{\Psi}_0(X) = \frac{8}{25}X.$$

The middle effect is still $8I/25$, so the two instruments have the same coarse record law on every input.

Theorem (Exact coarse-record instrument gap). *The two coarse instruments satisfy*

$$d_\diamond(\mathscr{F}_{\text{coarse}}, \mathscr{G}_{\text{coarse}}) = \frac{4}{25}\left(1 - \frac{1}{\sqrt{2}}\right) > 0.$$

The input ρ_+ already attains this distance without a reference.

Proof. Write $Z = P_0 - P_1 = -Q$ and $\kappa_0 = 1/\sqrt{2}$. The actual middle map is

$$\Psi_0(X) = \frac{8}{25}\mathscr{D}_{\kappa_0}(X), \qquad \mathscr{D}_{\kappa_0} = \frac{1+\kappa_0}{2}\mathrm{id} + \frac{1-\kappa_0}{2}\mathrm{Ad}_Z.$$

This follows by adding the two phase conjugations in ; off-diagonal entries acquire $\cos(\pi/4) = \kappa_0$. Only the middle recorded block differs. The diamond norm of $\mathrm{id} - \mathrm{Ad}_Z$ is two: the channel-difference upper bound is two, and ρ_+ gives orthogonal outputs. Multiplying by $(8/25)(1-\kappa_0)/2$ and using half-diamond normalization proves .

As in Theorem , implementation errors subtract from this ideal gap by the triangle inequality. This is an incompatibility of declared targets, not a hardware defect.

Proposition (A residual audit enlarges the boundary). *The initial diagonal algebra is sufficient for all geometric histories in the two-step model. If the fine-history residual observable X is additionally audited on every branch, the minimal initial observation space is the full algebra $\mathscr{B}(\mathbb{C}^2)$.*

Proof. The diagonal sufficiency was proved above. For the two middle histories,

$$L_{+-}^{\dagger} X L_{+-}, \qquad L_{-+}^{\dagger} X L_{-+}$$

are $4/25$ times rotations of X through opposite angles $\pi/4$ in the X, Y plane. Their sum and difference span X, Y. The history effects already span I, Q. The minimal backward construction of Proposition therefore gives all four qubit matrix directions.

One cannot treat coherence as inaccessible for source control and simultaneously claim that a later coherence audit needs no enlargement of the observation boundary.

Finite clock, residual audit, and encoding limits

Let the clock have dimension $D = 2^m$, with orthonormal calibration basis $\{|\tau_s\rangle\}_{s=0}^{D-1}$. Let S denote the surviving finite payload. Apply the basis change taking $|\tau_s\rangle$ to $|s\rangle$, then destructively read all m clock names.

Theorem (Complete destructive clock). *With $D_s = \langle \tau_s|_C \otimes I_S$,*

$$\mathscr{M}_C(X) = \sum_s \operatorname{proj} s_R \otimes D_s X D_s^\dagger = \sum_s \operatorname{proj} s_R \otimes \operatorname{Tr}_C[(P_s \otimes I)X(P_s \otimes I)], \quad P_s = |\tau_s\rangle\langle\tau_s|,$$

is a channel. It returns the classical code and the subnormalized conditional payload, including every untouched reference. It consumes the quantum clock names and obeys

$$\operatorname{Tr}_R \mathscr{M}_C(X) = \operatorname{Tr}_C X.$$

If an outcome-selected residual instrument has operators $A_{s,y}$ with $\sum_y A_{s,y}^\dagger A_{s,y} = I$, the complete clock–audit map is

$$X \operatorname{longmapsto} \sum_{s,y} \operatorname{proj} s_R \otimes \operatorname{proj} y_Y \otimes A_{s,y} D_s X D_s^\dagger A_{s,y}^\dagger.$$

Proof. The clock Kraus operators are $|s\rangle_R \otimes D_s$. Their squared moduli sum to I_{CS}. Expansion in the calibration basis proves the partial-trace formula. Summing the diagonal clock blocks proves the record-discard identity. The audit Kraus family is also complete by its stated normalization. All equalities hold on matrix units and remain valid under reference extension.

The geometry does not occur in this proof. The agreement with I-B's interface is by the explicit formula, not by treating a clock code as the metric [9].

A finite payload for both separations

Use a two-qubit clock for the four histories of , with a declared dictionary from its basis labels to:

• the fine history and its coarse terminal slice;

• its finite branch certificate $(k, q, r, T(k, q), J_\mu, \mathrm{loc})$;

• a selected residual audit, for example the X-measurement with projectors $(I \pm X)/2$. The X-audit can be represented with one fresh pointer: rotate to the computational basis, copy to the pointer, rotate the surviving qubit back, and destroy the pointer. Its residual disturbance is exactly the declared Lüders instrument.

The history encoder is the channel

$$\mathscr{E}(X) = \sum_h |\tau_h\rangle\langle\tau_h|_C \otimes L_h X L_h^\dagger.$$

It can be obtained by retaining the actual source history and preparing its corresponding clock basis code. A coherent normal form

$$W\psi = \sum_h |\tau_h\rangle_C \otimes L_h\psi$$

has the same final destructive readout because $\sum_h L_h^\dagger L_h = I$. This equality is not permission to move a geometry update past a required intermediate record.

The one-qubit witness of Theorem is another finite setting, with one coarse outcome and an X-audit. It reads expectations 1 and 0 for the two ideal residuals.

Neither finite encoder is an acquisition map from a continuum field or an unknown metric to the register. The payload is a finite instrument and a finite certificate table, not a finite-qubit field instrument.

Calibration and dictionary nonuniqueness

Declare three maps separately:

1. a clock calibration $s \mapsto \theta_s$ and, if desired, a history-event tag $\kappa(s) = (\theta_s, x_A)$;

2. a rod map assigning surviving names to installed ports and developed spatial coordinates;

3. a causal map embedding every actual scheduled dependency, including classical control, in the prescribed conical relation. The selected slice heights $T(k, q)$ are a fourth named quantity and are not automatically the clock calibrations. In particular, two histories can select the same slice height.

Proposition (Clock limits). *The following hold:*

1. *if the labels θ_s are distinct, exact calibration to one actual readout event,*

$$p_s > 0 \Rightarrow \theta_s = T(e),$$

forces one deterministic code, or admits no normalized input when $T(e)$ is not a label;

2. *$\mathscr{M}_C$ has no universal left inverse;*

3. *finite matrices cannot satisfy* $[T_C, H_C] = iI_C$*;*

4. *the instrument's records do not uniquely determine the geometric dictionary.*

Proof. Distinct labels allow at most one supported outcome and probabilities sum to one. For (ii), the clock states $(|\tau_0\rangle \pm |\tau_1\rangle)/\sqrt{2}$, with the same payload, have identical destructive outputs. For (iii), take the trace of the proposed commutator.

For (iv), keep all finite matrices unchanged and relabel history times or rotate and translate the local rod frame. Small regular laboratories for different prescribed deficits can also carry the same finite instrument. The record law does not change.

The residual obstruction supplies a separate nonuniqueness: even with one dictionary fixed, compatible records can conceal different residual instruments. This is not, by itself, a proof of geometric nonuniqueness; the preceding independent relabeling construction provides that proof.

A multi-outcome history reading at one fixed event is therefore not exact equality of all its distinct history labels with that event's coordinate. No clock-conditioned Schrödinger evolution is claimed without the extra hypotheses used in En09-A [18].

Finite compression and implementation bounds

Proposition (Finite parameter compression). *Fix the finite routing and geometric label dictionary. For active source instruments with* $0 \le \eta, \widehat{\eta} \le \eta_* < 1$*, put*

$$L_* = \frac{1}{2\sqrt{2(1-\eta_*)}}.$$

Their complete one-step channels satisfy

$$d_\diamond(\mathscr{F}, \widetilde{\mathscr{F}}) \le \min\left\{1, 2\left(L_*|\eta - \widehat{\eta}| + \max_h |\theta_h - \widehat{\theta}_h|\right)\right\}.$$

Thus finite numerical approximations to the matrix calibrations converge in complete channel norm on this fixed finite model. No uniform Lipschitz assertion at $\eta = 1$ *is made.*

Proof. The derivatives of the square-root diagonal entries of M_a are bounded by L_*. Also

$$\left\| e^{-i\theta Q} - e^{-i\hat{\theta} Q} \right\|_\infty \le |\theta - \hat{\theta}|.$$

For contraction operators $K, \widetilde{K}$,

$$\| \mathrm{Ad}_K - \mathrm{Ad}_{\widetilde{K}} \|_\diamond \le 2 \| K - \widetilde{K} \|_\infty,$$

by expanding the difference into two terms, including after amplification. Sum over the two recorded branches and divide by two.

For compatible finite channel sequences, the same one-factor-at-a-time expansion gives

$$d_\diamond(\widetilde{\Phi}_n \cdots \widetilde{\Phi}_1, \Phi_n \cdots \Phi_1) \le \min\{1, \sum_{j=1}^{n} d_\diamond(\widetilde{\Phi}_j, \Phi_j)\}.$$

Keeping history registers inside every comparison makes the bound apply to the entire history instrument.

Conditional normalization is more delicate. If the complete history channels are within ε in half-diamond norm, a fixed unnormalized branch differs in trace norm by at most 2ε. For positive branch probabilities at least $p_{\min}$, the normalized conditional trace distance is at most $2\varepsilon/p_{\min}$, by adding and subtracting one unnormalized block divided by the other probability. There is no uniform conditional estimate across arbitrarily rare or zero-probability branches.

Numerical compression does not replace an exact event guard. The reversible event rule continues to use the exact finite parameter word $j = 0$, not an approximate length report.

Typed locality, physical containment, and transport

The typed schedule bound

Let a finite metric site set (X, d_{comp}) carry local finite quantum–classical algebras. At a prescribed layer, the complete channel factors over a partition $\mathscr{B}_t$, with $\mathrm{diam}_{d_{\mathrm{comp}}} B \le \Delta$. All control records read by a block belong to that block.

For a terminal region Y, define

$$N_{n,n}(Y) = Y, \qquad N_{s,n}(Y) = \bigcup \{B \in \mathscr{B}_{s+1} : B \cap N_{s+1,n}(Y) \neq \varnothing\}.$$

Theorem (Typed schedule locality). *Every terminal observable on Y pulls back to an observable on* $N_{0,n}(Y)$*, and*

$$N_{s,n}(Y) \subseteq \{x : d_{\mathrm{comp}}(x, Y) \leq (n - s)\Delta\}.$$

Equal input reductions on the backward region, including any retained reference, give equal corresponding output reductions.

Proof. A block disjoint from the current backward support acts on an identity factor. Its adjoint fixes that identity. A block meeting the support can enlarge it only within that block. Backward induction proves the support inclusion. Each added point is within one block diameter of an existing point; the triangle inequality proves the radius bound. Equality of all pulled-back expectations proves the reduction statement.

For feedback in one fixed envelope R_t, replace the backward step by adjoining R_t whenever it intersects the current set. The same proof applies only when R_t contains every classical and quantum control actually inspected. A global controller cannot be omitted from these envelopes.

The theorem is VII-E/VII-G's typed interface bound. It is not yet I-B's physical cone containment. In particular, the physical size of the four-face patch is not a certificate for Δ.

Theorem (Containment in the prescribed cone). *Suppose each actual input-output dependency edge of the complete finite network is assigned future-causal ports in* $(M, \bar{g})$*. Then scheduled ancestors of a terminal port lie in its metric past.*

Operational intervention influence is contained in scheduled ancestry. Neither converse is asserted.

Proof. Compose future-causal paths along any directed dependency path. Transitivity gives metric containment.

An intervention outside the backward dependency region changes maps acting only on identity factors in every pulled-back terminal observable; its effect is zero. Conversely, a scheduled input to a replacement channel can be

ignored by that channel, so ancestry need not imply influence. A metric-causal pair need not be connected by an installed network.

Thus three objects remain:

$$\text{intervention influence} \subseteq \text{scheduled reachability} \subseteq \text{supplied conical causality}.$$

The second inclusion requires the embedding. This is the distinction compared with VII-J, En03-A, and En05-A [18].

A target-adapted causal route

Choose two regular spatial ports x_A, x_B whose straight developed connecting segment lies in a convex part of the laboratory. Let its length be $L > 0$. Install $n + 1$ sites

$$x_j = \chi^{-1}\Big(\chi(x_A) + \frac{j}{n}(\chi(x_B) - \chi(x_A))\Big), \quad j = 0, \dots, n,$$

each with an equal-dimensional payload register S_j. Initialize $S_1, \dots, S_n$ in the same blank state ω.

At hop j, use the admitted communication channel that exchanges the contents of S_{j-1} and S_j over duration $L/(nc)$. Its two transfer directions have causal ports; it is not an instantaneous spatially extended gate.

Theorem (Complete finite payload and record transport). *After hop j, every initial payload-reference state has the form*

$$\rho_{S_j E} \otimes \text{bigotimes}_{\text{substack}\, 0 \le i \le n}$$

The logical channel is exactly the identity, including references, and arrival occurs at $T_{\text{dep}} + L/c$. All communication paths lie inside the supplied cone.

A classical record can be forwarded on the same route. An operation conditioned on that record at the receiver is performed only after both record and payload arrive. The resulting complete recorded residual instrument is the declared one with its payload relocated.

Proof. Each exchange transfers the whole payload factor and all of its reference correlations into the next blank

factor. Induction proves the state identity. Every hop covers spatial distance L/n in time $L/(nc)$, hence follows a null transfer path in the developed chart. Its pullback is causal.

Apply the payload argument with the classical record included in the reference. Forward its jointly classical blocks by classical copying and causal communication. At the receiver the code selects the same conditional maps. No copying of an unknown quantum state is used.

The protocol assumes installed communication permissions. It is not a derivation of field propagation or an exact null-routing theorem on every endpoint of one fixed lattice.

Proposition (No zero-duration remote SWAP). *A remote identity transmission or SWAP between distinct simultaneous spatial ports is not an admitted zero-duration operation.*

Proof. Two orthogonal sender inputs give different receiver outputs. Thus the operation has intervention influence. Its simultaneous distinct endpoints are spacelike and cannot satisfy the causal dependency contract.

One explicit storage ledger

For the two-step one-qubit model, with all route payload sites reserved in advance:

$l\|l$item	reserve
hline payload	$n+1$one-qubit site registers
source pointer	1fresh qubit per active attempt
source history	2classical bits
controller(k,q)	3bits for six valid labels
history clock	2qubits, then consumed
residual audit pointer	1qubit after clock consumption
route code storage	$5(n+1)$classical bits
audit outcome	1classical bit

Source pointers and audit pointers need not coexist with the two-qubit audit clock, so a sufficient quantum laboratory peak is $n+3$, before any optional event-code carriers. A sufficient classical reserve is $5(n+1)+1$, with the sender controller and history included in its route code.

If the reversible four-face code is also represented by live quantum carriers, add

$$N_E + \max\{N_E - 2, 0\}$$

qubits while that circuit is live. Its retained history is not uncomputed. Spectator and external reference storage are charged separately.

These are stated reserves, not optimality or thermodynamic claims. Local source gates and final audits have separately allocated positive durations. The departure time is after the necessary local preparation and clock readout.

Release, corrections, and unchanged analytical boundaries

Theorem (VII-E-ST local Grade S release). *For the supported presentation and finite permissions specified above:*

1. *the observation contract has exact record and residual criteria, a robust residual obstruction, a sharp Lüders criterion, compatible continuations, restricted deferral, and its spectator theorem;*

2. *the hybrid contract has a complete state-independent branch representation, an intrinsic observation criterion, history closure, its own spectator theorem, and the whole-quantum-input recovery obstruction;*

3. *the four-face transverse family has explicit charts, edge laws, a compact collar, a supported* $3+1$*-dimensional lift, an exact event guard, and a decoder-correct finite reversible implementation;*

4. *the independent finite slice instrument has a certificate for every branch and changes no conical metric or worldsheet data;*

5. *the two-step model has the equal-slice residual separation and exact coarse-record channel gap ;*

6. *finite clock readout, residual audits, parameter compression, and reference-preserving causal transport are constructed on their stated finite interfaces. These satisfy Definition . Neither source contract is used as an unproved premise of the other. The general interface results do not depend on the four-face illustration.*

Proof. Theorems – give (i). Theorems –, Theorem , and Corollary give (ii).

Theorem gives (iii). Theorem gives (iv). Proposition and Theorem give (v). Sections – give (vi). All five defining

Grade S interfaces have been specified.

Scope corrections that matter mathematically

Record and residual. Record compatibility is an effect identity. Instrument compatibility is a selective-map identity. The one-qubit witness and the two-step example exhibit the difference on fully specified ideal targets.

History quantifiers. Branch closure gives a universal history theorem. It is stronger than agreement of one terminal marginal. No necessity assertion for accidental equality on a single prepared input is made.

References and spectators. Channel equalities are reference stable. Comparison of two different extended inputs requires their agreement on the appropriate reference-extended observation space. Spectator consistency compares an extension with its restriction and requires a blind complete controller.

Geometry and dimension. The four-face construction is a transverse marking in a regular patch. Its compact 3 + 1 lift was proved rather than inferred by dimensional relabeling. Its local junction, and the axial extension of that junction, are not $\mathscr{W}$. The fixed ambient conical metric is not generated by the marking's intrinsic angle defect.

Finite data and guards. The branch certificate is a finite specimen of a declared family. It is not a classification of all conical transitions. Finite numerical reports do not measure arbitrary exact real parameters. The discrete event guard remains exact on its declared finite code domain.

Recovery and observable preservation. An informative record excludes exact recovery of every unknown quantum input on the full matrix algebra. It does not exclude a named effect, a classical sector, or an appropriately specified code from being preserved. The finite radiation decoder of En02-C is a separate task, not an input to this obstruction.

Named comparisons that are not incorporated

The supported-laboratory pattern is comparable with III-B and V-B; represented apparatus questions with IV and IV-B; finite-sample certificates with II and II-B; and clock, schedule, and transport questions with En09-A, En03-A, En05-A, and VII-J [18]. Their hypotheses are not silently imported.

The following objects remain separate:

• VII-A through VII-D and VII-I do not supply a quantum source instrument, product domain, sharp interacting observable, or algebra for the present model.

• VII-H's free-scalar susceptibility is not this record, residual instrument, or inherited characteristic coefficient.

• III's equation-space rows and its unconstructed sourced successor are not the direct-sum channel.

• IX-A through IX-E, X-G, and XI-G are different interface or admission questions and are not repaired here.

• VII-F's three-to-six particle event is not the four-face marking, not $\mathscr{W}$, and not a premise of the finite slice model. A readiness record cannot replace its exact guard.

• VIII-B's packet family does not select the supplied deficit. VIII-C's promised source token is not an acquired expectation or a derived dynamical law.

• Em02-E and XX-A's classical lapses, and XIX-A's clock prescriptions, are not geometric code labels or event-time readings.

• En08-A's scheduler consistency does not select our cone. En08-B's null-boundary approximation is not the installed exact route proved above.

• Oai282-A's finite local Ward residual has its own improvement data; it is neither this observation boundary nor a quantum Master Ward identity.

• The OpenAI catalogue is not a premise or a verification. No family supplies the cone, hybrid channel, or clock. Family 265's static area-law question is not the exchange or a Page curve.

• The supplied Hawk, Psy, and Em packet records are not identified with this observation package. These are documentary comparisons in the supplied source dossier.

Standing analytical stops

This paper does not close the historical H2 requirement as stated in XIV-H. Its release must nevertheless

distinguish that historical ending from XIV-I's constructed internal I2 amplitude. That internal construction is not the full characteristic map still missing at I3/J2.

No full characteristic map, joint remainder, transverse extension, contact compatibility theorem, or quantum coefficient is admitted here. The downstream quantum exit called XV-B is not opened. This does not deny the existence of technical manuscripts with that identifier.

XVI-N is not discharged. Within the stated XVI-O prescription,

$$\mathrm{O.1} = \mathrm{texttt\,detokenize}\, NOT_{C}LOSED.$$

Separately scoped results using enlarged prescriptions do not update that statement or admit the inherited insertion.

par **Standing refusals** par Not spacetime emergence, Grade E, Einstein dynamics, a global conical Cauchy theorem, or an intrinsic cone field theory. Not a Page curve, island, interior, bounce, ultraviolet completion, or gravity-generated-entanglement test. Not quantized relational time without external scheduling.

Record compatibility is not residual agreement. An informative classical record is not recovery of every quantum input. A nonconstant deterministic packet selection is not an unconditional affine channel. Matter-controlled slicing is not matter-driven gravitational dynamics.

The geometric time axis remains after clock consumption. No quantum field coefficient, quantum Ward identity, or physical thermal implementation is supplied. par

Declarations

Authorship. The author field is intentionally empty for anonymous review. Authorized authorship and affiliation metadata are required for a signed submission. VII-E's source author field is empty. Citation or registry attribution to N. Cheung does not assign authorship of this adaptation.

Proof and dependency scope. All positive claims released here have explicit finite-dimensional or local

geometric proofs above. VII-E and VII-G are source records for the adapted contracts, not unprinted theorem premises. The supplied long characteristic-graph programme is a distinct unresolved programme, not a plan purportedly completed by this finite observation package.

Execution and implementation. No successful pdflatex execution, proof-assistant verification, independently executed symbolic or numerical calculation, physical circuit compilation, experiment, independent referee certification, or journal acceptance of this adaptation is asserted.

Book expansion notes (t433u)

Following the I-C-Th three-ledger split, access, reset, and heat stay separate. Channel equality does not fix heat. Hybrid feedback on the prescribed cone is not Einstein dynamics. Parent observation-boundary record: [4]; shredder interface: [19].

Standing ledger. Not spacetime emergence; not Einstein dynamics; not a Page curve, island, bounce, vacuum-energy selection, or de Sitter state as an Enter theorem; not a derived metric. O.1 stays NOT_CLOSED. XVI-N is not discharged. XV-B is not opened. No quantum coefficient is admitted. Host C is not created. Dom (T) remains undetermined; J2 remains unresolved. Problems 6, 7, and 9 are named, not solved. Gate 0 and ST4b stay NOT_SUPPLIED. Host-A stays NAMED_COMPARISON_ONLY $\{GI, CB\}$. The shredder is not Gibbons–Hawking. Cited sheets are source records, not premises. Conjectures stay conjectures. wired=false.

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