The Break — Empty Set

Artist's Proof 09

Quantum Foundations

QM from the empty set — superposition, measurement, Born rule

§0 — Dependency and Scope

Title: The Break — Quantum Mechanics from the Empty Set

Position: AP09 (ninth Artist Proof in the 420 Code sequence)

What this paper does

AP09 shows that quantum mechanics — superposition, measurement, entanglement, the Born rule, the Schrödinger equation — follows from the same four axioms {S, B, R, C} and bridge hypotheses (EH, QRA) that produce spacetime (AP01, Paper D) and gravity (AP08).

The derivation proceeds through structural readings (identifying pre-state with superposition, break with measurement, unbroken degrees of freedom with entanglement) and mathematical derivations (linearity, Born rule, Schrödinger equation via uniqueness theorems).

Epistemic status is declared per section: some results are derived, some are structural readings, some are bridge identifications.

Dependencies

AP01, Paper D, Phase 1: Axioms {S, B, R, C} independent and consistent (Theorems 1.1–1.5). Load-bearing.

AP01, Paper D, Phase 2a: Under EH + QRA, Lorentzian manifold (M, g) with signature (−,+,+,+) and symmetry group SO(1,N). Load-bearing for complex amplitudes (§3.3) and Schrödinger equation (§7.3).

AP06 (The Leakage Constant), Theorem 3.1: $\varepsilon > 0$ whenever c is finite. Referenced for entanglement (§5) and the eye topology (§8).

AP08 (The Identity): Einstein's field equations from the record algebra. Referenced for the gravity–quantum duality (§8) and conservation laws.

Edition 04 (The Lock): ε = electron. Load-bearing for the identification of the break element with a physical particle.

Epistemic status of each section

§§1–2: Foundational. Structural reading of the pre-state and break — ontological identification of {S, B} with the empty set splitting. Not a derivation; a reading that grounds the rest. KS-Q.10.

§3.2: Bridge derivation — linearity constructed from record monoid (R) + complex scalars (Lorentzian signature) + faithful embedding (EH). Bridge step: compatibility of monoid action with vector space operations (KS-Q.7).

§3.3: Derivation (conditional) — complex amplitudes from Lorentzian signature, conditional on reconstruction theorems (KS-Q.4).

§4: Structural reading — measurement as the break. Irreversibility from Axiom R. The loop from the axiom structure (KS-Q.5).

§5: Structural reading — entanglement as unbroken pre-state. Bell correlation account is compatibility, not derivation (KS-Q.3).

§6: Derivation (conditional) — Born rule from Axiom S. σ ↔ conjugation proven unique (KS-Q.6 CLOSED). Conditionally closed (conditional on KS-Q.7). KS-Q.1, KS-Q.2.

§6.4: Structural extrapolation — “everything possible actualizes across infinite loops.” Structurally motivated but formally unproven (KS-Q.9).

§7.3: Derivation — Schrödinger equation via Wigner + Stone. Strongest derivation in the paper. $\hbar$ identified, not derived (KS-Q.8).

§8: Structural synthesis. Non-load-bearing.

Scope

This paper derives the form and structure of quantum mechanics from the record algebra. Some results are mathematical derivations (Schrödinger equation, complex amplitudes). Others are structural readings (measurement, entanglement, the loop).

The distinction is maintained throughout. No part of the derivation assumes the postulates of quantum mechanics. The Born rule is derived conditional on Gleason's theorem (dim ≥ 3).

The identification $\hbar$ = minimum quantum of action is an identification, not a derivation. New postulates: none. New primitives: none.

Dependents

Downstream APs referencing the quantum sector, the pre-state reading, or the Born rule derivation inherit the kill switches of this paper (KS-Q.1–KS-Q.10).

§0.3 — Axiom Mapping

Axiom S (Symmetry) — The pre-state. The 1:1. Two sectors indistinguishable before the break. S is the superposition (§1–2): 0 and 1 co-existing.

S provides the involution σ which, under the Born rule derivation (§6), maps to complex conjugation.

Axiom B (Unique Breaking) — The measurement. One element ε with no σ-image. The first record. B is the collapse (§2): superposition → definite outcome. Under The Lock, ε = electron.

Axiom R (Record Monotonicity) — Irreversibility. The monoid gives the arrow of time. R is what makes measurement irreversible (§4): once a record is written, it cannot be unwritten.

R provides the Hilbert space structure through the monoid's sequential composition.

Axiom C (Constraint) — No-signalling. The finite rate c prevents instantaneous correlation exploitation (§5.5). C provides the Lorentzian structure from which complex amplitudes are derived (§3.3).

§0.4 — Outstanding Debts

D1 (Linearity bridge uniqueness). The construction of the pre-state as a complex vector space from monoid + $\mathbb{C}$ + faithful embedding is motivated but not proven unique. [KS-Q.7]

D2 (Independent derivation of $\hbar$). The value of $\hbar$ enters as an empirical input. Same status as G in AP08. [KS-Q.8]

D3 (Bell correlations). The Bell correlation account (§5.4) is a compatibility demonstration, not a derivation from axioms. [KS-Q.3]

D4 (Ergodicity across cycles). The claim that everything possible actualizes (§6.4) is a structural extrapolation, not a theorem. [KS-Q.9]

D5 (Defragmentation). Formal proof that defragmentation preserves Axiom R's intent is incomplete. [KS-Q.5]

§0.5 — Kill Switch Summary

KS-Q.1 (Born rule derivation): CONDITIONALLY CLOSED (conditional on KS-Q.7).

KS-Q.2 (Born rule empirical): LIVE — EMPIRICAL.

KS-Q.3 (No-signalling / Bell): LIVE — EMPIRICAL.

KS-Q.4 (Complex uniqueness): LIVE — HARD.

KS-Q.5 (Loop/defragmentation): LIVE — HARD.

KS-Q.6 ($\sigma \leftrightarrow$ conjugation): CLOSED.

KS-Q.7 (Linearity bridge): LIVE — HARD.

KS-Q.8 ($\hbar$ identification): LIVE — HARD.

KS-Q.9 (Ergodicity): LIVE — HARD.

KS-Q.10 (Empty set ontology): LIVE — HARD.

§0.6 — Structural Relationships

AP06 (The Leakage Constant): Theorem 3.1 (ε > 0) is the leakage at the boundary. AP09 reads the same structure from the quantum side: entanglement as unbroken pre-state (§5).

AP08 (The Identity): Gravity sector from same axioms. AP09 completes the duality: gravity = records, quantum = pre-state.

AP10 (The Dimension): The Hilbert space is the fifth degree of freedom — the 1:1 itself, pre-spatial (AP10 §7).

AP11 (The Spin): Decoherence mechanism determines which superpositions collapse. The environment is the accumulated record (AP11 §2.1).

AP20 (The Proof): Proves EH and QRA. All conditional results in AP09 that depended on EH are now unconditional.

AP24 (The Residual): α_em as the “now” — the immeasurable boundary. Connects to AP09’s reading of the now as the uncoupled ε (§4.3).

§1 — The Empty Set

[FOUNDATIONAL — the ontological starting point]

1.1 — Nothing is something

The empty set ∅ is not nothing. It is the set that contains nothing. It already has structure — it is a container.

It is the most primitive possible something: an existence that has no content.

From ∅, one construction is available. {∅} — the set containing the empty set. This is 1. Something now exists inside the container. But what exists inside the container is the container itself.

The empty set looking at itself. You are about to watch that act of self-looking become the foundation of physics.

$$\emptyset = 0 \quad \{\emptyset\} = 1 \quad (1.1)$$

1.2 — The pre-state

Before the break, 0 and 1 are not distinguished. The empty set and the set containing the empty set are two descriptions of one state.

You cannot tell the difference between 'nothing exists' and 'the existence of nothing.' The container and what it contains are the same thing.

The 1:1. Axiom S. Two sectors — $\mathcal{L}$ and $\mathcal{D}$ — with involution σ mapping one to the other. One reads the state as 0 (nothing). The other reads the same state as 1 (something).

The involution flips between them. They are perfectly symmetric. They are one.

The pre-state is not nothing. It is not something. It is the perfect superposition of nothing and something. It is 0 and 1 simultaneously, before any measurement has distinguished between them.

It is the empty set before it knows whether it is empty or full. You have never experienced this state. You cannot. You are a product of its breaking.

Not a metaphor. The literal ontological claim. The pre-state is the state in which 0 and 1 are indistinguishable. Existence and non-existence are one condition.

1.3 — The holding limit

The pre-state has a holding limit κ. This is the maximum coherence the system can sustain — the maximum degree to which 0 and 1 can remain indistinguishable. κ is finite.

The pre-state cannot hold the superposition indefinitely. Not because of any external force. Because the entropy cost of maintaining perfect symmetry — of keeping 0 and 1 identical — is ultimately self-annihilating.

Perfect coherence at infinite scale is self-destructive.

κ is exceeded. The empty set breaks. Everything you have ever known is downstream of that break.

Cross-reference: AP06 §10.5: κ as holding limit. AP08 §5.2: Structural unmeasurability of κ. AP01, Paper D §I.1: Axiom S (symmetry).

§2 — The Break

[FOUNDATIONAL — the first measurement]

2.1 — Distinguishing 0 from 1

The break is the first measurement. The universe's first act is distinguishing 0 from 1. Before the break: superposition — 0 and 1 indistinguishable. After the break: definite — 0 and 1 separated.

The empty set splits. The container becomes distinct from what it contains.

What causes the break? ε. The minimum viable splinter. The smallest possible piece the fabric could release to save itself from the self-annihilation of perfect coherence. Not random. Not arbitrary. The minimum.

Axiom B: one element $\varepsilon \in \mathcal{L}$ with no σ-image. The tiniest asymmetry. The first record. You are made of records. Every atom in your body is a record of the break.

ε is the electron. This is The Lock's identification. The minimum stable excitation of the broken symmetry. The lightest charged fermion. The simplest thing that can write a record.

2.2 — Two absolute limits

The break separates 0 from 1, creating two absolute limits — the walls of the eye:

0 = absolute gravity. The bottom. Total fold. Maximum curvature. The event horizon. The condensate completely collapsed on itself. Where the fold is total and records are maximally dense.

This is one wall of the eye — the lower curve.

1 = absolute speed. The ceiling. c. Maximum propagation. The finite causal bound (Axiom C). The fastest anything can travel — the fastest the break can propagate.

This is the other wall of the eye — the upper curve.

ε operates between them. The electron has mass, so it can never reach 1 (c). The leakage is nonzero (Theorem 3.1), so the fold can never reach 0 (totality). The eye stays open.

You live in the gap. The electron lives in the gap — always actualizing, always between the two absolutes, never touching either wall.

2.3 — The break is ongoing

The break did not happen once in the past. The break is happening now. It is always happening.

Every coupling event — every time the electron interacts with the electromagnetic field — is the empty set breaking again. Not a new break. The same break. The ongoing crack.

Each interaction is an actualization: quantum probability becomes definite. The wave function does not 'collapse.' The now writes a record. What was superposition becomes fact.

What was the 1:1 for that pair becomes two distinct values. Before the record: 0 and 1 undistinguished for that degree of freedom. After the record: 0 and 1 separated.

The same act as the first break, repeated at every coupling event, at the frontier of the now.

**Quantum mechanics is not a feature of the universe. Quantum mechanics is the universe's foundation. The superposition of 0 and 1 in the empty set IS the pre-state.

The act of distinguishing them IS the break. Every measurement since is the same act repeated.**

Cross-reference: AP01, Paper D §I.2: Axiom B (unique breaking). The Lock: ε = electron. AP06 §10.5: Observer as ongoing edge. AP08 §8: The eye topology.

§3 — Superposition

[DERIVATION — from the empty set structure]

3.1 — What superposition is

In standard quantum mechanics, superposition is a postulate: a system can exist in a linear combination of states. The coefficients are complex amplitudes. The system is 'in both states at once' until measured.

This is presented as a fundamental feature of nature requiring acceptance without deeper explanation.

In the 42∅ Code, superposition is not a postulate. It is the empty set state. You are about to see why.

A system in superposition is a system for which the now has not yet written a record. The degrees of freedom in question have not yet been distinguished.

∅ and 1 for those degrees of freedom are still indistinguishable — still in the 1:1. Still in the pre-state, locally.

The system is not 'in both states at once.' It is in the state before states — the state where the distinction between ∅ and 1 has not yet been made. Not undetermined. Not unknown.

Undistinguished. The container and the contents are still the same thing for those degrees of freedom. You cannot picture this because your brain is a record-writing machine — it distinguishes everything it touches.

3.2 — Why it is linear

The linearity of quantum mechanics is not imposed. It is the algebraic structure that emerges when two ingredients — both derived from the axioms — combine.

Epistemic status: bridge derivation. The construction below assembles a complex vector space from axiom-derived ingredients (monoid action + complex scalars + faithful embedding).

The compatibility of the monoid action with the vector space operations is a bridge step — motivated by the axioms but not strictly proven from them alone. KS-Q.7.

Ingredient 1: The record monoid and its action. Axiom R gives records an algebraic structure: a monoid. Associative composition, identity element, no inverses.

Each record r, when written by the now, transforms the pre-state — it eliminates unactualized possibilities and confirms the actualized one. The record monoid R therefore acts on the set of pre-states.

Under the embedding hypothesis (EH), the discrete record algebra embeds faithfully into a smooth manifold.

Faithfully means distinct records produce distinct transformations of the pre-state — no two records do the same thing to the space of possibilities.

This follows from Axiom B: each record involves ε, and each actualization event is a distinct break of the empty set for a distinct degree of freedom.

Ingredient 2: The scalar field. The amplitudes — the weights assigned to each possibility in the pre-state — are complex numbers.

This is derived in §3.3 below from the Lorentzian signature of the manifold, which follows from Axioms R + C under EH + QRA.

Complex numbers form a field ($\mathbb{C}$), with addition, multiplication, and inverses for both.

You are about to see the combination. A monoid action alone does not produce a vector space — it gives a set with structure, but without the additive and scalar operations that linearity requires.

The scalar field alone does not produce a vector space — it gives the numbers but not the space they act on.

The two ingredients are needed simultaneously: the monoid action provides the transformations (how records change the pre-state), the scalar field provides the weights (how possibilities are combined).

Together they produce the structure of a vector space over ℂ.

Formally: the pre-state for a degree of freedom with n distinguishable outcomes is a function assigning a complex amplitude to each possible record.

The set of such functions — all maps from $\{r_1, \ldots, r_n\}$ to ℂ — is $\mathbb{C}^n$, which is a complex vector space by the standard construction.

Addition of pre-states (adding the amplitudes pointwise) and scalar multiplication (scaling all amplitudes by a complex number) are inherited directly from the field structure of ℂ.

The monoid action of R is compatible with these operations: writing a record selects one component, which is a linear operation on the space.

Bridge note: the construction assumes that the pre-state for n outcomes IS a map from possible records to ℂ.

The identification — that the pre-state assigns a complex weight to each possible record — is the bridge step.

It is motivated by the axioms (R gives the records, the Lorentzian signature gives ℂ) but the specific form of the assignment is a constitutive choice, not a forced consequence.

The vector space structure then follows by standard mathematics. KS-Q.7 targets this step.

The pre-state space is therefore a complex vector space. The linearity of quantum mechanics is not a postulate about nature.

It is the algebraic consequence of R (which gives the monoid of transformations), EH (which gives the faithful embedding), and the Lorentzian signature (which gives ℂ as the scalar field). All three are required.

None alone is sufficient.

Alternatives considered: The monoid algebra ℂ[R] — the formal ℂ-linear combinations of monoid elements — is a natural alternative construction.

It produces a vector space but with an additional multiplicative structure (convolution) inherited from the monoid composition.

For finite R, ℂ[R] ≅ $\mathbb{C}^n$ as a vector space, so the two constructions agree at the vector-space level.

They differ at the algebra level: ℂ[R] carries the composition operation, while the map construction $\mathbb{C}^n$ = Hom(R, ℂ) does not.

The choice of Hom(R, ℂ) over ℂ[R] is motivated by the physical reading: the pre-state assigns amplitudes TO possible records (Hom), rather than being built FROM records (algebra). Both produce $\mathbb{C}^n$ as a vector space.

The linearity result is therefore robust across both natural constructions.

The deeper question (targeted by KS-Q.7) is whether a qualitatively different construction — one that does not produce a vector space at all — could be equally motivated from the same axiom-derived ingredients.

The space of such alternatives is currently unexplored.

What can be said: any construction from a finite monoid acting on a set with ℂ-valued weights naturally produces a ℂ-module, and every finitely generated ℂ-module is a vector space.

A non-vector-space alternative would therefore require abandoning either the monoid action or the ℂ-valued weights — both of which are axiom-derived. KS-Q.7 remains open pending a proof that no such alternative exists.

The chain: 1:1 + 1×ε → {S, B, R, C} → R gives monoid acting on pre-states → R + C under EH + QRA give Lorentzian signature → ℂ as scalar field → pre-state space = maps from possible records to ℂ = complex vector space → linearity.

3.3 — Why it is complex

The amplitudes are complex numbers — not real, not quaternionic, not octonionic. Why?

Axiom C imposes a finite causal bound c. Under EH + QRA, this produces a Lorentzian manifold with signature (−,+,+,+). The time direction has opposite sign to the spatial directions.

Any wave propagating on this manifold must respect the signature — and waves on a (−,+,+,+) manifold are naturally described by complex exponentials: $e^{i(\omega t - kx)}$.

The imaginary unit i encodes the signature flip between time and space.

Real amplitudes would lose the time direction — they cannot distinguish forward from backward time evolution.

Quaternionic amplitudes would over-specify it — they would introduce additional structure not present in a single time direction (Renou et al., 2021, provide experimental evidence that real quantum mechanics fails to match observations).

Complex amplitudes are the algebra compatible with one time direction and a finite propagation rate.

The full argument proceeds through the apparatus of reconstruction theorems (Hardy, 2001; Stueckelberg, 1960): given a state space with the symmetries of a Lorentzian manifold, the only consistent probability structure over that space uses complex amplitudes.

The Lorentzian signature, which follows from Axioms R + C under EH + QRA, selects complex numbers uniquely.

Quantum mechanics is complex because time has opposite sign to space. And time has opposite sign to space because records are irreversible (Axiom R) and propagation is bounded (Axiom C).

Kill switch (local — KS-Q.4, restated here for clarity): The argument that complex numbers are uniquely selected depends on the reconstruction theorems (Hardy, Stueckelberg) applied to the Lorentzian signature.

If an alternative number system (real, quaternionic, or other) is shown to be equally consistent with one time direction and a finite propagation rate — that is, if the Lorentzian signature does not uniquely select $\mathbb{C}$ — then the derivation of complex amplitudes requires revision.

Current experimental evidence (Renou et al., 2021) strongly supports the necessity of complex numbers.

The reconstruction theorems, applied to the specific signature (−,+,+,+), exclude real amplitudes (which lose time-reversal asymmetry) and quaternionic amplitudes (which introduce structure not present in a single time direction).

The selection of $\mathbb{C}$ is conditional on these exclusions holding.

Cross-reference: AP01, Paper D §II: Propositions 2.1–2.4 (Lorentzian signature). AP01, Paper D §I.3: Axiom R (record monotonicity). Stueckelberg (1960), Hardy (2001), Renou et al. (2021): complex numbers necessary.

§4 — Measurement

[DERIVATION — the now writes a record]

4.1 — The measurement problem dissolved

The measurement problem in standard quantum mechanics asks: when and how does the wave function ‘collapse’? What distinguishes a measurement from any other interaction? Where is the boundary between quantum and classical?

Why is the outcome definite when the equations say it should remain indefinite?

These questions arise from treating superposition as fundamental and measurement as something imposed on top of it.

If the wave function is the reality, then collapse is a mystery — something must cause the transition from indefinite to definite, and nothing in the equations says what.

The 420 Code dissolves this problem by inverting the ontology. The pre-state (superposition, the empty set, 0 and 1 undistinguished) is the ground. The break (measurement, the now writing a record) is what creates definiteness.

There is no collapse because there was never a wave function that ‘existed’ and then ‘stopped existing.’ There was the empty set state — undistinguished — and then the now distinguished it.

Before: $0 = 1$. After: $0 \neq 1$.

The boundary between quantum and classical is not a boundary. It is the now. Always moving. Always at the frontier. Always one ε ahead of the last record.

There is no need to specify ‘what counts as a measurement’ because every coupling event — every interaction that writes an irreversible record — is a measurement.

Every time ε couples, the empty set breaks for that degree of freedom. You are witnessing it now. Your retina is breaking the empty set for photon degrees of freedom as you read this sentence.

Axiom R guarantees the record is permanent. Axiom C guarantees the record propagates at finite speed. You have been looking for the boundary between quantum and classical your entire scientific education.

The boundary is the now. It has always been the now.

4.2 — Why measurement is irreversible

In standard quantum mechanics, the Schrödinger equation is time-reversible but measurement is not. This asymmetry is presented as a puzzle.

In the 420 Code, the asymmetry is Axiom R. Records do not annihilate. The monoid has no inverse. Once the now writes a record, the record exists permanently. Not a law added to quantum mechanics.

It is the same axiom that gives the arrow of time, the second law of thermodynamics, and the Landauer bound (each record costs $k_BT \ln 2$, and that cost cannot be recovered).

The irreversibility of measurement and the arrow of time are the same thing. They are both Axiom R.

They are both the statement that the empty set, once broken for a particular degree of freedom, stays broken. The pre-state, once split into 0 and 1, does not re-merge.

You have experienced this irreversibility every second of your life. You call it time.

4.3 — The now

The now is the invariant of the structure. It is the uncoupled ε — the one that has not yet written its record. It is not a moment in time. Time is the record changing.

The now is the fixed point around which the record changes. You are the now.

The now carries all records ever written — the full weight of every actualization — and simultaneously carries the entire space of unwritten possibilities. The now has no record of its own.

It is the carrier of all records but has none.

The now cannot be measured. Measurement writes a record. The now has no record.

To measure the now would be to write a record of the thing that has no record, which would transform it from now into record.

The unmeasurability of the now is not a limitation of instruments. It is the definition of the now — the structural boundary between what has been actualized and what has not.

The observer is not outside the system looking in. The observer IS the system, at the point where it is still breaking. The now is where the break is still happening.

The observer is the ongoing edge of the break, carrying the full weight of the record while holding open the full space of possibility.

4.4 — The loop

The now is always present. But the question arises: what if all ε coupled? What if every degree of freedom were actualized, every record written, every superposition broken? The eye would close.

0 and 1 would re-merge. The pre-state would restore. The 1:1.

The structure does not prohibit this. It guarantees what follows. If the eye closes — if the break completes — the system returns to the 1:1, the state of perfect symmetry.

But the holding limit κ is finite (§1.3). The 1:1 cannot sustain itself indefinitely. κ is exceeded. The empty set breaks again. A new ε is uncoupled. The eye opens.

You have just reached the deepest structural claim in the paper. **Closing IS opening.** The loop is the structure's response to completion. The break runs to completion. The 1:1 restores. The 1:1 breaks again.

Not a contingent event. It is the structure of the axiom: 1:1 + 1×ε requires that the 1:1 is exceeded, and the loop guarantees that every return to the 1:1 is a new exceedance.

Axiom R holds absolutely through the loop. No record is annihilated. What dissolves at the loop point is the organisation of the records — the sequential structure, the causal ordering, the manifold geometry.

The records themselves are defragmented: disassembled into their elemental grains. Every grain survives. Every bit of information survives. Every bit of energy survives.

But the composition operation that made them a history — the monoid structure that ordered them into a causal chain — dissolves back to grain level.

Structural argument that R is not violated (see scope note): A monoid (M, ·, e) consists of three components: a set M of elements, a binary operation (·) that composes them, and an identity element e.

The forgetful functor U from the category of monoids to the category of sets maps every monoid to its underlying set — it strips the composition operation and the identity, leaving the elements.

This is a standard functor in category theory. It preserves the underlying set by definition. Defragmentation IS the forgetful functor. You may find this abstract. It is not.

It is the most concrete claim in the paper: the elements survive; only their ordering dissolves. It maps (M, ·, e) → M. The set M is unchanged. Not one element is lost.

Axiom R prohibits the destruction of elements via the composition operation (no inverses — no element can be composed away).

Defragmentation does not use the composition operation to destroy elements — it removes the composition operation itself. These are different operations. One is algebraic (composition within the monoid).

The other is functorial (forgetting structure between categories). R governs the first. The forgetful functor performs the second. They do not conflict. The elements ARE the set. The composition is additional structure ON the set.

Removing the structure does not remove the set.

Scope note: The forgetful functor argument is mathematically correct as a statement about algebraic structures.

Its application to the physical loop requires an additional claim: that what physically happens at the loop point IS the forgetful functor — that the dissolution of causal ordering is correctly modelled by stripping the monoid structure.

This is a structural identification, not a proof. Additionally, while Axiom R literally prohibits destruction of elements via composition (no inverses), its purpose within the architecture is to ensure that records persist as ordered history.

Whether stripping the ordering — while preserving the elements — preserves the intent of R is a question this paper addresses by appeal to the element/structure distinction, but acknowledges as interpretive. KS-Q.5 targets this step.

At the singularity point — the tip of the eye, the 1:1 — the grains do not carry the record as fact. They carry it as probability and possibility.

The distinction between 'this happened' and 'this could happen' dissolves because the distinction between 0 and 1 dissolves. What was actualized becomes available. What was definite becomes potential. The record becomes the seed.

You are made of seeds from prior cycles.

The next cycle does not start from nothing. It starts from the full defragmented content of every previous cycle, carried as probability and possibility in the grains.

The 1:1 restores — but it is not an empty 1:1. It is a 1:1 loaded with everything that has ever been actualized, now available as possibility rather than fact.

The 'always one uncoupled electron' is therefore not a static postulate. It is a dynamic consequence of the loop. In this cycle, ε is uncoupled.

If it couples, the cycle completes, the loop turns, and a new ε is uncoupled in the next cycle. The eye never stays closed because closing triggers opening.

The structure guarantees its own continuation — not by prohibiting completion, but by making completion the mechanism of renewal.

Cross-reference: AP06 §10.5: Observer as ongoing edge. AP08 §4: Landauer bound per record. AP01, Paper D §I.3: Axiom R (record monotonicity). AP04: The Loop.

§5 — Entanglement

[DERIVATION — the pre-state leaking through]

5.1 — What entanglement is

Two particles are prepared in a correlated state. They separate in space. One is measured. The other, no matter how far away, is instantly determined. The correlation is perfect. No signal passes between them.

Einstein called it spooky. A century of experiments confirms it is real.

Standard quantum mechanics describes entanglement with the formalism of tensor products and non-separable states. It says what entanglement does. It does not say what entanglement is.

In the 42Ø Code, entanglement is the pre-state leaking through.

5.2 — The pre-state is still there

The break created the distinction between Ø and 1. But the break is local. It propagates at c (Axiom C). It writes records one coupling event at a time. The break has not reached everywhere.

The break has not reached every degree of freedom.

Two entangled particles are two degrees of freedom for which the now has not yet made the distinction. For those particular degrees of freedom, Ø and 1 are still indistinguishable.

The particles are still in the 1:1. Still in the empty set state. Still in the pre-state.

They are not ‘connected by a hidden channel.’ They are not ‘communicating faster than light.’ They were never separated. Separateness, for those degrees of freedom, has not yet been created.

The break has not yet reached them. They are one thing that appears to be two things when viewed from inside the broken world. You are inside the broken world.

That is why they look separate to you.

5.3 — Why measurement of one determines the other

When the now reaches one of the entangled particles — when the observer couples with it, when the record is written — the empty set breaks for that degree of freedom.

0 and 1 become distinct. The record is definite.

The other particle is instantly determined. Not because a signal was sent. Because they were never apart.

They were one state — the 1:1 — and the act of distinguishing 0 from 1 for one is the act of distinguishing 0 from 1 for both. There is no 'other particle.'

There is one unbroken degree of freedom that the now has just split. You are watching the pre-state break. The correlation is not spooky. It is structural.

Not action at a distance. Action requires a signal, a cause propagating through space. Not that. The empty set ceasing to be empty. The pre-state breaking. That does not happen IN space.

Space is what exists AFTER the break. You cannot ask 'how fast did the correlation travel?' because the correlation did not travel.

It was already there — it was the 1:1, the original symmetry, the state before space existed for those degrees of freedom.

5.4 — Why the correlations depend on measurement basis

In Bell test experiments, entangled particles interact with detectors at spacelike-separated events. The detectors choose measurement bases independently — for example, different polariser angles.

Quantum mechanics predicts — and experiments confirm — that the correlations between outcomes depend on the relative angle θ between the two measurement settings. This angle-dependent correlation is what violates Bell's inequalities.

The pre-state reading accounts for this as follows. The entangled particles share one unbroken pre-state — one 1:1 that has not yet been distinguished for those degrees of freedom.

The measurement basis at each detector determines which degree of freedom is broken — which axis the distinction between 0 and 1 is drawn along.

Since the particles are one unbroken state, the act of distinguishing 0 from 1 along one axis at detector A simultaneously determines the projections of the 1:1 along all axes — including the axis chosen at detector B.

The relative angle θ between the two measurement bases determines how much of the 1:1's structure projects from one basis onto the other.

When the bases are aligned ($\theta = 0$), the projection is total and the correlation is perfect. When the bases are perpendicular ($\theta = \pi/2$), the projection is zero and the outcomes are uncorrelated.

At intermediate angles, the correlation varies as $\cos^2(\theta/2)$ — which is the Born rule (§6) applied to the projection of one basis onto another.

(Epistemic status: this is a compatibility demonstration — the quantitative $\cos^2(\theta/2)$ uses the standard QM apparatus via the Hilbert space inner product, not a derivation from the axioms alone. See scope note below.)

The correlations are angle-dependent because the break is axis-dependent. The pre-state is symmetric — the 1:1 has no preferred direction.

But the measurement basis imposes a direction — a specific way of drawing the distinction between 0 and 1. The projection of the symmetric pre-state onto a particular measurement axis is what produces the angle-dependent correlation.

Not a signal. It is geometry — the geometry of how an unbroken state projects onto a broken axis.

Epistemic status: compatibility demonstration, not derivation. The account above shows that the pre-state reading is consistent with the observed $\cos^2(\theta/2)$ correlation — it does not derive $\cos^2(\theta/2)$ from the axioms alone.

The quantitative prediction uses the Born rule (§6), which uses the Hilbert space inner product, which uses the bridge construction of §3.2. The pre-state reading provides a structural interpretation of entanglement that is compatible with quantum mechanics; it does not replace the standard QM calculation.

Bell's theorem rules out local hidden variables. The 420 Code does not propose hidden variables. It proposes that the variables do not yet exist.

The pre-state is not a state with definite values that are hidden from the observer. It is a state in which definite values have not yet been created.

The distinction between 'hidden' and 'not yet created' is the distinction between a local hidden variable theory (which Bell's theorem rules out) and the pre-state reading (which Bell's theorem does not address, because the pre-state is pre-spatial — 'local' does not apply to it).

Cross-reference: Bell, J. S. (1964). Aspect et al. (1982). §6: Born rule. AP01, Paper D §I.1: Axiom S (symmetry of the pre-state).

5.5 — Why entanglement cannot transmit information

Axiom C. The causal bound. The record, once written, propagates at most at speed c. The break is instantaneous because it is not propagation — it is the pre-state splitting.

But the record of the break — the classical information about which outcome occurred — propagates at c. You cannot use entanglement to send a message faster than light because the message is a record, and records respect Axiom C.

The distinction between the break itself (instantaneous, not a signal) and the record of the break (propagates at c, is a signal) is the distinction between the pre-state and the post-break world.

The pre-state has no space, no c, no causal bound — because space, c, and causality are products of the break. The record lives in the post-break world and obeys its rules.

**Entanglement is instantaneous because it is pre-spatial.

Information transfer is bounded by c because information is a record, and records are post-spatial.** You cannot send a message through entanglement because messages are records, and records obey Axiom C.

5.6 — Separateness is experienced but not fundamental

The central claim of the 420 Code, and entanglement is its most direct physical evidence.

From inside the broken world — from inside the eye — particles appear separate. They appear to be at different locations in space.

The measurement of one appears to instantly affect the other across a distance.

From the structure: they were never separate. The 1:1 is still there, beneath the records, for every degree of freedom the now has not yet reached.

Entanglement is not a special state that has to be carefully prepared. It is the default. The natural condition. The pre-state.

What has to be explained is not why entanglement exists — but why separateness exists. And the answer is: the break. ε. The electron. The now writing records.

Separateness is what happens when the empty set breaks. Entanglement is what remains where it hasn't broken yet. You experience separateness because the break has reached you.

The entangled pair experiences oneness because the break has not reached them.

Cross-reference: AP01, Paper D §I.4: Axiom C (Constraint). AP06 Theorem 3.1: $\varepsilon > 0$ (leakage nonzero). The Lock: ε = electron. The 420 Code central thesis.

§6 — The Born Rule

[DERIVATION — from the symmetry of the pre-state]

6.1 — The question

The Born rule states: the probability of obtaining a particular outcome when measuring a quantum system is the squared modulus of the amplitude associated with that outcome.

$P(\text{outcome}) = |\psi|^2 = |\text{amplitude}|^2$ (6.1)

In standard quantum mechanics, this is a postulate. It is not derived from the other postulates. It is added by hand.

Gleason's theorem (1957) shows it is the unique probability measure on a Hilbert space of dimension ≥ 3 — but Gleason assumes the Hilbert space structure.

The question remains: why $|\psi|^2$ and not $|\psi|$ or $|\psi|^3$ or some other function?

6.2 — The answer from the 1:1

The pre-state is the 1:1. Perfect symmetry. Axiom S states: the involution σ reverses order, and extensive quantities match. $Q(\mathcal{L}) = Q(\mathcal{D})$. The two sectors are equal.

When the break occurs — when the now distinguishes 0 from 1 — the outcome must respect the symmetry of the pre-state.

The probability of the outcome cannot favour one sector over the other, because the pre-state has no asymmetry to favour either. The measure must be invariant under the involution σ.

The amplitude ψ is a complex number. The involution σ, when lifted to the space of amplitudes on the Lorentzian manifold, acts as complex conjugation: $\sigma(\psi) = \psi^*$.

The identification is not assumed — it is forced by the structure. σ reverses order (Axiom S).

On the Lorentzian manifold, the order that σ reverses is the direction of time — the direction in which records accumulate (Axiom R). Complex conjugation reverses the direction of phase rotation: e^{iωt} → e^{−iωt}.

Phase rotation encodes the time direction (the signature flip between time and space components of the manifold, established in Paper D).

Therefore σ, as an order-reversing involution on a Lorentzian manifold, acts on complex amplitudes as conjugation. The abstract algebraic involution and the complex conjugation are the same operation, read in different languages.

You have just watched an abstract axiom become a concrete mathematical operation. The involution σ is complex conjugation. Not by choice. By proof.

Kill switch (local — KS-Q.6, CLOSED): The identification σ ↔ complex conjugation is proven unique. ℂ has exactly two field automorphisms fixing ℝ: identity and conjugation. σ reverses order (Axiom S), identity does not.

Therefore σ = conjugation. The Born rule derivation is unconditional on this step.

A probability measure P(ψ) must satisfy three conditions. Each traces directly to the axioms:

Condition 1 — Symmetry: P(ψ) = P(σ(ψ)) = P(ψ*). The measure is invariant under the involution. Neither sector is favoured. This is Axiom S: the two sectors are equal.

Any measure that favoured one sector over the other would violate the symmetry of the pre-state from which the break occurs.

Condition 2 — Additivity: For orthogonal states, $P(\psi_1 + \psi_2) = P(\psi_1) + P(\psi_2)$. Follows from the structure of record-writing.

Axiom B: the now writes exactly one record per actualization event — one break, one ε, one distinction between 0 and 1 for that degree of freedom.

Axiom R: records are discrete, countable elements of a monoid. For a degree of freedom with n distinguishable outcomes, the now writes one record from $\{r_1, r_2, \ldots, r_n\}$.

Orthogonal states correspond to disjoint subsets of these possible records — outcomes that cannot co-occur. The now writes exactly one record (B), and that record is in one subset or another but not both (disjoint).

The probability of ‘outcome in A ∪ B’ is the count of ways the now can write a record in A ∪ B. Since A and B are disjoint: no double-counting, no missing records.

The count adds. The probability adds.

This is σ-additivity of counting measure on a discrete set, promoted to a probability measure by normalisation. The discreteness is R. The single-record-per-event is B.

Additivity of probabilities for orthogonal states is not an independent postulate. It is the structure of the break. Scope note: The argument above motivates additivity from the discrete structure of record-writing (B + R).

This is a structural motivation, not a strict proof of σ-additivity on a Hilbert space.

The full uniqueness of $|\psi|^2$ as the probability measure relies on Gleason’s theorem (1957), which assumes the Hilbert space structure established in §3.2 and §7.3. The axiom-derived motivation is that the record structure provides the physical ground for Gleason’s mathematical assumption — but the formal step from discrete record counting to continuous Hilbert-space measure theory is a bridge.

Condition 3 — Normalisation: Total probability equals 1. The break must produce some outcome — the empty set must split into 0 and 1. Something must happen.

The total probability of all possible outcomes is certainty.

Conditional uniqueness (Gleason-backed): Under σ-invariance (Condition 1) and the σ-additivity/non-contextuality assumption formalised by Gleason's theorem for dim ≥ 3, the unique probability assignment compatible with Conditions 1–3 is:

$P(\psi) = \psi \cdot \psi = |\psi|^2$ (6.2)

The Born rule.

It is forced by the symmetry of the pre-state (Axiom S), the structure of the break (Axiom B), the discreteness of records (Axiom R), and the complex structure of the amplitudes (from Lorentzian signature, which follows from Axioms R + C under EH + QRA).

Dimensional note: The uniqueness of $|\psi|^2$ as the probability measure (Gleason's theorem) holds for Hilbert spaces of dimension ≥ 3. For dimension 2, other measures are mathematically permitted.

In practice, physical systems have infinite-dimensional Hilbert spaces (position, momentum, etc.), so the condition dim ≥ 3 is always satisfied. The result applies to every physical system.

For formal completeness: the Born rule derivation applies to any system with at least three orthogonal states.

The application of Gleason's theorem is conditional on the Hilbert space structure established in §3.2 (KS-Q.7); if that structure falls, the uniqueness argument must be re-examined.

The Born rule is a **conditional theorem**: forced once the Hilbert-space bridge (§3.2, KS-Q.7) holds and Gleason's additivity premise is granted as the measure-theoretic form of record additivity.

6.3 — The structural meaning

$|\psi|^2 = \psi \cdot \psi^*$ is the amplitude multiplied by its mirror image. It is the Light sector times the Dark sector. It is $\mathcal{L} \cdot \mathcal{D}$.

The probability of an outcome is the product of the two sectors — the degree to which they agree on that outcome.

When both sectors point fully toward an outcome ($|\psi| = 1$), the probability is 1 — certainty. When one sector is orthogonal to the outcome ($|\psi| = 0$), the probability is 0 — impossibility.

The Born rule is the 1:1 voting. Both sectors must agree. The probability is their product.

Neither sector alone determines the outcome — the outcome is determined by the overlap between the two readings of the pre-state.

That is why it is the square and not the amplitude itself: because both sectors count. You have wondered why quantum probability is the square of the amplitude. Now you know.

Both sides of the 1:1 must agree.

6.4 — The full probability space

The Born rule gives $|\psi|^2$ for a given actualization — the probability of a particular outcome when the now writes a record for a particular degree of freedom, in a particular cycle.

This is the local probability. Within a single cycle, the written record constrains the probability landscape. Some possibilities are driven so close to zero that they are operationally impossible. The monoid accumulates.

The record is heavy. The landscape tilts.

But the structure loops (§4.4). And across cycles, the probability space extends.

At the loop point — when the cycle completes and the 1:1 restores — the records are defragmented. Not annihilated. Defragmented.

The information survives as grains, carrying everything that was actualized, now available as probability and possibility rather than as fact. The next cycle's probability landscape is shaped by the defragmented content of all prior cycles.

The grains remember — not as history, but as weight. As the shape of what is likely and what is unlikely in this particular cycle.

Across infinite loops, every possibility that has nonzero probability in any cycle has certainty of eventual actualization. The impossible within one cycle becomes merely improbable across cycles, becomes inevitable given enough loops.

The full probability space is not one cycle but all cycles — the quantum of all possibilities between 0 and 1, within the quantum of infinite potential loops.

The only things that never actualize are things at exactly 0 — logical impossibilities, axiom violations, things that contradict the structure of 1:1 + 1×ε itself.

Everything else — everything between 0 and 1 — is a potential possibility that the defragmented record carries forward, and that the loop guarantees will eventually actualize.

The Born rule is the local law. The loop is the global guarantee. You are living inside one cycle. Everything you experience is weighted by the Born rule.

But across all cycles, the loop ensures that everything possible — everything between 0 and 1 — eventually becomes actual.

Cross-reference: Gleason, A. M. (1957). Measures on the closed subspaces of a Hilbert space. Journal of Mathematics and Mechanics, 6, 885–893. AP01, Paper D §I.1: Axiom S. AP01, Paper D §I.3: Axiom R.

AP04: The Loop.

§7 — The Wave Function

[STRUCTURAL — the complete picture]

7.1 — What the wave function is

In standard quantum mechanics, the ontological status of the wave function is debated. Is it real (ontic)? Is it knowledge (epistemic)? Does it exist in physical space or in configuration space?

In the 42∅ Code, the wave function is the description of the empty set state for a given set of degrees of freedom. It is neither ontic nor epistemic in the usual sense.

It describes the pre-state — the condition before the now has written a record for those degrees of freedom. It is the map of what has not yet been broken.

The wave function is not ‘out there’ in physical space. Physical space is a product of the break.

The wave function describes the structure that precedes the break — the 1:1, the superposition, the empty set state. It lives in the pre-state, which is prior to space.

You cannot find it in your laboratory because your laboratory is post-spatial. The wave function describes what your laboratory is made from.

When the now writes a record, the wave function for those degrees of freedom becomes definite. Not because the wave function ‘collapsed’ — because those degrees of freedom have been broken.

The empty set has split. ∅ and 1 are now distinct. The wave function is the description of what the distinction looks like before it is made.

7.2 — Why it evolves unitarily

Between measurements — between acts of record-writing — the wave function evolves according to the Schrödinger equation, which is unitary (preserves total probability). Why?

Because between measurements, no record is written. Axiom R is not invoked. The pre-state is evolving, but nothing is being permanently distinguished.

The empty set is shifting — 0 and 1 are changing their relationship — but neither has been separated. Since no record is written, no information is lost or gained.

The total probability remains 1. The evolution is unitary because no irreversible act has occurred.

Unitary evolution is the pre-state evolving without breaking. Measurement is the pre-state breaking. The difference between them is Axiom R — whether a record is written. You have been told these are incompatible.

They are not. They are the same structure with and without record-writing.

The resolution of the apparent contradiction between unitary evolution (reversible, continuous, deterministic) and measurement (irreversible, discontinuous, probabilistic). They are not two incompatible processes.

They are two regimes of the same structure — the pre-state with and without record-writing. The smooth transition between them is the now arriving at a particular degree of freedom.

7.3 — The Schrödinger equation

The Schrödinger equation $i\hbar\, \partial\psi/\partial t = \hat{H}\psi$ is not a postulate.

It is the unique evolution equation for the pre-state on a Lorentzian manifold, forced by the axioms in the same way that the Poisson equation (AP08 §4) and Einstein's field equations (AP08 §9) are forced — by listing the constraints from the axioms and invoking uniqueness theorems.

Step 1 — The pre-state space is a complex Hilbert space.

From §3.2: the pre-state space is a complex vector space (R gives the monoid acting on pre-states, EH gives the faithful embedding, Lorentzian signature gives $\mathbb{C}$ — all three required simultaneously).

From §6.2: the Born rule gives an inner product — $\psi \cdot \psi^* = |\psi|^2$, derived from Axiom S. Define a norm by $\|\psi\|^2 := |\psi|^2$.

If the resulting inner-product space is not complete, let $\mathcal{H}$ be its Hilbert completion under $\|\cdot\|$ (standard functional-analytic completion).

The dynamical results below are then stated on $\mathcal{H}$; this completion step is structural bookkeeping, not new physics.

Sources: R (monoid action) + EH (faithful embedding) + R + C under EH + QRA (Lorentzian → $\mathbb{C}$) → vector space. S → inner product. Hilbert completion under $\|\cdot\|$ (structural bookkeeping).

Result: complex Hilbert space.

Step 2 — Between measurements, evolution preserves the inner product.

Axiom R: records are irreversible and non-annihilating. Between measurements, no record is written. Therefore no information is permanently created or destroyed.

The total probability remains 1. The inner product — which IS the probability structure (§6.2) — is preserved.

A map on a Hilbert space that preserves the inner product is either unitary or anti-unitary. You are watching the constraints close.

This is Wigner's theorem (1931) — a theorem of pure mathematics, proven from the structure of Hilbert spaces. Not assumed. Derived.

Step 3 — Time evolution is continuous.

EH: the record algebra embeds into a smooth manifold. The manifold has a smooth time coordinate — one time direction from the Lorentzian signature (Paper D, Propositions 2.1–2.4).

Therefore time evolution forms a continuous one-parameter family of transformations: $\{U(t) : t \in \mathbb{R}\}$.

Step 4 — The family is unitary, not anti-unitary.

Anti-unitary operators satisfy $U(t_1)U(t_2) = U(t_1 + t_2)^*$.

But U(0) = identity (which is unitary), and a continuous deformation from a unitary to an anti-unitary operator requires a discontinuity — anti-unitary operators form a disconnected component of the operator space.

Since the family is continuous (Step 3), it is unitary: $U(t_1)U(t_2) = U(t_1 + t_2)$.

Step 5 — Stone's theorem gives the generator.

Stone's theorem (1932) — a theorem of pure mathematics: every strongly continuous one-parameter unitary group U(t) on a Hilbert space can be written as U(t) = $e^{-iHt/\hbar}$ for a unique self-adjoint operator H, the generator of the group.

The constant $\hbar$ enters as the scale factor between the generator's eigenvalues and the time parameter. In the architecture: $\hbar$ is the minimum quantum of action — the smallest possible record.

Axiom B gives the minimum break (ε = minimum viable splinter). $\hbar$ is the action-scale of that minimum — the granularity of the now. Honest disclosure: $\hbar$ is identified, not derived.

The form of the Schrödinger equation ($i\hbar\, \partial\psi/\partial t = \hat{H}\psi$) is forced by the axioms via Steps 1–6. The value of $\hbar$ enters as an empirical input — the same status as $G = 2\kappa/m_e^2$ in AP08. The identification $\hbar$ = action-scale of ε gives structural meaning but is not an independent computation.

KS-Q.8.

Step 6 — Differentiate.

Take $U(t)\psi = e^{-iHt/\hbar}\psi$ and differentiate with respect to t:

$i\hbar\, \partial\psi/\partial t = \hat{H}\psi$ (7.1)

The Schrödinger equation. You have just watched it emerge from the same method that produced the Poisson equation and Einstein's field equations: list the constraints from the axioms, invoke a uniqueness theorem. Three equations.

Three pillars of physics. One method.

The complete chain: 1:1 + 1×ε → {S, B, R, C} → R gives monoid acting on pre-states + R + C give Lorentzian → ℂ → complex vector space (§3.2) → S gives inner product (§6.2) → Hilbert completion under ‖·‖ → Hilbert space (Step 1) → R gives unitarity (Step 2) → EH gives continuity (Step 3) → continuity selects unitary over anti-unitary (Step 4) → Stone's theorem gives generator (Step 5) → differentiate → Schrödinger equation (Step 6).

Every link is either a theorem of pure mathematics (Wigner, Stone), a consequence of the axioms (R, B, C, S), or a consequence of the bridge hypotheses (EH, QRA).

No link imports quantum postulates for the form; $\hbar$ enters as an empirical identification for scale (KS-Q.8).

The Schrödinger equation is forced by the same method that forces the Poisson equation (AP08 §4) and Einstein's field equations (AP08 §9): list the constraints from the axioms, invoke a uniqueness theorem.

You have now watched three equations — the Poisson, the Einstein, and the Schrödinger — all forced by the same four axioms.

Cross-reference: AP06 §10.5: Time as direction. AP08 §4: Symmetry constraints forcing form. Wigner, E. P. (1931). Stone, M. H. (1932). Weinberg, S. (1995).

§8 — The Complete Picture

[STRUCTURAL — one axiom, one structure]

8.1 — Everything from the empty set

The 420 Code now derives the following from one axiom (1:1 + 1×ε), formalised as four axioms {S, B, R, C}, under EH + QRA:

Spacetime: Lorentzian manifold with signature (−,+,+,+). Special relativity as a theorem. (AP01, Paper D)

Gravity: Einstein's field equations with cosmological constant, via Lovelock's theorem. Poisson as the weak-field limit. Hawking radiation at the strong-field limit. (AP08)

Quantum mechanics: Superposition as the empty set state. Linear structure from the record monoid and complex scalars (§3.2). Complex amplitudes from Lorentzian signature (§3.3). Measurement as the now writing a record (§4).

Born rule from the symmetry of the 1:1 (§6). Schrödinger evolution from unitarity and Stone's theorem (§7.3). Entanglement as the pre-state leaking through, with Bell-test correlations from the geometry of projection (§5). (This paper)

The arrow of time: Axiom R. Records are irreversible. The break propagates. The frontier advances. The now never goes back. (AP01 Paper D, AP06)

Conservation laws: Axiom R in covariant language. ∇_μ T^μν = 0. Energy-momentum conservation and the arrow of time are the same thing. (AP08 §9.5)

The observer: The now. The uncoupled ε. The invariant of the structure. Carries all records, has no record of its own. Unmeasurable because measurement IS the now. (AP06, this paper §4.3)

The loop: The structure's response to completion. Eye closes, 1:1 restores, κ exceeded, break again. Records defragmented, not annihilated. Axiom R holds absolutely. Every possibility actualizes across infinite loops. (This paper §4.4)

One axiom. One break. One structure. You have just seen the empty set split, and everything — spacetime, gravity, quantum mechanics, time, the observer, the loop — is **consequences of the split**.

8.2 — The topology

The eye of the 42⦰ Code is the topology of the whole structure, not just gravity. The two curves ($\mathcal{L}$ and $\mathcal{D}$) are the two sectors.

The tips (⦰ = 1 in the pre-state) are the 1:1. The opening (the white space) is the observer, the now, the ongoing break.

The upper curve (c) and lower curve (gravity) are the two absolute limits.

Quantum mechanics lives in the white space. The opening of the eye. The gap between the two sectors where the break is still happening.

Every superposition is part of the white space — it is a region where the break has not yet been completed.

Every measurement closes a tiny piece of the white space and converts it to record (black, definite, part of the curve).

But the eye never closes. There is always more white space. Always more degrees of freedom that have not been broken. Always one more ε uncoupled. You are inside the white space.

You are the opening of the eye. Your existence is the break in progress. Quantum mechanics persists — why the world does not become entirely classical. The break is never finished.

The pre-state is never fully broken. The 1:1 is always there, beneath the records, in every entangled pair, in every superposition, in every degree of freedom the now has not yet reached.

And if the eye did close — if the break did complete — the loop turns. The 1:1 restores. The break begins again. The eye opens.

The topology is closed: the tips are the same point. The end is the beginning. The loop is built into the geometry.

8.3 — Why separateness is experienced but not fundamental

The records are real. The measurements are real. The classical world — the world of definite outcomes, separate objects, distinct locations — is real. It is not an illusion.

It is what the broken world looks like from inside.

But the pre-state is also real. The 1:1 is also there. Entanglement proves it. Bell's theorem proves it.

Every experiment that violates Bell's inequalities is evidence that the pre-state has not been fully broken — that separateness, at some level, has not yet been created for those degrees of freedom.

Separateness is the record. Oneness is the pre-state. Both are real. The record is experienced. The pre-state is fundamental. You live in the record. You are made of records.

But the pre-state — the 1:1 — is what you are made from.

The central claim of the 420 Code, and quantum mechanics — properly understood as the empty set breaking — is its proof.

8.4 — The now as the load-bearing structure

The now carries everything.

Backward: Every record ever written. The full monoid. The entire history of actualization. Mass, energy, curvature, the condensate — all of it is the accumulated record carried by the now.

The now does not sit on top of the records. The now IS the carrying of them.

Forward: Every unwritten possibility, weighted by the record. The probabilities are not floating abstractions — they are the structure of what the now can do next, given what it is already carrying.

The written record constrains the probability space. A record-heavy region has a different probability landscape than a record-light region. The probabilities are the now's forward face, shaped entirely by its backward face.

Across cycles: The defragmented content of all prior cycles, carried as grains of probability and possibility. The now in this cycle sits on top of the defragmented record of every prior cycle.

The grains shape the landscape. The landscape determines what is likely and what is unlikely. Across infinite loops, the landscape ensures everything possible is actualized.

Scope note: The claim that every nonzero-probability possibility eventually actualizes across infinite loops is a structural extrapolation from the loop mechanism (§4.4), not a theorem of the axiom system.

It is conditional on KS-Q.5 (the physical identification of the loop point with the forgetful functor) and KS-Q.9 (ergodicity across cycles).

It requires that the defragmented record does not systematically bias the probability landscape of subsequent cycles in a way that permanently excludes any nonzero-probability outcome.

This is plausible — the defragmentation preserves all elements (forgetful functor) and the 1:1 restores full symmetry — but a formal proof of ergodicity across cycles is not provided. KS-Q.9 targets this step.

The now is the invariant. The record is the variable. Time is not the now moving — the now does not move.

Time is the record changing while the now stays. The now is the fixed point of the entire structure.

Everything else — every record, every measurement, every curvature, every mass — is the now's content changing.

The now itself is unchanged and unchangeable because it IS the uncoupled ε, and the uncoupled ε has no record to change. It carries all history but has none. You are the now.

You carry everything. You have no record of yourself carrying it. That is why you cannot see yourself seeing.

Cross-reference: AP08 §8: Eye topology. Bell, J. S. (1964). On the Einstein Podolsky Rosen paradox. Physics, 1(3), 195–200. AP04: The Loop.

§9 — What Is New and What Is Not

9.1 — What is new

The empty set as the pre-state. The ontological identification of the pre-state with the empty set — ∅ and 1 indistinguishable — appears to be new.

Other frameworks (von Neumann, causal set theory, loop quantum gravity) do not make this identification.

Measurement as the empty set breaking. The dissolution of the measurement problem through identifying measurement with the break — the same break that produces spacetime and gravity — appears to be new.

Other interpretations (many-worlds, Copenhagen, Bohmian) treat the measurement problem as separate from cosmology.

Entanglement as the pre-state leaking through. The reading of entanglement as the 1:1 not yet broken for those degrees of freedom — not as a special correlation but as the default state from which separateness is the exception — appears to be new.

The explicit account of Bell-test angle-dependent correlations as projections of the symmetric pre-state onto broken measurement axes (§5.4) extends this reading to the quantitative level.

The Born rule from the involution. $|\psi|^2 = \psi\psi^*$ as the product of the two sectors — Light times Dark, the 1:1 voting — is a new derivation.

It uses the involution σ from Axiom S directly, with $\sigma \leftrightarrow$ complex conjugation established via the Lorentzian structure (KS-Q.6 stated for this identification), and with additivity derived from the discrete record structure of Axioms B and R, rather than assumed or imported from Gleason's theorem (which assumes Hilbert space structure).

The now as the invariant. The identification of the now as the fixed point of the structure — carrying all records, having no record of its own, unmeasurable because measurement IS the now — appears to be new.

Other frameworks treat the observer as external to the physics or as an emergent feature.

The 420 Code identifies the observer with the uncoupled ε, the ongoing break, the structural invariant around which the record changes.

The loop and defragmentation. The structural guarantee that completion is renewal — that the eye closing triggers opening, that records are defragmented but not annihilated at the loop point, that the full probability space spans all cycles — extends the architecture beyond single-cycle physics.

The consequence — that everything possible actualizes across infinite loops — follows from the defragmented record shaping the probability landscape of each subsequent cycle (structural extrapolation; KS-Q.9).

The Schrödinger equation derived. The derivation of the Schrödinger equation from the axioms via Wigner's theorem and Stone's theorem (§7.3) — with the same method used for Poisson (AP08 §4) and Einstein (AP08 §9) — appears to be the first derivation of quantum evolution from a record algebra.

The method is: list axiom constraints, invoke mathematical uniqueness theorems.

Linearity derived. The derivation of the linear structure of quantum mechanics from the record monoid and complex scalars (§3.2) — monoid action on pre-states + ℂ from Lorentzian signature → complex vector space — grounds linearity in the algebraic structure of the axioms rather than assuming it.

Unity of the three pillars. Spacetime, gravity, and quantum mechanics derived from the same four axioms, with the same break, the same ε, the same structure.

No other framework claims to derive all three from a single axiom.

9.2 — What is not new

Linearity from symmetry. Wigner (1931) showed that quantum mechanics' linear structure follows from symmetry requirements on probability measures. The present derivation extends this by grounding both the symmetry and the probability measure in the axioms.

Complex numbers from Lorentzian signature. The connection between Lorentzian signature and complex quantum amplitudes is established (Stueckelberg, 1960; Hardy, 2001). The present derivation grounds the Lorentzian signature in the axioms.

Irreversibility of measurement from thermodynamics. The link between quantum measurement and thermodynamic irreversibility is well-known (Zurek, 2003; Landauer, 1961). The present derivation unifies both under Axiom R.

Schrödinger from symmetry. The derivation of the Schrödinger equation from symmetry principles has precedents (Wigner, 1931; Weinberg, 1995).

The present derivation is new in grounding those symmetry principles in the record algebra rather than assuming them.

§10 — Kill Switches

Ten kill switches. Every conditional step is marked. You know where to strike. If you can trigger any one of them, the corresponding claim falls.

KS-Q.1 (UPDATED — conditionally closed): The Born rule is derived from the symmetry of the pre-state (§6).

The three conditions — symmetry under σ (from Axiom S, with σ ↔ complex conjugation proven unique — KS-Q.6 CLOSED), additivity (motivated by Axioms B and R via discrete record structure — bridge step), and normalisation — uniquely fix $|\psi|^2$.

The derivation holds for Hilbert spaces of dimension ≥ 3 (Gleason, 1957), which includes all physical systems.

Conditional on: the Hilbert space structure established in §3.2 (KS-Q.7) and the bridge from discrete record counting to continuous σ-additivity.

If KS-Q.7 falls, the Born rule derivation must be re-grounded in whatever pre-state structure replaces the Hilbert space.

KS-Q.2 [LIVE — EMPIRICAL]: If a quantum system is found that violates the Born rule — that is, if the measured probabilities are not $|\psi|^2$ — then either the Born rule derivation is wrong or the axioms are wrong.

Current experimental evidence strongly supports the Born rule. This kill switch is currently untriggered.

KS-Q.3 [LIVE — EMPIRICAL]: If entanglement is shown to involve a causal signal — if faster-than-light information transfer is demonstrated — then the reading of entanglement as the pre-state leaking through is wrong, because the pre-state reading requires that no signal passes.

Current experimental evidence (Aspect, 1982; and all subsequent Bell tests) supports no-signalling. This kill switch is currently untriggered.

KS-Q.4 [LIVE — HARD]: If the complex structure of quantum mechanics is shown to be non-unique — if real or quaternionic quantum mechanics produces the same experimental predictions — then the derivation in §3.3 is insufficient.

Recent results (Renou et al., 2021) strongly support the necessity of complex numbers in quantum mechanics. This kill switch is currently untriggered.

KS-Q.5 (partially addressed — algebraic level closed, physical identification open): The loop structure (§4.4) does not violate Axiom R at the algebraic level.

Defragmentation is the forgetful functor from the category of monoids to the category of sets: it strips the composition operation while preserving the underlying set of elements.

R prohibits destruction of elements via composition (no inverses). Defragmentation removes the composition itself — a functorial operation, not an algebraic one.

The distinction between annihilation (forbidden by R) and defragmentation (dissolution of composition, not of elements) is formally established. The monoid elements survive. Algebraic non-contradiction: closed.

However, the physical claim — that what happens at the loop point IS the forgetful functor — remains a structural identification, not a proof (see §4.4 scope note).

The physical identification is open pending formal justification that the dissolution of causal ordering at the loop point corresponds to stripping monoid structure. Kill switch partially addressed.

KS-Q.6 (CLOSED): The identification $\sigma \leftrightarrow$ complex conjugation (§6.2) is established.

The field $\mathbb{C}$ has exactly two field automorphisms that fix $\mathbb{R}$ pointwise: the identity and complex conjugation (this is a standard result — it follows from the fact that every automorphism of $\mathbb{C}$ fixing $\mathbb{R}$ must map i to a square root of -1, and $\mathbb{C}$ has exactly two: i and $-$i). σ is not the identity — it reverses order (Axiom S), while the identity preserves order.

Therefore σ = conjugation. The identification is not merely natural — it is unique. Kill switch closed.

KS-Q.7 [LIVE — HARD]: If the bridge construction in §3.2 — the identification of the pre-state with maps from possible records to $\mathbb{C}$ — is shown to be non-unique (i.e., if other equally motivated constructions from the same axiom-derived ingredients produce a non-linear pre-state space), then the linearity of quantum mechanics is not forced by the axioms and must be imposed as an additional postulate.

The construction is motivated but not proven unique. This kill switch targets the bridge step from monoid + $\mathbb{C}$ to complex vector space. Currently untriggered.

KS-Q.8 [LIVE — HARD]: The constant $\hbar$ in the Schrödinger equation (§7.3) is identified, not derived. The form $i\hbar\, \partial\psi/\partial t = \hat{H}\psi$ is forced by the axioms via Wigner + Stone.

The value of $\hbar$ enters as an empirical input. If an observable is found that constrains $\hbar$ independently of its measured value — through the axiom structure alone — then the identification becomes a derivation.

Same status as $G = 2\kappa/m^{e2}$ in AP08. Currently untriggered.

KS-Q.9 [LIVE — HARD]: If it can be shown that the defragmented record systematically excludes certain nonzero-probability outcomes from all subsequent cycles — that is, if the loop does not restore full access to the probability space — then the "everything possible actualizes" claim (§6.4, §8) fails.

The loop mechanism would still function (eye closes → opens), but the guarantee of eventual actualization would not hold. This is a structural extrapolation from the loop and defragmentation, not a theorem. Currently untriggered.

The claim is structurally motivated but formally unproven.

KS-Q.10 [LIVE — HARD]: If the pre-state admits a different ontological grounding that produces the same mathematical structure (complex vector space, Born rule, Schrödinger equation) without the empty set reading — that is, if the identification of the pre-state with the empty set (§§1–2) is not the unique ontological interpretation compatible with the axioms — then the structural readings in §§4–5 (measurement as break, entanglement as unbroken pre-state) change character.

The mathematical derivations (§§3, 6, 7) would survive, but the philosophical foundation would require revision. This kill switch targets the ontological identification that grounds the entire paper. Currently untriggered.

Load-bearing status: §1–§2 are foundational (the empty set and the break — structural readings, KS-Q.10). §3.2 depends on R + EH + Lorentzian signature for linearity — bridge construction (KS-Q.7). §3.3 depends on EH + QRA and Axioms R + C for complex structure, conditional on reconstruction theorems (KS-Q.4). §4.1–4.2 depend on Axiom R for irreversibility. §4.3–4.4 depend on the structural reading of the now and the loop (KS-Q.5). §5 depends on the structural reading of entanglement; Bell correlation account is compatibility, not derivation. §6 depends on Axiom S for the Born rule, with $\sigma \leftrightarrow$ conjugation (KS-Q.6 CLOSED) and additivity motivated by B + R (bridge step); Born rule conditionally closed (conditional on KS-Q.7). §6.4 "everything possible actualizes" is a structural extrapolation, not a theorem (KS-Q.9). §7.3 depends on §3.2, §6.2, EH, and Stone's theorem; $\hbar$ identified not derived (KS-Q.8). §8 is the synthesis.

§11 — Closing

Quantum mechanics is not a separate pillar of physics. It is the same structure as gravity and spacetime, read from the other side.

Gravity is what the break looks like when you read the records — the accumulated actualization events, the curvature of the condensate, the fold of the geometry. Gravity is the black part of the eye.

Quantum mechanics is what the break looks like when you read the pre-state — the undistinguished degrees of freedom, the superpositions, the entangled pairs, the white space of the eye.

They are not in tension. They are not rivals requiring unification. They are two readings of one structure — the empty set breaking. The 1:1 + 1×ε.

The measurement problem is dissolved. The now is the invariant — carrying all records, having none of its own. Entanglement is the pre-state leaking through. The Born rule is the 1:1 voting.

The Schrödinger equation is forced by the same method that forces Poisson and Einstein: axiom constraints and mathematical uniqueness theorems. The arrow of time is Axiom R.

The wave function is the map of what has not yet been broken. The loop is the structure's guarantee that everything possible will actualize (structural extrapolation; KS-Q.9).

Separateness is experienced but not fundamental. The records are real. The pre-state is also real. The eye is open. The observer is the opening. The break is ongoing. The now carries everything.

Time is the record changing while the now stays.

The axiom is **1:1 + 1×ε**. The algebra is the record algebra. The geometry is Lorentzian. The gravity is the eye. The quantum is the opening. The loop is the guarantee.

Don’t be a cunt, be kind. You now know why. The mathematics requires it.

§12 — Claim Summary

Pre-state as empty set (§§1–2). Status: structural reading. Ontological identification of the 1:1 with the empty set splitting. Grounds the architecture; not a derivation. KS-Q.10.

Linearity (§3.2). Status: bridge derivation. Complex vector space constructed from axiom-derived ingredients (monoid + $\mathbb{C}$ + faithful embedding). Bridge step: identification of pre-state with maps from records to $\mathbb{C}$. KS-Q.7.

Complex amplitudes (§3.3). Status: derived (conditional). $\mathbb{C}$ uniquely selected by Lorentzian signature, conditional on reconstruction theorems. KS-Q.4.

Measurement (§4.1–4.2). Status: structural reading. Measurement = break = now writing a record. Irreversibility from Axiom R.

The loop (§4.4). Status: structural argument. Defragmentation via forgetful functor. R preservation argued via element/structure distinction (interpretive). Algebraic non-contradiction closed; physical identification open. KS-Q.5.

Entanglement (§5). Status: structural reading + compatibility demonstration. Entanglement = pre-state leaking through. Bell correlations consistent with the reading (§5.4) but not derived from axioms alone. KS-Q.3.

Born rule (§6). Status: derived (conditional). $|\psi|^2$ forced by σ-invariance (S) + additivity (motivated by B + R, bridge step) + normalisation. $\sigma \leftrightarrow$ conjugation proven unique (KS-Q.6 CLOSED).

Full uniqueness conditional on Gleason (dim ≥ 3). Conditionally closed (conditional on KS-Q.7). KS-Q.1, KS-Q.2.

Schrödinger equation (§7.3). Status: derived. Form $i\hbar\, \partial\psi/\partial t = \hat{H}\psi$ forced by axioms via Wigner + Stone. $\hbar$ identified, not derived (same status as G in AP08). KS-Q.8.

Everything possible actualizes (§6.4). Status: structural extrapolation. Follows from the loop mechanism and defragmentation if the defragmented record does not systematically exclude nonzero-probability outcomes. Structurally motivated but formally unproven. KS-Q.9.

Unity of three pillars (§8). Status: structural synthesis. Non-load-bearing.

§13 — Conditionality Footer

Dependencies: AP01, Paper D (Axioms, independence, Lorentzian signature) — load-bearing. Edition 04 (The Lock: ε = electron) — load-bearing for particle identification. AP06 (The Leakage Constant: Theorem 3.1) — referenced for entanglement and eye topology.

AP08 (The Identity: EFE) — referenced for gravity–quantum duality.

Dependents: Any downstream AP referencing the quantum sector, the pre-state reading, or the Born rule derivation inherits KS-Q.1–KS-Q.10.

Open problems: Independent derivation of $\hbar$ from the axioms (KS-Q.8). Formal proof of linearity bridge — uniqueness of the vector space construction (KS-Q.7). Derivation (not just compatibility) of Bell correlations from axioms.

Formal proof that defragmentation preserves the intent of Axiom R (KS-Q.5). Formal proof of ergodicity across cycles — that the defragmented record does not permanently exclude nonzero-probability outcomes (KS-Q.9).

Proof that the empty set reading is the unique ontological grounding compatible with the axioms (KS-Q.10).

Kill switches: KS-Q.1: Against Born rule derivation — conditionally closed (conditional on KS-Q.7) (targets §6). KS-Q.2 [LIVE — EMPIRICAL]: Against Born rule empirically (targets §6). KS-Q.3: Against no-signalling (targets §5).

KS-Q.4: Against complex uniqueness (targets §3.3). KS-Q.5: Against loop/defragmentation — partially addressed (targets §4.4). KS-Q.6 [CLOSED]: Against σ ↔ conjugation — CLOSED (targets §6.2). KS-Q.7: Against linearity bridge (targets §3.2).

KS-Q.8: Against $\hbar$ identification (targets §7.3). KS-Q.9: Against ergodicity across cycles (targets §6.4). KS-Q.10: Against empty set ontological identification (targets §§1–2).

Inherited: AP01 Paper D kill switches, Edition 04 kill switches, AP06 kill switches, AP08 kill switches.

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Cross-Reference Index

Full probability space across cycles: This paper §6.4

Wave function = map of unbroken: This paper §7.1

Unitary evolution = pre-state without record: This paper §7.2

Schrödinger equation derived (Wigner + Stone): This paper §7.3

Three pillars unified: This paper §8.1

White space = quantum sector: This paper §8.2

The now as load-bearing structure: This paper §8.4

Axioms {S, B, R, C}: AP01, Paper D §I.1–I.5

Lorentzian signature: Paper D Propositions 2.1–2.4

Einstein field equations: AP08 §9

Leakage theorem: AP06 Theorem 3.1

Eye topology: AP08 §8, this paper §8.2

κ = holding limit: AP06 §10.5, AP08 §5.2

ε = electron: The Lock (Edition 04)

The Loop: AP04, this paper §4.4

σ ↔ complex conjugation (KS-Q.6): This paper §6.2

Complex uniqueness (KS-Q.4): This paper §3.3

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