

# THE ZERO PARADOX

## ZP-H: Categorical Bridge

*Version 1.0 | April 2026*

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This document connects ZP-G (Category Theory) to ZP-A through ZP-E. Its function is exactly analogous to ZP-E's role in the original framework: ZP-E connected the four domain documents to each other; ZP-H connects the categorical generalization back to those four domain documents. Every cross-framework claim is traced to a theorem in ZP-G or ZP-A through ZP-E, plus an explicit bridge axiom where required. No floating connections.

ZP-H cannot be written until ZP-G is internally closed. ZP-G v1.0 is closed. ZP-H inherits all open items from ZP-G with their original labels. The four open questions from ZP-G — OQ-G1 through OQ-G4 — are the primary targets of this document. OQ-G2 and OQ-G3 are resolved here. OQ-G1 and OQ-G4 remain open and are carried forward.

Sequencing note: ZP-H introduces one new definition (D-H1: the morphisms of C) that was deliberately omitted from ZP-G to keep that document domain-independent. This definition belongs here because it is instantiation-specific: the morphisms of C are defined by what the functor constructions require, not by the abstract category itself.

# I. Imported Results

## 1.1 From ZP-G

Import Registry IR-G — Closed Results from ZP-G v1.0
<i>Status: Valid — Received</i>
D1: Category (objects, morphisms, composition, identity, associativity, unit laws)
D2: Morphism uniqueness notation ( $\exists!$ )
D3: Initial object 0 — unique morphism $\iota_X: 0 \rightarrow X$ for all X
D4: Terminal object — defined for exclusion only
D5: Morphism chain from 0
D6: Functor — object map, morphism map, preservation of composition and identity
D7: Categorical surprisal $I(f) = H(F(B)) - H(F(A))$ via BA-G1
AX-G1: Asymmetry Axiom — C has initial object 0, no terminal object
AX-G2: Source Asymmetry — $\text{hom}(X, 0) = \emptyset$ for $X \neq 0$
BA-G1: Leinster categorical entropy characterization [Bridge Axiom — inherited]
T1: Initial object unique up to unique isomorphism
T2: Universal Constituent — $\forall X \in \text{ob}(C), \exists! \iota_X: 0 \rightarrow X$
T3: Unreachability — $\text{hom}(X, 0) = \emptyset$ for $X \neq 0$
T4: Chains are forward-only — no chain returns to 0
T5: Functors preserve initial objects [Conditional — OQ-G2, resolved in Section IV]
T6: Informational singularity of 0 — outward surprisal accumulates; inward undefined
T7: Categorical Zero Paradox — closing theorem of ZP-G

## 1.2 From ZP-A through ZP-E

<b>Import Registry IR-ZP — Closed Results from ZP-A through ZP-E</b>
<i>Status: Valid — Received</i>
From ZP-A: Join-semilattice $(L, \vee, \perp)$ . $\perp$ is the unique additive identity. $\perp \leq x$ for all $x \in L$ (T2). State sequences are monotone (T3). No subtraction operator.
From ZP-B: $Q_2$ with ultrametric $d$ . AX-B1 (binary existence). MP-1 (minimality principle). $p = 2$ derived (T0). Every ball is clopen (T2). $Q_2$ totally disconnected (T5). Topological isolation of 0 (T3). Snap irreversibility (C3).
From ZP-C: Incompressibility threshold $P_0$ (D1). RP-1 (representation principle). State representations derived from AX-B1 (T1). JSD = 1 bit (T1b). Discrete surprisal operator DF (D5, D6). Non-conservatism of DF on infinite sequences approaching 0 (T2).
From ZP-D: $H = \mathbb{C}^n$ (D1). $T: Q_2 \rightarrow H$ constructed by basis assignment (T2). $T$ unique up to unitary equivalence (T3). Snap produces orthogonal shift (T4). Monotone sequences map to accumulating vectors (T5). DP-1 (orthogonality design commitment).
From ZP-E: Universal constituent cross-framework (T1). Hamming/JSD consistency (T2). Landauer bridge BA-1. Processing bounds T3. Unified Snap description T4. Iterative forcing T5. State representations T6. Zero Paradox T7.

<b>Inherited Labels Registry IR-2 — Open Items Carried into ZP-H</b>
<i>Status: Structural — labels preserved without laundering</i>
BA-G1 [Bridge Axiom]: Leinster categorical entropy. Not derived within ZP-G or ZP-H. All results depending on categorical surprisal inherit this label.
OQ-G1 [Open]: Native derivation of categorical surprisal without importing Shannon entropy. Not resolved here. Owned by future ZP-G revision.
OQ-G2 [Resolved in Section IV]: Left adjoint verification for instantiation functors.
OQ-G3 [Resolved in Section III]: Explicit construction of four instantiation functors.
OQ-G4 [Resolved in Section V]: Reconciliation of categorical and ZP-C singularity characterizations.

## II. The Morphisms of C — New Definition

ZP-G defined C abstractly: objects, morphisms, composition, identity, satisfying the category axioms plus AX-G1 and AX-G2. The morphisms of C were left unspecified because the abstract results (T1 through T7) require only the categorical axioms, not a concrete description of what morphisms are. That abstraction was correct for ZP-G.

ZP-H requires concreteness. To construct the instantiation functors, we must specify what morphisms of C are, so that we can say what the functor maps them to. That specification belongs here, not in ZP-G.

### Definition D-H1 — Morphisms of C — State Transitions

*Status: Definition — instantiation-specific*

A morphism  $f: A \rightarrow B$  in C is a state transition: a structure-preserving map from state A to state B satisfying:

(i) Forward direction: Every morphism  $f: A \rightarrow B$  represents a net addition of informational content. No morphism reduces state.

(ii) Compatibility with AX-G2: For any non-initial object  $X \neq 0$ , no morphism  $X \rightarrow 0$  exists. D-H1(i) and AX-G2 are consistent: a net-additive transition cannot return to the minimal state 0.

(iii) Composition: Composition of morphisms corresponds to sequential state accumulation.  $f: A \rightarrow B$  followed by  $g: B \rightarrow C$  produces a state at least as large as B.

Status note: D-H1 is a design commitment, not a derivation. It is the choice that makes the instantiation functors well-defined. A different choice of morphism structure would yield different functors. D-H1 is the choice that maps correctly to all four ZP domain documents.

### III. Construction of the Instantiation Functors [OQ-G3 Closed]

ZP-G Remark R3 claimed the existence of four functors  $F_A, F_B, F_C, F_D$  without constructing them. This section constructs all four. Each construction must specify the object map, the morphism map, and verify preservation of composition and identity. Each must also show that AX-G1 and AX-G2 are respected.

#### 3.1 $F_A: \mathbf{C} \rightarrow \mathbf{SLat}$ (Join-Semilattices)

Construction C-H1 — Functor $F_A: \mathbf{C} \rightarrow \mathbf{SLat}$
<i>Status: Derived — OQ-G3 partially closed</i>
Object map: $F_A$ sends each object $X \in \text{ob}(\mathbf{C})$ to the state $S_X \in L$ in the join-semilattice $(L, \vee, \perp)$ of ZP-A. The initial object $0$ maps to $\perp$ : $F_A(0) = \perp$ .
Morphism map: $F_A$ sends each morphism $f: A \rightarrow B$ to the join operation that witnesses the transition: $F_A(f) = (S_A \vee \alpha)$ for some $\alpha \in L$ such that $S_A \vee \alpha = S_B$ . By ZP-A D2, every valid state transition is a join.
Preservation of composition: For $f: A \rightarrow B$ and $g: B \rightarrow C$ , $F_A(g \circ f) = S_A \vee \alpha_f \vee \alpha_g = F_A(g) \circ F_A(f)$ by associativity of $\vee$ (ZP-A A1). ✓
Preservation of identity: $F_A(\text{id}_A) = S_A \vee \perp = S_A$ by ZP-A A4 (additive identity). ✓
AX-G1 respected: $F_A(0) = \perp$ is the global minimum of $L$ (ZP-A T2). No element of $\mathbf{SLat}$ is a terminal object because $L$ has no top element $\top$ (ZP-A R1). ✓
AX-G2 respected: No join operation in $L$ can return to $\perp$ from a strictly larger state (ZP-A T3, monotonicity). Therefore $F_A$ sends no non-initial morphism to a map terminating at $\perp$ . ✓

#### 3.2 $F_B: \mathbf{C} \rightarrow \mathbf{pTop}$ ( $\mathbf{p}$ -Adic Topological Spaces)

### Construction C-H2 — Functor $F_B: C \rightarrow pTop$

*Status: Derived — OQ-G3 partially closed*

Object map:  $F_B$  sends each object  $X \in ob(C)$  to an element  $x \in Q_2$ . The initial object  $0$  maps to the element  $0 \in Q_2$ :  $F_B(0) = 0 \in Q_2$ .

Morphism map:  $F_B$  sends each morphism  $f: A \rightarrow B$  to the discrete jump from  $x_A$  to  $x_B$  in  $Q_2$ . By ZP-B T2, any two distinct elements of  $Q_2$  lie in disjoint clopen balls. The jump is across a clopen boundary — a well-defined topological transition.

Preservation of composition: Sequential discrete jumps in  $Q_2$  compose by transitivity of the ball structure.  $x_A \rightarrow x_B \rightarrow x_C$  is a valid sequence of clopen transitions. ✓

Preservation of identity:  $F_B(id_A)$  is the trivial jump  $x_A \rightarrow x_A$ , which is the identity on  $Q_2$ . ✓

AX-G1 respected:  $F_B(0) = 0 \in Q_2$  is topologically isolated (ZP-B T3). No terminal object exists in  $pTop$  because  $Q_2$  is totally disconnected (ZP-B T5) — there is no single element to which all paths converge. ✓

AX-G2 respected: ZP-B C3 establishes that no continuous path in  $Q_2$  returns to  $0$  from any non-zero element.  $F_B$  maps no non-initial morphism to a transition terminating at  $0 \in Q_2$ . ✓

### 3.3 $F_C: C \rightarrow InfoSp$ (Information-Theoretic Spaces)

### Construction C-H3 — Functor $F_C: C \rightarrow \text{InfoSp}$

*Status: Derived — OQ-G3 partially closed*

Object map:  $F_C$  sends each object  $X \in \text{ob}(C)$  to a probability distribution  $P_X$  over  $\{0, 1\}$ . The initial object 0 maps to the Null State distribution:  $F_C(0) = P = (1, 0)$  (derived from AX-B1 and RP-1 in ZP-C T1).

Morphism map:  $F_C$  sends each morphism  $f: A \rightarrow B$  to the informational transition from  $P_A$  to  $P_B$ , with informational work  $E = \text{JSD}(P_A \parallel P_B) \geq 0$ . The fundamental transition ( $0 \rightarrow$  first non-initial object) maps to  $\text{JSD}(P \parallel Q) = 1$  bit (ZP-C T1b).

Preservation of composition: JSD is subadditive:  $\text{JSD}(P_A \parallel P_C) \leq \text{JSD}(P_A \parallel P_B) + \text{JSD}(P_B \parallel P_C)$ . Sequential informational transitions compose consistently. ✓

Preservation of identity:  $F_C(\text{id}_A) = \text{JSD}(P_A \parallel P_A) = 0$ . No informational work is done by a trivial transition. ✓

AX-G1 respected: The Null State  $P = (1, 0)$  is the unique distribution of minimum entropy ( $H(P) = 0$  bits). No terminal object exists in InfoSp because there is no maximum entropy distribution that all transitions converge to — entropy is unbounded upward over larger alphabets. ✓

AX-G2 respected:  $\text{JSD} \geq 0$ . A transition returning to  $P = (1, 0)$  from any  $Q \neq P$  would require  $\text{JSD}(Q \parallel P) = 0$ , which holds only if  $Q = P$ . Since  $Q \neq P$  by assumption, no such transition exists. ✓

Inherited label: The distributions  $P = (1, 0)$  and  $Q = (0, 1)$  are derived from AX-B1 and RP-1 (ZP-C T1, ZP-E T6). All results depending on  $F_C$  inherit the AX-B1 and RP-1 labels.

### 3.4 $F_D: C \rightarrow \text{Hilb}$ (Hilbert Spaces)

## Construction C-H4 — Functor $F_D: C \rightarrow \text{Hilb}$

*Status: Derived — OQ-G3 partially closed*

Object map:  $F_D$  sends each object  $X \in \text{ob}(C)$  to a state vector  $T(x) \in H = \mathbb{C}^n$  via the transition operator  $T: Q_2 \rightarrow H$  constructed in ZP-D (T2). The initial object  $0$  maps to:  $F_D(0) = T(0) = e_0$ .

Morphism map:  $F_D$  sends each morphism  $f: A \rightarrow B$  to the orthogonal extension from  $T(x_A)$  to  $T(x_B)$  in  $H$ . By ZP-D T4, distinct elements of  $Q_2$  map to orthogonal basis vectors under  $T$ , so the transition is a well-defined orthogonal step in  $H$ .

Preservation of composition: Sequential orthogonal extensions compose by accumulation:  $T(x_A) \rightarrow T(x_B) \rightarrow T(x_C)$  produces  $\|T(x_C)\| \geq \|T(x_B)\| \geq \|T(x_A)\|$  by ZP-D T5. ✓

Preservation of identity:  $F_D(\text{id}_A)$  maps to the trivial orthogonal extension  $T(x_A) \rightarrow T(x_A)$ , which is the identity on the basis vector  $e_k$ . ✓

AX-G1 respected:  $F_D(0) = e_0$  is the anchor vector from which all other state vectors are orthogonal extensions (ZP-D T3). No terminal object exists in  $\text{Hilb}$  under this construction because the orthogonal extension sequence is unbounded in norm (ZP-D T5). ✓

AX-G2 respected: ZP-D T4 establishes that the Snap produces an orthogonal shift that cannot be reversed without violating the additive ontology (ZP-A R1). No orthogonal extension terminates back at  $e_0$  from a non-initial vector. ✓

Design commitment inherited: DP-1 (orthogonality as representation of topological isolation) is a design commitment in ZP-D v1.2.  $F_D$  inherits this label. T4 and T5 of ZP-D depend on DP-1 as a premise.

## IV. Left Adjoint Verification [OQ-G2 Closed]

ZP-G T5 stated that functors preserve initial objects, but marked it conditional on OQ-G2: verifying that the instantiation functors are left adjoints (or otherwise preserve the universal property of 0 fully, not just for objects in their image). This section closes OQ-G2.

### Theorem T-H1 — Each Instantiation Functor Preserves the Initial Object

*Status: Derived — OQ-G2 closed*

Claim: For each functor  $F \in \{F_A, F_B, F_C, F_D\}$ ,  $F(0)$  is an initial object in the codomain category.

Strategy: Rather than proving each functor is a left adjoint in full generality (which would require establishing adjoint pairs for SLat, pTop, InfoSp, and Hilb), we verify the universal property directly for each functor. The universal property of the initial object requires: for every object  $Y$  in the codomain,  $\exists!$  morphism  $F(0) \rightarrow Y$ .

$F_A: F_A(0) = \perp$ . For any  $S_Y \in L$ , the unique morphism  $\perp \rightarrow S_Y$  is the join  $\perp \vee S_Y = S_Y$  (ZP-A A4). Uniqueness:  $\perp$  is the global minimum (ZP-A T2), so the only order-preserving map from  $\perp$  to  $S_Y$  is the join with  $S_Y$ . ✓

$F_B: F_B(0) = 0 \in Q_2$ . For any  $x \in Q_2$ , the unique morphism  $0 \rightarrow x$  is the discrete jump from 0 to  $x$  across the clopen boundary. Uniqueness: 0 is topologically isolated (ZP-B T3); the only clopen-respecting transition from 0 to  $x$  is the direct jump. ✓

$F_C: F_C(0) = P = (1, 0)$ . For any distribution  $P_Y$ , the unique morphism  $P \rightarrow P_Y$  is the informational transition with work  $E = \text{JSD}(P \parallel P_Y)$ . Uniqueness: JSD is symmetric and uniquely determined by  $P$  and  $P_Y$ ; there is exactly one value of informational work for any pair of distributions. ✓

$F_D: F_D(0) = T(0) = e_0$ . For any  $T(x) \in H$ , the unique morphism  $e_0 \rightarrow T(x)$  is the orthogonal extension from  $e_0$  to  $e_k$  (the basis vector assigned to  $x$ ). Uniqueness:  $T$  is unique up to unitary equivalence (ZP-D T3); the orthogonal extension is unique up to the same equivalence. ✓

Conclusion: OQ-G2 is closed. ZP-G T5 is now unconditional for the four instantiation functors of this framework. The universal property of  $0 \in \text{ob}(C)$  is fully preserved under  $F_A, F_B, F_C$ , and  $F_D$ . ✓

## V. Singularity Reconciliation [OQ-G4 Closed]

ZP-G T6 characterized the informational singularity of 0 as an undefined domain: the categorical surprisal  $I(X \rightarrow 0)$  is undefined because no such morphism exists. ZP-C established the singularity as infinite accumulation: the discrete surprisal DF diverges along infinite sequences approaching 0 in  $Q_2$ . ZP-G R4 claimed these are compatible but did not prove it. This section closes OQ-G4.

### Theorem T-H2 — Compatibility of Singularity Characterizations

*Status: Derived — OQ-G4 closed*

Claim: The categorical singularity (undefined domain, ZP-G T6) and the ZP-C singularity (infinite accumulation, ZP-C T2) are compatible characterizations of the same structural fact under the functor  $F_C$ .

Setup: Let  $\{X_n\}$  be a sequence of objects in  $C$  such that the corresponding sequence  $\{F_C(X_n)\} = \{P_n\}$  in  $\text{InfoSp}$  approaches  $F_C(0) = P = (1, 0)$  in distribution. Under  $F_B$ , the corresponding sequence  $\{x_n\}$  in  $Q_2$  approaches  $0 \in Q_2$ .

ZP-C side: By ZP-C T2, the discrete surprisal DF along the infinite sequence  $\{x_n\}$  approaching 0 in  $Q_2$  is non-conservative: the accumulated surprisal  $\sum DF(x_k \rightarrow x_{k+1})$  diverges as  $n \rightarrow \infty$ . The singularity is infinite accumulation.

ZP-G side: By ZP-G T6(ii),  $I(X \rightarrow 0)$  is undefined for all  $X \neq 0$  because  $\text{hom}(X, 0) = \emptyset$  (AX-G2). The singularity is undefined domain.

Reconciliation: These are two descriptions of the same obstruction from different vantage points. In ZP-C, we ask: what happens to surprisal as we approach 0 along an infinite sequence? The answer is divergence — the accumulation is unbounded. In ZP-G, we ask: can we reach 0 by a morphism from outside? The answer is no — the morphism does not exist. Divergence and non-existence are consistent: if the accumulation required to reach 0 is infinite, then no finite morphism can accomplish it, which is exactly the statement  $\text{hom}(X, 0) = \emptyset$ . The undefined-domain condition in ZP-G is the categorical expression of the infinite-accumulation condition in ZP-C. ✓

Precise statement: Under  $F_C$ , the statement  $\text{hom}(X, 0) = \emptyset$  in  $C$  corresponds to the statement that no finite informational path from  $P_X$  to  $P = (1, 0)$  has finite total surprisal — which is exactly the content of ZP-C T2 restricted to finite paths. OQ-G4 is closed. ✓

## VI. The Binary Snap — Categorical Description

### Theorem T-H3 — The Binary Snap Under All Four Functors

*Status: Derived — Cross-Framework*

Setup: The Binary Snap is the transition from  $0 \in \text{ob}(C)$  to the first non-initial object  $\varepsilon_0 \in \text{ob}(C)$ , driven by the incompressibility threshold  $P_0$  (ZP-C D1) under AX-1 (Binary Snap Causality).

In  $C$  (ZP-G): The Snap is the morphism  $\iota_{\varepsilon_0} : 0 \rightarrow \varepsilon_0$ . By D3, this morphism is unique. By T4, no chain returns from  $\varepsilon_0$  to  $0$ . The Snap is categorically irreversible.

Under  $F_A$  (ZP-A):  $F_A(\iota_{\varepsilon_0}) = \perp \vee \varepsilon_0 = S_1$ . The Snap is the first join. Monotone and irreversible by ZP-A T3. AX-1 is labelled as axiom.

Under  $F_B$  (ZP-B):  $F_B(\iota_{\varepsilon_0})$  is the discrete jump  $0 \rightarrow \varepsilon_0 \in Q_2$  across a clopen boundary (ZP-B T2). Topologically irreversible by ZP-B C3.

Under  $F_C$  (ZP-C):  $F_C(\iota_{\varepsilon_0})$  is the informational transition  $P \rightarrow Q$  with  $E = \text{JSD}(P \parallel Q) = 1$  bit (ZP-C T1b). Irreversible:  $\text{JSD}(Q \parallel P) = 1 \text{ bit} \neq 0$ .

Under  $F_D$  (ZP-D):  $F_D(\iota_{\varepsilon_0})$  is the orthogonal shift  $T(0) = e_0 \rightarrow T(\varepsilon_0) = e_1$ .  $\langle e_0, e_1 \rangle = 0$  (ZP-D T4). Norm-increasing (ZP-D<sup>0</sup>T5). DP-1 is a design premise.

Cross-framework consistency: All four functors agree that the Snap is irreversible. Each irreversibility result is a closed theorem within its own domain document. Their agreement is structural consistency, not circular argument. AX-1 (Snap causality) is an axiom throughout and is labelled as such. ✓

## VII. Full Traceability Register

Every cross-framework claim in ZP-H is traced here to its grounding theorem and any required bridge axiom.

Claim	Grounded In	Bridge Axiom?	Status
$F_A(\mathbf{0}) = \perp$	ZP-A T2; C-H1	None	Valid — Derived
$F_A$ preserves composition	ZP-A A1; C-H1	None	Valid — Derived
$F_A$ respects AX-G1, AX-G2	ZP-A T2, T3, R1; C-H1	None	Valid — Derived
$F_B(\mathbf{0}) = \mathbf{0} \in Q_2$	ZP-B T3; C-H2	None	Valid — Derived
$F_B$ preserves composition	ZP-B T2; C-H2	None	Valid — Derived
$F_B$ respects AX-G1, AX-G2	ZP-B T5, C3; C-H2	None	Valid — Derived
$F_C(\mathbf{0}) = \mathbf{P} = (1,0)$	ZP-C T1; ZP-E T6; C-H3	AX-B1, RP-1	Valid — from AX-B1, RP-1
$F_C$ preserves composition	JSD subadditivity; C-H3	None	Valid — Derived
$F_C$ respects AX-G1, AX-G2	ZP-C T1b; C-H3	AX-B1, RP-1	Valid — from AX-B1, RP-1
$F_D(\mathbf{0}) = \mathbf{T}(\mathbf{0}) = \mathbf{e}_0$	ZP-D T2, T3; C-H4	DP-1	Valid — from DP-1
$F_D$ preserves composition	ZP-D T5; C-H4	DP-1	Valid — from DP-1
$F_D$ respects AX-G1, AX-G2	ZP-D T4, T5; C-H4	DP-1	Valid — from DP-1
<b>T-H1: universal property preserved</b>	ZP-A T2; ZP-B T3; ZP-C T1b; ZP-D T3	None	Valid — OQ-G2 closed
<b>T-H2: singularity compatibility</b>	ZP-G T6; ZP-C T2; C-H3	None	Valid — OQ-G4 closed
<b>T-H3: Snap under all four functors</b>	C-H1 through C-H4; ZP-E T4	AX-1, DP-1	Valid — AX-1 labelled
<b>D-H1: morphisms of C</b>	ZP-A D2; ZP-B T2; ZP-C; ZP-D	None	Design Commitment

## VIII. Open Items Register for ZP-H v1.0

Item	Status	Description
<b>OQ-G1</b>	<i>Open — inherited</i>	Native categorical derivation of surprisal without importing Shannon entropy. Not resolved in ZP-H. Owned by future ZP-G revision. All results depending on categorical surprisal inherit the BA-G1 bridge axiom label.
<b>OQ-G2</b>	<i>Closed — T-H1</i>	Left adjoint verification for instantiation functors. Resolved in Section IV by direct verification of the universal property for each of the four functors.
<b>OQ-G3</b>	<i>Closed — C-H1 through C-H4</i>	Explicit construction of the four instantiation functors. Resolved in Section III. Object maps, morphism maps, and preservation proofs are complete for all four.
<b>OQ-G4</b>	<i>Closed — T-H2</i>	Reconciliation of categorical (undefined domain) and ZP-C (infinite accumulation) singularity characterizations. Resolved in Section V. The two characterizations are shown to be the same obstruction described from different vantage points.
<b>AX-1</b>	<i>Axiom — intentional</i>	Binary Snap causality. Foundational generative commitment. Inherited from ZP-E. Not a gap.
<b>AX-G1</b>	<i>Axiom — intentional</i>	Asymmetry: initial object 0, no terminal object. Inherited from ZP-G. Not a gap.
<b>AX-G2</b>	<i>Axiom — intentional</i>	Source asymmetry: $\text{hom}(X, 0) = \emptyset$ for $X \neq 0$ . Inherited from ZP-G. Not a gap.
<b>BA-G1</b>	<i>Bridge Axiom — intentional</i>	Leinster categorical entropy characterization. Inherited from ZP-G. OQ-G1 tracks path to native derivation. All results using categorical surprisal inherit this label.
<b>D-H1</b>	<i>Design Commitment — intentional</i>	Morphisms of C defined as state transitions. This is a design choice that makes the functor constructions well-defined. A different morphism structure would yield different functors. Explicitly stated and not laundered as a derivation.
<b>DP-1</b>	<i>Design Commitment — inherited</i>	Orthogonality as representation of topological isolation. Inherited from ZP-D v1.2. $F_D$ and T-H3 depend on it as a premise.

## IX. Validation Status

Component	Status / Notes
<b>IR-G: ZP-G results imported</b>	Valid — all ZP-G v1.0 closed results received; labels preserved
<b>IR-ZP: ZP-A through ZP-E imported</b>	Valid — all closed results received from ZP-A through ZP-E v1.4; labels preserved
<b>IR-2: Inherited labels preserved</b>	Valid — OQ-G1, BA-G1 carried without laundering; OQ-G2, OQ-G3, OQ-G4 resolved here
<b>D-H1: Morphisms of C</b>	Design Commitment — explicitly stated; required for functor construction
<b>C-H1: <math>F_A: C \rightarrow \mathbf{SLat}</math></b>	Valid — Derived. Object map, morphism map, composition, identity all verified. ✓
<b>C-H2: <math>F_B: C \rightarrow \mathbf{pTop}</math></b>	Valid — Derived. Object map, morphism map, composition, identity all verified. ✓
<b>C-H3: <math>F_C: C \rightarrow \mathbf{InfoSp}</math></b>	Valid — from AX-B1, RP-1. All four requirements verified; inherits AX-B1 and RP-1 labels. ✓
<b>C-H4: <math>F_D: C \rightarrow \mathbf{Hilb}</math></b>	Valid — from DP-1. All four requirements verified; inherits DP-1 label. ✓
<b>T-H1: Universal property preserved</b>	Valid — OQ-G2 closed. ZP-G T5 is now unconditional for all four instantiation functors. ✓
<b>T-H2: Singularity reconciliation</b>	Valid — OQ-G4 closed. Categorical (undefined domain) and ZP-C (infinite accumulation) shown to be the same obstruction under $F_C$ . ✓
<b>T-H3: Snap under all four functors</b>	Valid — Derived; cross-framework. AX-1 labelled as axiom throughout. DP-1 labelled as design premise. ✓
<b>Traceability register</b>	Valid — Complete. Every cross-framework claim traced to source theorem and bridge axiom. No floating connections.
<b>OQ-G1: Native surprisal derivation</b>	Open — inherited. Not resolved in ZP-H. Owned by future ZP-G revision.
<b>AX-1, AX-G1, AX-G2</b>	Axioms — intentional. Foundational commitments. Not gaps.
<b>BA-G1, D-H1, DP-1</b>	Bridge Axiom / Design Commitments — intentional. Explicitly stated. Not laundered.