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VII-F-ST: A particle-supported slicing certificate with a finite spacetime Enter interface

Transverse three-to-six incidence, framed affine holonomy, destructive clock encoding, and causal payload transport

Ngo Cheung

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Abstract

We construct a self-contained local Grade S adaptation of VII-F's particle-supported slicing event to I-B's prescribed 3 + 1-dimensional conical product. The background has fixed deficit $\pi/2$; its singular set is a worldsheet. An explicit product lift preserves VII-F's transverse three-to-six incidence change, the exact birth laws for six vertices, twelve edges, and six faces, and one common framed affine peripheral holonomy. The construction distinguishes a developing atlas around the defect from the compact regular laboratory in which all quantum operations occur.

The additional contribution is a complete finite operational certificate. An exact guarded metadata update has a forward decoder, a constructive NOT–CNOT–Toffoli realization with retained history, and an explicit storage and gate bound. A destructive finite clock returns both its classical code and every unnormalized conditional payload block, including arbitrary untouched references. Four exact classical evaluations are represented by finite diagonal matrices and a completely specified table-probe instrument. The resulting package separates event-time calibration from history labeling: reading an installed event code is not acquiring information from the singular worldsheet. A buffered, target-adapted causal route transports the surviving payload, location/history data, and classical control

record without changing the complete instrument.

Two useful diagnostic conclusions are proved explicitly. Intrinsic lengths and areas alone cannot determine the exact event guard, even before rounding, because they are constant throughout the incoming epoch. Also, matching classical records leaves a possible residual discrepancy of trace distance 1/2. These features make the package a reproducible finite test case for separating geometric consistency, finite readout, and physically scheduled implementation. The classical incidence event and the general channel principles are not claimed as new in themselves. The contribution is their dimensionally explicit, supported assembly with checked interfaces. No metric emergence, singular detector, Einstein dynamics, continuum-field acquisition, quantum Ward identity, or inherited quantum response coefficient is constructed.

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par **Exact scope** par The metric, deficit, conical worldsheet, lapse, clock calibration, preparations, finite tables, and communication permissions are inputs. The event changes a prescribed marking and its transverse cell incidence, not the ambient spacetime.

The geometric certificate may meet the stipulated singular stratum. The quantum laboratory does not. A finite clock reads a prepared encoding of the event; it does not measure an unknown continuum geometry at the defect.

par

Introduction, Enter philosophy, and the adaptation contract

VII-F constructs one explicit particle-supported slicing event on a fixed 2 + 1-dimensional spinless cone [1]. I-B supplies a finite Enter interface on the regular part of a prescribed 3 + 1-dimensional conical product [2]. Their combination requires more than appending an axial coordinate to a transverse diagram. The singular set changes dimension, a meridian needs an atlas rather than one regular chart, and the finite apparatus must remain separated from the singular stratum. These points are addressed explicitly below.

The conical and polygonal context is classical [6, 7]. Neither particle-supported incidence changes nor the instrument formalism are introduced here as new general ideas. The purpose is a complete certificate for one precisely declared adaptation.

The Enter interface discipline

In Cheung's Enter calculus, a runtime quantum name is an access right to a tensor factor. Destructive computational-basis readout consumes the measured names and returns classical outcomes, while unmeasured factors may survive [3, 4]. The accompanying philosophy separates:

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

A classical code is not the return of an unknown quantum clock; a channel is not a thermal machine; a suggestive geometric label is not a derivation of a metric [5].

We adopt a specified finite Born instrument and prove its complete channel formula. We do not rederive the measurement characterization of Manuscript I from abbreviated axioms, certify an arbitrary apparatus to satisfy that manuscript's strategy class, or extend its conclusion to quantum fields.

Definition (Local Grade S). A local Grade S package comprises:

1. a prescribed Lorentzian background, a supported classical presentation, and a compact regular operational laboratory;

2. an explicitly proved classical certificate on its declared geometric domain;

3. a complete finite destructive-clock instrument;

4. a finite encoding of already-defined evaluations and labels, with its decoder domain and resources;

5. reference-preserving transport whose complete dependencies are embedded in the prescribed causal relation.

Grade E would additionally require a construction deriving the geometric data from operational records. It is not constructed.

Source roles. VII-F provides the source family and certificate discipline. I-B provides the operational pattern. VII-E, VII-G, VII-E-ST, En09-A, En05-A, and VII-J provide documentary comparisons [19, 20, 21, 22, 23]. Every positive result used in this adaptation is proved below. A documentary separation is not a proof transfer.

Prescribed conical product and two different supports

Fix a length unit $\ell > 0$, speed $c > 0$, and time origin T_*. Write

$$t = \frac{c(T - T_*)}{\ell}, \qquad z = \ell\zeta, \qquad \mu = \frac{\pi}{2}, \qquad \alpha = \frac{3}{4}.$$

The regular physical spacetime 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 has period 2π. Its stipulated conical completion $\overline{M}$ has

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

No smooth field equation is imposed on $\mathscr{W}$.

Use a cut transverse wedge of opening $3\pi/2$, with developed directions

$$e_i = (\cos(i\pi/2), \sin(i\pi/2)), \qquad i = 0, 1, 2, 3.$$

Sector i, $i = 0, 1, 2$, has dimensionless coordinates

$$x = \xi e_i + \eta e_{i+1}, \qquad \xi, \eta \geq 0.$$

Physical spatial coordinates in that sector are ℓx. Cone-ray labels are cyclic modulo three, but e_0 and e_3 are distinct cut-space copies.

The upper seam is identified with the lower by the affine map

$$J = (\mathrm{diag}\,(1, R(\pi/2), 1), 0), \qquad R(\pi/2) = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix},$$

in dimensionless coordinates (t, X, Y, ζ). It sends $(t, 0, -r, \zeta)$ to $(t, r, 0, \zeta)$. This is wedge gluing, not a quotient of the entire plane by the finite rotation group.

Proposition (Local geometry). *The signature is* $(-, +, +, +)$*, with future orientation* ∂_T*. Static observers have* $\mathrm{d}\tau = \mathrm{d}T$*. On a lifted regular angular interval,*

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

is a local Minkowski isometry. A future-causal curve satisfies

$$\text{spatial path length} \leq c\,\Delta T.$$

The map J fixes $\mathscr{W}$ *pointwise and has neither time nor axial translation.*

Proof. The first two assertions follow directly from . The identity

$$\mathrm{d}X^2 + \mathrm{d}Y^2 = \mathrm{d}r^2 + \alpha^2 r^2 \mathrm{d}\varphi^2$$

proves local isometry. The causal inequality follows by integrating the pointwise causal-speed bound. Equation proves the last assertion.

Proposition (The regular product is not globally hyperbolic). *The manifold M has a noncompact causal diamond.*

Proof. Fix $r_0 > 0$, an angle, and $z = 0$. Take endpoints at that spatial position and times $T_* \pm 2r_0/c$. For

$r_n \downarrow 0$, the events at time T_*, radius r_n, and the same angle and axial coordinate lie in the diamond, using radial causal paths. They have no convergent subsequence in M.

Definition (Supported presentation). Fix $Z > 0$. The geometric presentation is the finite sector atlas on

$$\{\xi + \eta \le 4\} \times [-Z, Z]$$

together with its prescribed exterior and its stipulated conical stratum. It is compact in the spatial completion and is not a single regular chart.

The operational laboratory is a relatively compact regular tube with closure disjoint from $\mathscr{W}$, containing all installed register ports, local gates, and communication paths. All preparations, ancillary inputs, and controller data are declared at the initial boundary. There is no undeclared incoming boundary input.

No Green operator, field propagation problem, or boundary-value evolution is constructed.

The distinction between the two supports is essential. A particle-supported geometric certificate cannot have its entire geometric closure disjoint from the defect. A finite apparatus can, and in this paper does.

The axial construction below is a product on the declared slab. At its axial ends the marking is the restriction of that same specified product. We do not infer a compactly supported axial interpolation to a different exterior, since such an interpolation could introduce additional incidence parameters.

The exact transverse family and its product lift

The following functions reproduce the source family [1, eq:family]:

$$\rho = \xi + \eta, \qquad h = \frac{2}{3}(\xi + \eta), \qquad k = \frac{3}{5}\min\{\xi, \eta\}, \qquad F_s = s + \min\{2, \max\{h, s + k\}\}, \quad -1 \le s \le 1.$$

They agree on identified rays: there $\rho = r/\ell$, $h = 2\rho/3$, and $k = 0$. Consequently F_s is a single-valued continuous function on the completed transverse cone.

Define the 3 + 1-dimensional markings

$$\widehat{\Sigma}_s = \left\{ (T,x,z) : T = T_* + \frac{\ell}{c} F_s(x/\ell), \quad z \in \mathbb{R} \right\}.$$

Only the supported slab of Definition and the separately specified regular laboratory are operationally used.

Lemma (Active region). *For all transverse points,*

$$h - k \geq \frac{11}{30}\rho.$$

Thus:

1. *for* $s \leq 0$, $F_s = s + \min\{2, h\}$*;*

2. *for* $s > 0$*, the branch* $s + k$ *can dominate* h *only where* $\rho \leq 30s/11 < 3$*;*

3. *for every parameter and* $\rho \geq 3$, $F_s = 2 + s$.

Proof. Use $\min\{\xi, \eta\} \leq \rho/2$. For $s \leq 0$, $s + k \leq h$. For $s > 0$, $s + k \geq h$ implies $s \geq 11\rho/30$. Finally $h \geq 2$ when $\rho \geq 3$.

Theorem (Embedded, uniformly spacelike ordered lift). *The markings* $\widehat{\Sigma}_s$ *are embedded graphs. Every regular affine piece is spacelike, with dimensionless spatial Lipschitz constant*

$$\lambda = \frac{2\sqrt{2}}{3} < 1.$$

Their induced metrics satisfy the lower bound

$$\bar{g}(v, v) \geq \frac{\ell^2}{9}|v|^2$$

for dimensionless spatial tangent coordinates. For $s_2 > s_1$,

$$s_2 - s_1 \leq F_{s_2}(x) - F_{s_1}(x) \leq 2(s_2 - s_1).$$

Distinct points on one regular marking are not causally related. The extension to the conical stratum is understood in the stratified Lipschitz sense, not as a smooth hypersurface theorem at $\mathscr{W}$*.*

Proof. The affine spatial gradients, including the axial component, are

$$(2/3, 2/3, 0), \qquad (3/5, 0, 0), \qquad (0, 3/5, 0), \qquad (0, 0, 0),$$

up to sector rotations. Taking minima and maxima preserves a common Lipschitz bound. On an affine graph of gradient a, the induced metric is $\ell^2(I - aa^{\mathrm{T}})$, whose least eigenvalue is at least $\ell^2(1 - \lambda^2) = \ell^2/9$.

Integrate the gradient bound along spatial paths and take the infimum of their lengths. The graph projection is a homeomorphism. The strict Lipschitz bound and Proposition exclude causal pairs of distinct graph points. For fixed x, the term after the initial s in is nondecreasing and 1-Lipschitz in s, which gives .

The radial collar

$$7/2 \le \rho \le 4, \qquad |\zeta| \le Z$$

is regular and horizontal at $t = 2 + s$. The exterior has fixed spatial cells and fixed gluing, translated according to this prescribed equation. It is not the same embedded subset for all s.

The singular intersection is

$$\widehat{\Sigma}_s \cap \mathscr{W} = \{(T_* + \ell p(s)/c, o, z) : z \in \mathbb{R}\}, \qquad p(s) = \begin{cases} s, & s \le 0, \\ 2s, & s \ge 0. \end{cases}$$

In a transverse section this is the source's particle point. In 3 + 1 dimensions it is a line in a worldsheet.

Cellulation, exact measures, and the unique event parameter

All coordinates and measures in this section are dimensionless unless a power of ℓ is displayed. The transverse data are adapted from VII-F, with their formulas checked directly below [1].

Vertices and faces

Let

$$A_i = 3e_i, \qquad D_i = 4e_i, \qquad B_i = \frac{3}{2}s\,e_i, \qquad C_i = \frac{15}{11}s(e_i + e_{i+1}) \quad (s > 0).$$

The complete sector vertex data are

$c\|c\|c$vertex	(ξ,η)	t
hline P	$(0,0)$	$p(s)$
A_i	$(3,0)$	$s+2$
A_{i+1}	$(0,3)$	$s+2$
D_i	$(4,0)$	$s+2$
D_{i+1}	$(0,4)$	$s+2$
B_i	$(3s/2,0)$	$2s$
B_{i+1}	$(0,3s/2)$	$2s$
C_i	$(15s/11,15s/11)$	$31s/11$

The last three entries are regular vertices only for $s > 0$.

For $s \le 0$, the core faces are

$$V_i = [P, A_i, A_{i+1}], \qquad t = s + \frac{2}{3}(\xi+\eta).$$

For $s > 0$, replace each core triangle by

$$U_i^- = [P, B_i, C_i], \qquad t = 2s + \frac{3}{5}\eta,$$

$$U_i^+ = [P, C_i, B_{i+1}], \qquad t = 2s + \frac{3}{5}\xi,$$

$$V_i = [B_i, A_i, A_{i+1}, B_{i+1}, C_i], \; t = s + \frac{2}{3}(\xi+\eta).$$

The persistent V_i is a simple, generally nonconvex polygon. For every s,

$$Q_i = [A_i, D_i, D_{i+1}, A_{i+1}], \qquad t = s + 2,$$

and the region $\rho \ge 4$ retains its prescribed horizontal exterior face and exterior ray labels.

Lemma (Exact decomposition). *These faces partition the transverse graph without overlapping face interiors or omitted regions.*

Proof. For $s \le 0$, apply Lemma . For $s > 0$, in $\xi \ge \eta$ the equality $h = s + k$ is

$$10\xi + \eta = 15s,$$

joining B_i to C_i. In $\eta \ge \xi$ it is

$$\xi + 10\eta = 15s,$$

joining C_i to B_{i+1}. The inner dominance region is exactly the union of the two triangles $U_i^{\pm}$. Since $\rho(C_i) = 30s/11 < 3$, it is separated from the crest $\rho = 3$. The remaining core region is the stated simple pentagon, and the cap gives the horizontal collar and exterior.

Edges and lengths

Persistent finite edges are

$$e_i = \begin{cases} [P, A_i], & s \le 0, \\ , & s > 0, \end{cases} \quad c_i = [A_i, A_{i+1}], \quad t_i = [A_i, D_i], \quad o_i = [D_i, D_{i+1}].$$

Born edge labels are

$$u_i = [P, B_i], \quad v_i = [P, C_i], \quad w_i^- = [B_i, C_i], \quad w_i^+ = [C_i, B_{i+1}].$$

Proposition (Complete finite-edge table). *Each row has multiplicity three. The physical lengths are*

$c\|c\|$edge	$s \le 0$	$s > 0$
hline e_i	$\ell\sqrt{5}$	$\ell\sqrt{5}(1 - s/2)$
c_i	$3\ell\sqrt{2}$	$3\ell\sqrt{2}$
t_i	ℓ	ℓ
o_i	$4\ell\sqrt{2}$	$4\ell\sqrt{2}$
u_i	inactive	$3\ell s/2$
v_i	inactive	$3\ell\sqrt{41}\, s/11$
w_i^-	inactive	$3\ell\sqrt{65}\, s/22$
w_i^+	inactive	$3\ell\sqrt{65}\, s/22$

At $s = 0$, the born labels are germ metadata, not regular zero-length edges.

Proof. For a developed segment, $L^2 = \ell^2(|\Delta x|^2 - (\Delta t)^2)$. On e_i, the spatial length is 3 or $3 - 3s/2$, with time slope $2/3$, giving the first row. The collar rows have $\Delta t = 0$. For u_i, both endpoint times equal $2s$. For v_i, put $b = 15s/11$; its displacement is $(3b/5, b, b)$, whose squared norm is $41b^2/25$. For w_i^-,

$$(\Delta t, \Delta\xi, \Delta\eta) = \frac{s}{22}(18, -3, 30),$$

whose squared norm is $585s^2/484$. The remaining edge follows by symmetry.

Proposition (Areas and one-sided laws). *The induced transverse areas are*

$c\|c\|c$face	$s \le 0$	$s > 0$
hline V_i	$3\ell^2/2$	$\ell^2(3/2 - 15s^2/22)$
U_i^-	inactive	$9\ell^2 s^2/11$
U_i^+	inactive	$9\ell^2 s^2/11$
Q_i	$7\ell^2/2$	$7\ell^2/2$

Every active face has positive area. In particular, $\mathrm{Area}\,(V_i) \ge 9\ell^2/11$. *The born edges vanish to first order and the born areas to second order at* $s = 0^+$. *The changing line in one half-sector has Euclidean parameter-normal speed* $15/\sqrt{101}$.

Proof. The graph-area factors are 1/3 for the *h*-plane and 4/5 for a *k*-plane. The original projected core triangle has area 9/2. Each new projected triangle has area

$$\frac{1}{2}\,\frac{3s}{2}\,\frac{15s}{11} = \frac{45s^2}{44}.$$

Subtract both from 9/2 and multiply by 1/3, or multiply one by 4/5, to obtain the table. The collar is horizontal and has area (16 − 9)/2. The speed follows from $10\xi + \eta = 15s$.

The endpoint derivatives are

$$B_i' = \frac{3}{2}e_i, \qquad C_i' = \frac{15}{11}(e_i + e_{i+1}).$$

Before the event all finite intrinsic lengths and areas are constant. These are slicing-parameter laws, not material velocity laws.

The transverse link and the lifted event locus

Theorem (Unique transverse incidence-event parameter). *The declared family has exactly one incidence-event parameter,* $s = 0$. *Across it:*

1. *the six vertices* B_i, C_i *emerge from P;*

2. *twelve edges and six faces emerge with the laws above;*

3. *the transverse link at the singular intersection changes from three incident faces to six. There is no other*

collision, vanishing active cell, or contact with the crest in the parameter window.

Proof. The incoming cyclic link is

$$e_0, V_0, e_1, V_1, e_2, V_2.$$

The outgoing cyclic link is

$$u_0, U_0^-, v_0, U_0^+, u_1, U_1^-, v_1, U_1^+, u_2, U_2^-, v_2, U_2^+.$$

The bisectors are genuine creases because the adjacent gradients are $(3/5, 0)$ and $(0, 3/5)$. Across a cone ray, unfolding changes the sign of the transverse gradient, so those creases are also genuine.

For each open epoch, the combinatorics is fixed. Positivity follows from Propositions and ; separation and complete coverage follow from Lemma . All born coordinates tend to the apex at zero, while the persistent cells have their incoming nondegenerate limits. The different link valences exclude a mere relabeling.

The transverse compact patch counts are

$c\|ccc\|c$	V	E	F	$V-E+F$
hline $s<0$	7	12	6	1
$s>0$	13	24	12	1

At $s = 0$, use the incoming regular cellulation and retain the outgoing formulas only as one-sided germ data.

Corollary (Dimensionally explicit lift). *On $|\zeta| < Z$, each transverse cell is replaced by its product with the axial interval. The unique event parameter remains zero. The event locus is*

$$\{T = T_*, x = o, |z| < \ell Z\} \subset \mathscr{W}.$$

The three-to-six assertion concerns the normal transverse link of this line, not the full link of a point in a three-dimensional hypersurface.

A transverse face of dimensionless area a_f has product-cell volume $2Z\ell^3 a_f$ on the closed slab.

Proof. The graph and cellulation are independent of ζ. Their induced metrics are orthogonal products with $\ell^2 \mathrm{d}\zeta^2$. Both assertions follow.

Axial end strata are inherited boundary data. They are not additional born transverse cells, and their complete boundary cellulation is not encoded by the transverse dictionary below.

Adapted affine charts and framed peripheral holonomy

We now verify the full affine certificate, not merely its Lorentz part. The source chart pattern is VII-F's finite table [1, sec:holonomy].

In (t, ξ, η), put

$$B_h = \begin{pmatrix} 3 & -2 & -2 \\ -2 & 2 & 1 \\ -2 & 1 & 2 \end{pmatrix}, \qquad B_x = \begin{pmatrix} 5/4 & -3/4 & 0 \\ -3/4 & 5/4 & 0 \\ 0 & 0 & 1 \end{pmatrix}, \qquad B_y = \begin{pmatrix} 5/4 & 0 & -3/4 \\ 0 & 1 & 0 \\ -3/4 & 0 & 5/4 \end{pmatrix}.$$

Let $O_i = \mathrm{diag}\,(1, R(i\pi/2))$. Extend all matrices by the identity on ζ. With $e_0 = (1,0,0,0)^{\mathrm{T}}$, define

$c\|c\|cf$	$\mathcal{A}_f$	face equation after adaptation
hline V_i	$O_i B_h O_i^{-1} - 3s e_0$	$t' = 0$
U_i^-	$O_i B_y O_i^{-1} - (5s/2) e_0$	$t' = 0$
U_i^+	$O_i B_x O_i^{-1} - (5s/2) e_0$	$t' = 0$
Q_i, exterior	id	$t' = s + 2$

An entry such as $L - a e_0$ denotes the affine map $u \mapsto Lu - a e_0$.

Lemma (Chart validity). *The matrices are proper future-oriented Lorentz matrices. The affine maps send their respective face planes to the displayed horizontal planes. They are regular charts only away from $\mathscr{V}$; their formulas extend to cell closures as affine formulas.*

Proof. For $\eta_{2+1} = \mathrm{diag}\,(-1,1,1)$, multiply to check $B^{\mathrm{T}} \eta_{2+1} B = \eta_{2+1}$, $\det B = 1$, and positive time component. For the h-plane, $3t - 2\xi - 2\eta = 3s$. For the U_i^--plane, $(5t - 3\eta)/4 = 5s/2$, and similarly for U_i^+. The axial extension changes none of these identities.

For a crossing from f to g, include its connected overlap component and signed seam exponent n_{gf}. Define

$$g_{g \leftarrow f} = \mathcal{A}_g J^{n_{gf}} \mathcal{A}_f^{-1}, \qquad n_{gf} \in \{-1, 0, 1\}.$$

Theorem (Winding-marked affine word). *For a closed word $f_0, \dots, f_m = f_0$,*

$$g_{f_0 \leftarrow f_{m-1}} \cdots g_{f_1 \leftarrow f_0} = \mathcal{A}_{f_0} J^N \mathcal{A}_{f_0}^{-1}, \qquad N = \sum_{j=0}^{m-1} n_{f_{j+1} f_j}.$$

For a realized loop avoiding $\mathscr{W}$, N is its oriented transverse winding number. Every small regular vertex loop has affine product I.

Proof. Substitution cancels adjacent chart inverses, leaving the powers of J. Lifting the spatial loop to the angular cover changes its lifted angle by $N(3\pi/2)$, which identifies the winding. Small regular loops have zero winding.

Choose the reference collar basepoint

$$b_s = (s + 2, 15/8, 15/8, 0).$$

A collar meridian $\rho = 15/4$ has increasing-angle word I, I, J. A common core meridian is $\rho = 29/10$, since

$$30/11 < 29/10 < 3.$$

It remains in the V_i faces and is connected to the collar without crossing the seam.

Theorem (One common framed primitive holonomy). *The collar meridian, the common core meridian, and the outgoing six-face-star meridian have reference-framed affine holonomy exactly J. The incoming and outgoing event germs have the same peripheral certificate.*

All these meridians are positively primitive; this assertion is not inferred from their matrix products.

Proof. The collar word is already J. For the core, with $\mathcal{A}_i = \mathcal{A}_{V_i}$, the chart-based word is

$$(\mathcal{A}_0 J \mathcal{A}_2^{-1})(\mathcal{A}_2 \mathcal{A}_1^{-1})(\mathcal{A}_1 \mathcal{A}_0^{-1}) = \mathcal{A}_0 J \mathcal{A}_0^{-1}.$$

The connecting path and its inverse conjugate this back to J.

For $s > 0$, the loop $\rho = s$ lies inside the new star because $h - k \le h = 2s/3 < s$. Its six successive face charts are $U_0^-, U_0^+, U_1^-, U_1^+, U_2^-, U_2^+$. Five ordinary crossings and one positive seam crossing give the same conjugation identity. A no-seam connecting path again returns J in the reference frame.

Every indicated loop increases the lifted transverse angle by exactly $3\pi/2$, independently proving positive

primitivity. At zero the common core loop avoids all collapsed cells and certifies both limiting germs.

Translation audit. For $\mathcal{A} = (L, a)$, the affine product convention is

$$(L, a)(M, b) = (LM, Lb + a).$$

Writing $\mathcal{A}_0 = (L_0, a_0)$, the core word is

$$(K, a_0 - Ka_0), \qquad K = L_0 J L_0^{-1},$$

where J in the expression for K denotes its linear part. Full affine conjugation gives

$$\mathcal{A}_0^{-1}(K, a_0 - Ka_0)\mathcal{A}_0 = (J, 0).$$

No time translation is discarded.

Because $J^4 = I$, a matrix product alone cannot distinguish a primitive meridian from a loop with winding $1 + 4m$, nor can it distinguish zero winding from winding four. The winding mark is indispensable.

The packet consists of a fixed geometric identifier, $\mu = \pi/2$, the worldsheet $\mathscr{W}$, reference rest vector $u_* = c^{-1}\partial_T$, particle-cell label P, and reference framing. It is constant. The incoming face normal has transverse components $(3, 2, 2)$; the outgoing ones have components $(5/4, 3/4, 0)$ or $(5/4, 0, 3/4)$, with axial component zero. Their rapidities relative to u_* are respectively $\operatorname{arcosh} 3$ and $\log 2$. Changing face-relative rapidity does not move the worldsheet.

Intrinsic-angle audit

Proposition (Slice curvature is not the spacetime deficit). *The transverse intrinsic defects at the singular intersection are*

$$\kappa_P^- = 2\pi - 3\arccos(-4/5), \qquad \kappa_P^+ = 2\pi - 6\arctan(4/5).$$

Neither equals the prescribed spacetime deficit $\pi/2$. The sum of all interior transverse vertex defects in the compact patch equals $\pi/2$ on every slice.

Proof. On a V_i-plane the ray-direction angle has cosine

$$\frac{-4/9}{5/9} = -4/5.$$

On U_i^-, the induced metric is $\operatorname{diag}(1, 16/25)$, so the angle between $(1, 0)$ and $(1, 1)$ is $\arctan(4/5)$. There are three incoming or six outgoing angles.

Triangulate each polygonal disk without changing its metric. Triangle angle sums and Euler's formula for the transverse disk give

$$\sum_{\text{interior}} \kappa_v + \sum_{\text{boundary}} (\pi - \theta_v) = 2\pi.$$

Each of the three outer boundary vertices has interior angle $\pi/2$; hence the boundary turning is $3\pi/2$. The stated interior sum follows. At zero only the noncollapsed limiting cells enter the sum.

This reproduces a useful source audit [1, prop:particle-defects,prop:angle-audit]. It is not a replacement for the framed affine calculation.

Exact geometry-only control and reversible finite encoding

The guard and two different location maps

Let g_{0^-} and g_{0^+} be the same limiting marking equipped with the incoming and outgoing one-sided data. The geometric singular-intersection map is the identity on $\{T = T_*, x = o\}$.

The abstract matter-name location transport is also the identity on persistent cell labels:

$$\tau(a) = a.$$

These are different typed maps. For example, e_i denotes $[P, A_i]$ before the event and $[B_i, A_i]$ afterward. Preserving that label does not prescribe a trajectory for a material point.

Choose integers $d \geq 1$, $r \geq 1$, and write

$$s = j2^{-d}, \qquad -2^d \leq j \leq 2^d, \qquad 0 \leq v < 2^r.$$

The exact forward guard is

$$m = 0, \qquad j = 0, \qquad v \geq 1, \qquad \text{canonical fixed-family validity.}$$

It changes m to one and v to $v - 1$, retaining the packet, locations, and internal matter state.

Proposition (Intrinsic reports cannot implement the guard). *No rule depending only on the intrinsic edge-length and face-area tables can recognize the exact incoming event parameter throughout the admitted incoming domain. This remains true with arbitrarily accurate reports, including the exact unrounded tables.*

Proof. For every $s < 0$ and for the incoming germ at $s = 0$, all intrinsic tables in Propositions and are identical. Their event predicates differ. Any function of the same observed table must have the same value on both.

The exact clock word resolves this ambiguity. Rounded zero born-edge reports also fail to distinguish the outgoing germ from sufficiently small positive parameters. This is an observation-boundary obstruction for the specified reports, not a theorem excluding every possible observation.

Finite code and decoder

Use the following transverse dictionary:

$c\|c@$	$c\|c$labels	codes	labels	codes
hline P		0	A_i	$1 + i$
D_i		$4 + i$	B_i	$7 + i$
C_i		$10 + i$	e_i	$13 + i$
c_i		$16 + i$	t_i	$19 + i$
o_i		$22 + i$	u_i	$25 + i$
v_i		$28 + i$	w_i^-	$31 + i$
w_i^+		$34 + i$	V_i	$37 + i$
Q_i		$40 + i$	U_i^-	$43 + i$
U_i^+		$46 + i$	exterior rays	$49 + i$
exterior faces		$52 + i$		

There are 55 labels; six bits suffice. Codes 55–63 are invalid. The dictionary describes transverse cells and their open axial products. It does not purport to list every auxiliary axial-end boundary cell or every physical apparatus port.

For a precision $b \geq 0$, store for each of the 24 finite edge slots

$$q_e = \lfloor 2^b L_e/\ell \rfloor$$

in $b + 3$ bits; inactive slots have report zero. All lengths are less than 8ℓ. At dyadic s, the floor is determined exactly by rational comparison and squaring of nonnegative algebraic quantities. No arbitrary-real oracle is required.

The geometric and particle word has

$$B = 1 + r + (d + 2) + 1 + 24(b + 3) + 9 = 24b + d + r + 85$$

bits: mode, permission, signed exact j, fixed-family identifier, length reports, and a nine-bit fixed packet. The packet uses six bits for P and three symbolic identifiers for the geometric source, deficit, and rest/worldsheet frame. It does not approximate $\pi/2$ numerically.

A canonical word decodes to the exact family formula, parameter, mode-appropriate cellulation or germ, chart table, packet, and reports. For $j < 0$, only $m = 0$ is admitted; for $j > 0$, only $m = 1$ is admitted; at zero either mode denotes its stated germ. Exact formulas are reconstructed from the fixed family identifier and finite parameter, not from rounded lengths.

For n original names, reserve six current location bits and six history bits per name. Axial port coordinates and any additional spectator locations are independently declared. Actual live quantum ports in this paper lie in the regular collar; the abstract singular label is not a quantum wire on $\mathscr{W}$.

Constructive reversible realization

For each valid event word g, let $f(g)$ be its outgoing word with permission decremented. There are $2^r - 1$ such input words.

Theorem (Forward decoder and exact reversible extension). *There is a finite NOT–CNOT–Toffoli circuit whose action on the declared forward domain is*

$$|g\rangle_G|0\rangle_H|x_1,\dots,x_n\rangle_L|0,\dots,0\rangle_{L_H} \operatorname{longmapsto} |f(g)\rangle_G|g\rangle_H|x_1,\dots,x_n\rangle_L|x_1,\dots,x_n\rangle_{L_H}.$$

It acts identically on internal matter and returns its clean work to zero.

A sufficient total bit-carrier reserve is

$$M_E = 4B - 2 + 12n.$$

A constructive upper bound on elementary NOT, CNOT, and Toffoli gates is

$$G_E \le (2^r - 1)(4B - 1)(8B - 5) + 6n.$$

This bound is not asserted optimal.

Proof. On the $2B$ geometric/current-history bits, exchange each string $(g, 0)$ with $(f(g), g)$, and fix all other strings. These pairs are disjoint: the first components have different modes, and the second component of the output identifies its input. This defines a permutation.

A transposition of two N-bit strings can be implemented along a Gray path of at most N edges by at most $2N - 1$ adjacent-string transpositions. Each adjacent transposition is a NOT on one target controlled on the other $N - 1$ bits. Convert negative controls with NOT gates, compute the conjunction of the controls with $N - 2$ clean work bits, flip the target, and uncompute. This uses at most $4N - 5$ elementary gates for $N \ge 2$. Set $N = 2B$ and sum over the $2^r - 1$ pairs.

Finally, six CNOTs per name copy its basis-coded current location into the blank location-history block. The current and retained-history blocks require $2B + 12n$ bits, and the clean conjunction reserve is $2B - 2$. The decoder reads $f(g)$, which is precisely the stated outgoing germ with the spent permission.

Only the forward canonical domain is given a geometric meaning. Intermediate compiler states and off-domain strings are not asserted to be geometric configurations. The reverse permutation does not move a physical readout backward in T. Retained history is not clean work. The general reversible-computation context is standard [10]; the construction above provides the particular finite realization needed here.

Spectator blindness and a classical–quantum lift

Assumption (Complete spectator blindness). The guard, fixed-family validity check, geometric successor, certificate, permission decision, and original-name transport do not inspect internal matter, occupancy counts, or inaccessible spectators. Spectator location/history storage is separately reserved. The controller has no hidden spectator input.

Theorem (Complete spectator consistency). *The guarded geometry-only event satisfies Assumption . For an entangled extension* $\tilde{\rho}_{MN}$ *with* $\mathrm{Tr}_N \tilde{\rho}_{MN} = \rho_M$*, its geometric trace, certificate, permission change, and original-name locations are unchanged, and its restricted matter output is* ρ_M*.*

The same restriction statement holds history block by history block when prescribed local instruments are inserted.

Proof. The guard reads only m, j, v and fixed geometric validity. The transport is the same fixed label function for each original name; it does not test how many names exist. The event's internal matter channel is the identity. For an inserted selective map Φ,

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

by expansion in matrix units of N. Apply this identity along each fixed history.

For completeness, let G be a finite set of all admitted coded labels and retained histories, with invalid strings assigned a fixed no-action convention. If F is the complete deterministic classical successor, its hybrid channel is

$$(\mathscr{T}X)_h = \sum_{g\,:\,F(g)=h} X_g, \qquad X \in \mathrm{bigoplus}_{g \in \mathrm{G}} \mathscr{B}(\mathscr{H}_M).$$

Its full-matrix lift has Kraus operators

$$|F(g)\rangle\langle g| \otimes I_M.$$

Their squared moduli sum to the identity, proving complete positivity and trace preservation. The lift discards off-diagonal input label blocks; it is a declared classical interface, not a quantum superposition of geometries.

Finite destructive clock and an exact evaluation table

The complete instrument

Let C have dimension $D = 2^m$, with calibration basis $\{|\tau_a\rangle\}$. Let S include all surviving payload registers and let E be any untouched reference. Write $P_a = |\tau_a\rangle\langle\tau_a|$ and $D_a = \langle\tau_a|_C \otimes I_S$.

Theorem (Complete destructive-clock identity). *The channel implemented by a calibrated basis change followed by destructive Enter on all m clock names is*

$$\mathscr{M}_C(X) = \sum_a \mathrm{proj}\, a_R \otimes D_a X D_a^\dagger = \sum_a \mathrm{proj}\, a_R \otimes \mathrm{Tr}_C[(P_a \otimes I)X(P_a \otimes I)].$$

It is completely positive and trace preserving on all operators, including after tensoring with id_E. *It returns the code and the unnormalized conditional payload, and*

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

The clock has no quantum output factor.

Proof. The Kraus operators are $|a\rangle_R \otimes D_a$, and

$$\sum_a D_a^\dagger D_a = \sum_a P_a \otimes I_S = I_{CS}.$$

Expand $X = \sum_{a,b} |\tau_a\rangle\langle\tau_b| \otimes X_{ab}$. Both expressions in have block X_{aa}. Summing the blocks proves . The calculation includes a reference without change. Consumption is the declared destructive interface: after the measurement the C-names are unavailable as quantum inputs.

The distinction between record and conditional residual is standard instrument theory [8, 9]. Equation is the same explicit finite interface compared with I-B and En09-A [2, 22, 23], not a field-measurement theorem.

Four exact classical evaluations

Take a two-qubit clock and the four labels

$$s_0 = -1, \qquad s_1 = 0, \qquad s_2 = \frac{1}{2}, \qquad s_3 = 1.$$

At zero, the table uses the incoming regular cellulation. The outgoing zero germ is an independently retained metadata option, not six positive-area faces.

The exact values are

$c\|c\|c\|c\|c\|c\|ca$	s_a	$p(s_a)$	link valence	L_e^2/ℓ^2	L_u^2/ℓ^2	Area $(U_i^-)/\ell^2$
hline 0	-1	-1	3	5	0	0
1	0	0	3	5	0	0
2	1/2	1	6	45/16	9/16	9/44
3	1	2	6	5/4	9/4	9/11

Zeros in inactive u, U slots are reporting conventions. Their cells are not active.

The persistent-face area vector is

$$(3/2,\ 3/2,\ 117/88,\ 9/11).$$

The exact incidence-event indicator is

$$\varepsilon = (0, 1, 0, 0).$$

Every table column v_a defines a finite diagonal matrix

$$A_v = \sum_{a=0}^{3} v_a P_a.$$

These matrices represent already calculated values of the prescribed family. They are not acquired observables of an unknown continuum field.

For example, normalize the born-face area by 9/11:

$$q = (0, 0, 1/4, 1).$$

After clock readout, prepare a fresh pointer in $\sqrt{1-q_a}|0\rangle + \sqrt{q_a}|1\rangle$, conditional on the classical code a, then destroy that pointer.

Proposition (Exact finite table probe). *The resulting complete channel is*

$$\mathscr{T}(X) = \sum_{a,y} \operatorname{proj} a_R \otimes \operatorname{proj} y_Y \otimes p_y(a) D_a X D_a^{\dagger}, \qquad p_1(a) = q_a, \quad p_0(a) = 1 - q_a.$$

It is trace preserving, leaves the payload unacted upon within each clock block, and satisfies

$$\Pr(Y = 1 \mid a) = q_a.$$

The formula holds with every reference.

Proof. Use Kraus operators $\sqrt{p_y(a)}|a\rangle_R|y\rangle_Y D_a$. Completeness is $\sum_y p_y(a) = 1$ followed by clock completeness. The probability and reference identities follow.

On the canonical preparation $P_1 \otimes \rho_S$, the clock reports the event code with certainty. A source supplying that preparation supplies a representation promise. No inference from unknown geometry to this preparation has been constructed.

Calibration is not singular acquisition

Declare distinct physical time labels

$$\theta_a = T_* + \frac{\ell}{c} p(s_a).$$

The history dictionary can associate code a with $(s_a, \theta_a,$ table row, $J,$ germ convention). It does not determine the apparatus event at which a history readout is performed.

Proposition (Event-time and history-label calibration). *At one actual readout event e, exact event-time matching*

$$p_a > 0 \Rightarrow \theta_a = T(e)$$

with distinct θ_a permits at most one outcome. If $T(e)$ equals no θ_a, no normalized preparation satisfies that matching rule.

By contrast, a multi-outcome history experiment can be read at one later fixed event and interpreted through the separate history dictionary.

Proof. There is at most one label equal to $T(e)$, and probabilities sum to one. The history interpretation makes no equality claim between every θ_a and the one apparatus coordinate.

For event-code readout choose a regular laboratory event at $T = T_*$ and prepare $P_1 \otimes \rho_S$ there. Its coordinate equals the incidence-time label, but its spatial position is not the apex. This is preinstalled calibration, not a signal arriving from $\mathscr{W}$. A history experiment may instead be read at $T = T_* + 4\ell/c$, after all four labeled singular-intersection times.

A finite-duration reversible update performed afterward operates on metadata describing the prescribed zero germ. It does not physically cause an earlier singular incidence. The incidence was already part of the fixed classical family.

Proposition (No universal clock return and no finite CCR). *The channel $\mathscr{M}_C$ has no left inverse on its full input space. Finite matrices cannot satisfy $[T_C, H_C] = i\hbar I_C$ for $\hbar \neq 0$. Clock records do not uniquely determine a geometric dictionary.*

Proof. The distinct clock states

$$(|\tau_0\rangle + |\tau_1\rangle)/\sqrt{2}, \qquad (|\tau_0\rangle - |\tau_1\rangle)/\sqrt{2}$$

with the same payload have identical destructive outputs. Taking the trace of a commutator proves the second assertion. For the third, keep the finite channel fixed and change the declared time labels or local rod-frame dictionary. Its record law is unchanged.

The time axis T, metric $\bar{g}$, and worldsheet $\mathscr{W}$ are background data not removed by consuming C.

Optional relational conditioning, with its actual hypotheses

The following comparison is independent of the event table. It clarifies the connection with Page–Wootters conditioning [11, 22, 23].

Proposition (Conditioning becomes evolution only with covariance). *Let finite Hermitian H_C, H_S and a state ρ_{CS} satisfy*

$$[H_C \otimes I + I \otimes H_S, \rho_{CS}] = 0.$$

Suppose a complete orthonormal clock basis satisfies, at its declared readings t_a,

$$P_a = U_C(t_a)P_0U_C(t_a)^\dagger, \qquad U_C(t) = e^{-iH_Ct/\hbar}.$$

Then

$$\sigma_{S,a} = U_S(t_a)\sigma_{S,0}U_S(t_a)^\dagger, \qquad U_S(t) = e^{-iH_St/\hbar},$$

where $\sigma_{S,a} = D_a\rho D_a^\dagger$. *All reading probabilities equal* $1/D$.

The same evolution statement on $S \otimes E$ *requires stationarity of the full extension, not merely its CS marginal.*

Proof. Stationarity gives

$$(U_C^\dagger \otimes I)\rho(U_C \otimes I) = (I \otimes U_S)\rho(I \otimes U_S^\dagger).$$

Insert the covariant P_a into the partial-trace expression for $\sigma_{S,a}$ and use invariance of partial trace under clock conjugation. This gives the displayed equality. Its traces are equal and sum to one. The extended proof is the same precisely when the extended stationarity hypothesis holds.

No covariance or stationarity assertion is made for the nonuniform event-time table . Extraction alone does not supply it. The external schedule is retained throughout.

Observation and recovery separations

The geometry-only rule acts identically on matter. Appending a clock instrument is a different operation. We retain the VII-E/VII-G distinction between record and residual interfaces [19, 20, 21].

Theorem (Record pullback versus residual compatibility). *Let* $T : \mathscr{B}(H) \to \mathscr{B}(K)$ *be a channel,* $\{P_z\}$ *a projective resolution, q a coarse-graining, and* $\{\mathscr{I}_w\}$ *an instrument on K. Set*

$$\Pi_w = \sum_{q(z)=w} P_z, \quad \Delta_w(X) = \sum_{q(z)=w} P_zXP_z, \quad E_w = \mathscr{I}_w^*(I).$$

The recorded maps

$$\mathrm{FF}(X) = \sum_w \mathrm{proj}\, w \otimes T(\Delta_w(X)), \qquad \mathrm{GG}(X) = \sum_w \mathrm{proj}\, w \otimes \mathscr{I}_w(T(X))$$

have identical record laws on every state exactly when

$$T^*(E_w) = \Pi_w.$$

They agree on recorded residual observables $\sum_w \mathrm{proj}\, w \otimes B_w$, $B_w \in \mathscr{O}$, *exactly when*

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

The identities persist under untouched reference extension.

Proof. Pair the record probabilities with the input state to obtain Π_w and $T^*(E_w)$. Pair the w-residual block with B to obtain the two displayed adjoints. States separate Hermitian matrices; complex linearity and tensoring give the remaining conclusions.

Corollary (An ideal residual gap survives accurate implementation). *Identical records can conceal residual outputs of trace distance* 1/2. *If two implementations have errors* $\varepsilon_f, \varepsilon_c$ *on that witness, their mutual distance is at least*

$$\frac{1}{2} - \varepsilon_f - \varepsilon_c.$$

Proof. Take one coarse outcome, $T = \mathrm{id}$, and $\mathscr{I}_* = \mathrm{id}$. Fine computational projection produces dephasing. On $\rho_+ = \mathrm{proj}\,+$, the residuals are ρ_+ and $I/2$. Their difference is $X/2$, with eigenvalues $1/2, -1/2$. Use $d_{\mathrm{tr}} = \|\cdot\|_1/2$, then the triangle inequality.

The fine residual in this comparison is a represented pointer measurement returning the qubit. It is not a destructive return of that same measured qubit name.

Proposition (Informative records exclude whole-input recovery). *For a finite recorded instrument*

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

if some effect $\Psi_w^*(I)$ *is nonscalar, no channel recovers every input in the full quantum algebra from the complete*

record-plus-residual output.

Proof. Choose branch Kraus operators $K_{w,v}$. Kraus operators of $\mathcal{N}$ are $A_{w,v} = |w\rangle_R \otimes K_{w,v}$. If a recovery channel has Kraus operators B_j, then $B_j A_{w,v}$ is a Kraus family for the identity. The identity channel has rank-one Choi matrix, so each such operator is a scalar multiple of I. Completeness of the B_j implies

$$A^{\dagger}_{w,v} A_{v,\kappa} = \lambda_{w,v;v,\kappa} I.$$

In particular, summing the diagonal terms at fixed w makes $\sum_v K^{\dagger}_{w,v} K_{w,v}$ scalar, a contradiction.

This is the standard full-code correction mechanism [12, 9]. It concerns every unknown quantum input, not one expectation or an already classical label. It does not preclude recovery on a restricted code or correct transport of the surviving payload.

Fixed-table stability and its limit

Use half-diamond normalization $d_{\diamond}(\Phi, \Psi) = \|\Phi - \Psi\|_{\diamond}/2$.

Proposition (Exact fixed-table comparison). *If the table probe is replaced by one with probabilities $\hat{q}_a$, on the same code and payload interfaces, then*

$$d_{\diamond}(\mathcal{P}_q, \mathcal{P}_{\hat{q}}) = \max_a |q_a - \hat{q}_a|.$$

Thus numerical approximation of this fixed finite table has a complete-channel limit.

Proof. Clock pinching gives diagonal blocks X_{aa}, and the two binary-record coefficients differ by $\pm(q_a - \hat{q}_a)$. The amplified trace-norm difference is at most $2\max_a |q_a - \hat{q}_a| \sum_a \|X_{aa}\|_1$. Pinching is trace-norm contractive, giving the upper bound. Input $P_a \otimes \rho_S$ attains the bound at a maximizing index.

This convergence is not convergence of a finite-qubit field instrument. It does not authorize replacing the exact event guard by a continuous threshold or a rounded report. Proposition remains in force.

Schedule locality and certified physical containment

Let a finite metric site set (X, d_{comp}) carry finite quantum–classical local algebras. At layer j, let the complete channel factor over a partition $\mathscr{B}_j$, with $\operatorname{diam}_{d_{\mathrm{comp}}} B \le \Delta$. Every classical controller register read by a block is included in that block's input interface.

For terminal region Y, define

$$N_{n,n}(Y) = Y, \qquad N_{j-1,n}(Y) = \bigcup \{B \in \mathscr{B}_j : B \cap N_{j,n}(Y) \neq \varnothing\}.$$

Theorem (Typed scheduled support). *A terminal observable on Y pulls back to an observable supported on* $N_{0,n}(Y)$*, and*

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

Input states agreeing on that backward region, jointly with any retained reference, have equal corresponding output reductions.

Proof. The adjoint of a trace-preserving block map fixes its identity. Blocks disjoint from the current backward support therefore cannot enlarge it. A block meeting it enlarges it only inside that block. Backward induction proves support containment. Each layer adds at most one block diameter, proving the metric bound. Pairing all terminal observables proves the reduction statement, also with reference observables included.

The same argument works for prescribed gate envelopes rather than partitions, adjoining the full input envelope whenever its output is encountered in the backward graph. It fails if a supposedly local block reads an omitted remote controller.

Theorem (Influence, schedule, and physical cone). *For a complete finite network, intervention influence is contained in scheduled ancestry. If every actual input-output dependency edge has future-causal ports in* $(M, \bar{g})$*, scheduled ancestry is contained in the prescribed metric causal relation. Neither converse follows.*

Proof. Outside the backward network, replacement trace-preserving operations act only on identity factors of the

pulled-back observable and cannot change its expectation. Compose the supplied causal paths along any directed dependency path to obtain physical containment.

A replacement channel can ignore a scheduled input, showing that ancestry need not be influence. A causally related pair need not have an installed communication path, showing failure of the other converse.

This reproves the finite support pattern compared with En05-A, En03-A, and VII-J. The computational metric and block certificate are additional data; the physical diameter of the particle patch is not a substitute. Scheduler consistency does not derive this conical metric.

Buffered regular realization and exact causal transport

An explicit regular route

Choose sector-zero spatial ports

$$x_A = \ell(15/8, 15/8, 0), \qquad x_B = \ell(31/16, 15/8, 0).$$

The segment has length

$$L = \ell/16.$$

It lies strictly inside the horizontal collar $7/2 < \rho < 4$ and away from the seam and worldsheet. A sufficiently thin regular tube around it is a single developing chart.

For any chosen integer $n \geq 1$, install sites

$$x_j = x_A + \frac{j}{n}(x_B - x_A), \qquad j = 0, \ldots, n,$$

each with a p-qubit payload register S_j. Initialize $S_1, \ldots, S_n$ in one fixed blank state ω. All source and receiver site reserves are included in the initial laboratory data.

At hop j, admit a content-exchange communication channel between S_{j-1} and S_j, with duration $L/(nc)$. Its two transfer directions have null-related ports. This is a stipulated finite communication primitive, not an instantaneous

spatially extended unitary.

Theorem (Reference-preserving payload transport). *After hop j, an arbitrary input* ρ_{S_0E} *has become*

$$\rho_{S_jE} \otimes \mathrm{bigotimes}_{\mathrm{substack}\,0 \le i \le n}$$

Thus the logical payload channel is exactly the identity, including every reference. Arrival is $T_{\mathrm{dep}} + L/c$*, and all communication dependencies lie inside the prescribed causal cone.*

Proof. The first exchange moves the whole payload factor and its reference correlations into S_1, leaving a blank in S_0. Repeat inductively. Each hop covers distance L/n in time $L/(nc)$, so its transfer paths are null in the developing chart and causal after pullback.

Location/history data can be included in the transported finite payload, or forwarded as separately classical registers. A classical control record is copied only in its designated classical basis and transmitted on an explicit causal wire.

Corollary (Transport of the complete recorded instrument). *If the clock is read at the sender and its record is causally forwarded with the surviving payload, the receiver obtains*

$$\sum_a \mathrm{proj}\, a_{R_B} \otimes \mathscr{V}\left(D_a X D_a^{\dagger}\right),$$

where $\mathscr{V}$ *is the exact relocation identity. Any record-controlled operation at the receiver is performed only after both required inputs arrive. This is the same complete instrument with relocated output.*

Proof. Apply Theorem with the classical record included in the reference. Forward that jointly classical record explicitly, then apply the same conditional maps at the receiver. Equality holds blockwise, including references.

Proposition (No instantaneous remote SWAP). *A zero-duration SWAP or identity transmission between the two distinct simultaneous ports is not admitted.*

Proof. Orthogonal sender inputs would produce distinguishable receiver outputs, hence intervention influence. The simultaneous distinct endpoints are spacelike and violate Theorem 's causal-port condition.

The buffer through the incidence parameter

Store the payload at the regular sender during the complete geometric window. At this port the marking crosses its static worldline at $t = s + 2$, hence at times $1 \le t \le 3$. The event at the worldsheet occurs at $t = 0$. Neither the storage channel nor its port touches the defect.

For the multi-outcome history experiment, complete clock readout at $t = 4$. Run the finite metadata circuit afterward. Give every elementary local gate a fixed positive duration γ, and, if necessary, an additional positive interval for record packaging. Choose departure after their sum.

A pointer used for a finite table probe is prepared and destroyed locally, with its own positive-duration slot. No logical identity allowing deferral changes this actual timing or memory ledger.

Proposition (A physically causal buffered execution exists). *The clock, reversible metadata circuit, storage, table probe, record forwarding, and target-adapted route admit one complete finite causal schedule in the regular tube. Its decoded geometric zero-germ update remains the exact update of Theorem .*

Proof. All local gate input and output ports are on the same static worldline and separated by positive time. The source table, exact guard word, and history reserves are preinstalled. Choose the departure time after the finite local gate list. The route uses the causal hops already proved. The decoder depends on the exact stored geometric parameter, not on the later physical execution time.

The last distinction is substantive: the circuit realizes a finite representation of the stipulated event, not an apparatus causing or observing a singular gravitational process at $t = 0$.

Resource ledger

Let

$$P_{\mathrm{pay}} = p + 2B + 12n_{\mathrm{m}},$$

where p is the number of internal matter qubits and n_{m} the number of original names whose current and history locations are represented. Here $2B + 12n_{\mathrm{m}}$ counts the current metadata and retained history after the reversible

event; clean work is not transported.

For a route with n hops, a sufficient reserve is:

$l\|l$resource	sufficient amount
hline payload site registers	$(n+1)P_{\text{pay}}$qubits
event clean work at sender	$2B-2$qubits
finite clock	2qubits, then consumed
optional table pointer	1qubit after clock readout
clock record buffers	$2(n+1)$classical bits
optional binary probe record	1classical bit
physical payload exchanges	n
classical record forwarding	$n$links
metadata elementary gates	$(2^{r}-1)(4B-1)(8B-5)+6n_{\text{m}}$

Using the clock before the metadata circuit, and the pointer after clock consumption, gives the sufficient quantum peak

$$Q_{\text{peak}} \le (n+1)P_{\text{pay}} + \max\{2B-2, 2\}.$$

The metadata registers are basis-coded when decoded as classical geometry; their quantum-carrier implementation does not make the cone a quantum variable. A purely classical implementation can reduce the charged quantum storage but is not needed for this bound.

All blanks at unused sites are counted. Spectator and external-reference holdings are separate. No claim of optimal storage, physical energy cost, Landauer saturation, or thermal reversibility is made.

Proposition (Complete implementation-error ledger). *For a fixed compatible sequence of ideal channels* $\Phi_1, \dots, \Phi_N$ *and implementations* $\widetilde{\Phi}_1, \dots, \widetilde{\Phi}_N$,

$$d_{\diamond}(\widetilde{\Phi}_N \cdots \widetilde{\Phi}_1, \Phi_N \cdots \Phi_1) \le \min\left\{1, \sum_{j=1}^{N} d_{\diamond}(\widetilde{\Phi}_j, \Phi_j)\right\}.$$

Records, histories, failures, and work outputs must remain on the same comparison interfaces.

Proof. Subtract the compositions and replace one factor at a time. Each summand has one difference of corresponding factors with channels before and after it. Diamond-norm contraction under channel composition and the triangle inequality give the bound. Half-diamond distance between channels is at most one.

This finite error estimate is not a continuum limit, a singular field estimate, or a uniform estimate after normalization of arbitrarily rare branches.

Assembly and precise release

Theorem (VII-F-ST local Grade S release). *For the declared inputs and finite permissions, the following package exists:*

1. *the prescribed conical* 3 + 1 *background, its singular worldsheet, finite developing atlas, and compact regular laboratory;*

2. *an embedded uniformly spacelike product marking with exactly one transverse incidence-event parameter, changing the normal transverse particle link from three faces to six;*

3. *exact coordinates, lengths, areas, one-sided laws, and nondegeneracy checks for every transverse cell in the compact certificate;*

4. *one common positively primitive, reference-framed affine peripheral holonomy on the collar, core, outgoing star, and both zero germs;*

5. *an exact geometry-only guard, spectator-blind location metadata transport, and a decoder-correct finite reversible implementation with explicit storage and gate bounds;*

6. *a complete finite destructive-clock instrument, an exact four-row evaluation and table-probe package, and explicit event-time/history-label separation;*

7. *a buffered causal execution and exact reference-preserving transport of the finite payload and its classical control record. These assertions satisfy Definition . They do not construct Grade E.*

Proof. Propositions and , together with Definition , give (i). Theorem , Theorem , and Corollary give (ii). Section gives (iii). Theorems and give (iv). Section gives (v). Theorem , Proposition , and Proposition give (vi). Section gives (vii). The five Grade S clauses have therefore been supplied. No extraction of the background geometry from records occurs.

What is new in the adaptation

The source's transverse kinematic event is retained, not renamed as a new gravitational process. The additional result is an end-to-end finite certificate with:

• an explicit dimension correction from worldline to worldsheet;

• separate geometric and operational supports;

• complete selective-map and reference identities;

• an exact finite guarded decoder with a constructive gate bound;

• a finite evaluation instrument and complete-channel error ledger;

• a regular buffered causal realization with charged route resources. The package can be used as a finite consistency benchmark for later proposed field acquisition or dynamics interfaces. It does not supply those missing interfaces.

Necessary limitations of the geometric claim

The admitted faces may be nonconvex and regular vertices need not be trivalent. This certificate is not an admission theorem for every stricter polygon calculus. The simultaneous three-to-six expansion is not claimed generic in the space of all slicings, and is not identified with one universal elementary transition catalogue.

In 3 + 1 dimensions there is one event *parameter* and an axial event locus, not an isolated singular event point. Only a transverse section has the finite vertex/edge/face counts. The axial product is stated explicitly; no compact axial taper or additional event-free interpolation is inferred.

Documentary comparisons, not incorporated premises

The supplied source comparisons have the following roles:

• I-B supplies the finite spacetime-interface pattern; En09-A supplies the conditioning/dynamics distinction [2, 22, 23].

• VII-E, VII-G, and VII-E-ST distinguish records, residual instruments, and whole-input recovery. They do not derive this cone or turn slicing selection into gravitational dynamics [19, 20, 21].

• VII-J, En03-A, and En05-A distinguish scheduled support, intervention influence, and independently certified physical causality.

• VI-B and VII-A-ST are supported Grade S presentation comparisons. Their classical descent, source equations, and plateau calculations are not imported.

• VIII-A/B/C concern preconstructed conical packets and separate source interfaces. Their packet families do not select this deficit, and a promised source token is not an acquisition instrument [21].

• The OpenAI catalogue is attributed to OpenAI. It supplies no formal premise, cone, field instrument, clock, or verification of this adaptation [13].

Standing analytical and physical boundaries

The supplied XIV-H historical H2 ending is not discharged here. It is distinct from XIV-I's constructed internal I2 amplitude. That internal amplitude is not the complete characteristic operation still missing at I3/J2.

No joint characteristic map, complete quantum remainder, transverse extension, singular contact compatibility theorem, output wavefront admission, or inherited quantum coefficient is constructed. The downstream quantum-admission exit called XV-B is not opened; this does not deny the existence of technical manuscripts with that identifier.

XVI-N and its universal obligations are not discharged. Within the stated XVI-O prescription,

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

Separately scoped revisions using enlarged prescriptions do not update that specific statement or admit the inherited insertion. The quantum certificate remains RG-open: no quantum renormalization separator is proved by this finite package.

par **Standing refusals** par Not spacetime emergence, Grade E, Einstein dynamics from records, a sourced Einstein–scalar solution, a global conical Cauchy/Green theorem, or an intrinsic conical field theory.

Not a cosmological bounce, ultraviolet completion, radiative coefficient, quantum Ward/BRST/BV identity, Page curve, island, interior, vacuum-energy stability theorem, 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 unknown quantum input. Matter-controlled slicing is not matter-driven gravitational dynamics.

The clock encoding is not the geometric time axis. The event code is not a detector at the worldsheet. No inherited quantum coefficient is admitted. par

appendix

Finite certificate checklist

1.18 toprule Certificate item Explicit witness

midrule Prescribed deficit and spinless gluing $\mu = \pi/2$, $J = (\mathrm{diag}\,(1, R(\pi/2), 1), 0)$.

Seam-compatible graph ρ, h, k agree on each identified ray.

Uniform spacelike margin $1 - \lambda^2 = 1/9$.

Strict ordering $1 \le \Delta F/\Delta s \le 2$.

Core–crest separation $\rho(C_i) \le 30/11 < 3$.

Nonvanishing persistent face $\mathrm{Area}\,(V_i) \ge 9\ell^2/11$.

Born edges $3\ell s/2,\ 3\ell\sqrt{41}s/11, ?3\ell\sqrt{65}s/22$.

Born faces $9\ell^2 s^2/11$, six copies.

Event guard Exact $m = 0$, $j = 0$, $v \ge 1$, with canonical validity.

Primitive winding Angular lift increment $3\pi/2$, separately from J.

Full affine matching $\mathcal{A}^{-1}(\mathcal{A}J\mathcal{A}^{-1})\mathcal{A} = J$.

Code space 55 transverse labels in six bits; exact dyadic parameter.

Event reserve $4B - 2 + 12n_{\mathrm{m}}$, $B = 24b + d + r + 85$.

Clock instrument Kraus family $|a\rangle_R(\langle\tau_a| \otimes I)$.

Finite acquisition boundary Known table input; no continuum-to-code extraction map.

Regular route Collar segment of length $\ell/16$.

Complete logical transport id on payload, including untouched references.

Physical timing Positive local gate durations and n causal hops.

bottomrule

Optional registry-facing scope record

The following text is a proposed documentary record, not an assertion that any external registry or user interface was updated.

identifier: VII-F-ST?grade: local Grade S?problemConnectionsFor: ["time"]?emergenceStatus: not constructed?quantumCertificate: RG-open??relationshipRole: separation?relationshipDistinction:? A documentary separation is not a proof transfer.??scope:? A supported classical transverse incidence certificate,? its explicit product lift, and a finite destructive-clock? encoding with reference-preserving causal transport.??standingBoundaries:? O.1 remains NOT_CLOSED in the stated XVI-O prescription.? The downstream XV-B quantum-admission exit is not opened.? XVI-N is not discharged.? Historical H2 and full I3/J2 records are not discharged.? No inherited quantum coefficient is admitted.

Suitable emergence-walk wording is: VII-F-ST realizes a finite readout and transport interface for one prescribed conical slicing certificate. It does not derive the cone, change the worldsheet, or measure an unknown singular

geometry.

Declarations

Authorship. The author field is intentionally empty for anonymous review. Authorized author and affiliation metadata are required for a signed submission. Citation of N. Cheung, registry attribution, or citation of OpenAI does not assign authorship of this adaptation.

Provenance. The classical formulas are adapted from the identified VII-F source and reproved on the stated presentation. The I-B and companion records identify interface patterns and scope distinctions, not unprinted theorem premises. Some comparisons are available only through the version-specific passages supplied with the problem; no independent verification of their complete programmes is asserted.

Verification and implementation. This is one standard pdfLaTeX source with an internal bibliography. No successful pdfLaTeX execution, proof-assistant verification, numerical execution, physical circuit compilation, experiment, independent referee certification, or journal acceptance of this adaptation is asserted.

Book expansion notes (t433u)

Destructive Enter on a clock register consumes the encoding and leaves the geometric time axis [22]. The slicing event is not quantized relational time without an external clock. Observation-boundary and CP-instrument source records: [19], [20].

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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