

What Physics Actually Closes

Causal Closure, Quantum Indeterminacy, and the Interpretive Asymmetry

Project: [Return to Consciousness](#)

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Abstract

Physicalism's most common implicit defense against consciousness-first frameworks is the appeal to causal closure: if every physical event has a sufficient physical cause, there is no work for consciousness to do. This essay examines whether physics actually delivers that closure. It does not. Classical mechanics provided deterministic closure — given initial conditions and laws, every subsequent state is fixed. Quantum theory replaced this with something structurally different: **statistical closure with outcome-level openness**. Probability distributions are fixed; which specific outcome actualizes is not determined by the formalism. This is a structural feature of the theory, not a gap in current knowledge. The founders of quantum mechanics recognized immediately that consciousness and measurement could not be cleanly separated. Subsequent interpretations each introduced their own ontological costs and open problems — yet only the consciousness-involving reading was treated as disqualified by its difficulties, driven not by new empirical findings but by the asymmetric methodological restraint this project diagnoses in consciousness studies. The standard formalism does not deliver causal closure; restoring it (as Bohmian mechanics attempts) requires adding unobservable structure to the theory — purchasing closure through metaphysical commitment, not empirical discovery.

Keywords: causal closure · quantum mechanics · measurement problem · Born rule · wave function · consciousness · interpretive history · von Neumann · quantum indeterminacy

What This Essay Does and Does Not Establish

This essay establishes:

- That classical causal closure (deterministic: given initial conditions and laws, every subsequent state is fixed) does not survive the transition to quantum theory
- That quantum theory provides statistical closure (probability distributions are fixed) with outcome-level openness (which specific outcome actualizes is not determined by the formalism)

- That this openness is a structural feature of the formalism, not a gap in current knowledge
- That probabilistic or stochastic reformulations of causal closure do not rescue the physicalist appeal, because they presuppose what is at issue
- That every interpretation of quantum mechanics carries ontological costs and open foundational problems — yet only the consciousness-involving reading was treated as disqualified by its difficulties
- That the interpretive shift away from consciousness-involvement was driven by cultural and metaphysical pressure, not by empirical findings — an instance of the asymmetric methodological restraint this project diagnoses across consciousness studies
- That the standard formalism does not deliver causal closure; restoring it requires adding to the formalism (as Bohmian mechanics does with unobservable pilot wave dynamics), purchasing closure through metaphysical commitment rather than reading what the physics provides

This essay does NOT establish:

- That quantum mechanics proves idealism or any consciousness-first metaphysics
- That consciousness causes collapse (this is one interpretation among several)
- That quantum indeterminacy provides a “mechanism” for mental causation
- That the measurement problem is solved — though it is worth noting that the problem is itself a product of the physicalist default: it arises from the demand that physics alone produce definite outcomes, which is precisely the assumption consciousness-first ontologies reject. Under such ontologies, the question is not how physics produces experience but how experience gives rise to what we call physics — and the “problem” of outcomes does not arise because experience is not something the formalism must generate
- That the founders’ interpretation is proven by this essay alone — the broader project argues the constructive case

The argument is diagnostic, not constructive. It shows that physics does not deliver what physicalism claims to borrow from it. The measurement problem remains open within the physicalist frame — and dissolves outside it. What this essay closes is the *appeal* to physics as a defeater of consciousness-first frameworks.

Role within the project: This essay is an *epistemic gatekeeper* — a companion to *Asymmetric Methodological Restraint* and *The Generativity Question*. AMR exposes asymmetric skepticism in how consciousness-first frameworks are treated. TGQ exposes the category error in demanding predictive track records from ontologies. This essay exposes the claim that physics mandates causal closure — and shows that the interpretive history of quantum mechanics itself exhibits the asymmetric restraint AMR diagnoses.

I. The Appeal to Causal Closure

When consciousness-first frameworks are dismissed as unscientific, the dismissal often rests — implicitly or explicitly — on an appeal to causal closure:

“Physics tells us that every physical event has a sufficient physical cause. If the physical world is causally closed, there is no causal role for consciousness to play. Consciousness must therefore be epiphenomenal, emergent, or identical to physical processes.”

This argument has enormous cultural force. It sounds like it is simply reporting what physics

has established. It is not.

The appeal depends on a specific version of causal closure — **deterministic closure** — that classical mechanics provided and quantum theory revoked. Understanding what physics actually closes, and what it leaves open, requires distinguishing two structurally different kinds of closure.

II. Two Kinds of Closure

Classical Deterministic Closure

Under Newtonian mechanics (and its Lagrangian and Hamiltonian extensions), the physical world is deterministically closed:

- Given the initial conditions (positions and momenta of all particles) and the laws of motion, every subsequent state of the universe is uniquely determined.
- There are no degrees of freedom left open. Every event that will ever occur is already implied by the initial state plus the laws.
- If you knew the initial conditions with perfect precision, you could in principle compute the state of the universe at any future time.

This is Laplace’s demon: a hypothetical intelligence that, knowing the positions and momenta of every particle, could calculate the entire future. Under this picture, causal closure is tight. There is genuinely no room for anything — consciousness, will, agency, purpose — to do causal work without violating the laws. Every “gap” in the causal chain is merely a gap in our knowledge, not in the physics.

Classical causal closure is the picture that physicalism implicitly invokes. It is the version of physics that makes the epiphenomenalism of consciousness seem logically forced. If the physical world is a deterministic clockwork, consciousness can only be either identical to some of the clockwork or a causally inert shadow of it.

Quantum Statistical Closure

Quantum theory replaced this picture with something structurally different. The formalism specifies two fundamentally distinct dynamics:

1. Unitary evolution. The wavefunction (or state vector) evolves deterministically according to the Schrödinger equation (or its relativistic generalizations in QFT). This evolution is linear, reversible, and perfectly deterministic. If the universe were described only by unitary evolution, deterministic closure would hold.

2. Measurement outcomes. When a measurement occurs (or, more carefully, when a system interacts with its environment in a way that produces a definite outcome), the formalism specifies:

- *Which* outcomes are possible (the eigenvalues of the measured observable)
- *With what probability* each outcome occurs (the Born rule: probability equals the squared modulus of the amplitude)
- But *not which specific outcome actualizes* in any given case

The Born rule is extraordinarily well-confirmed. No experiment has ever found a deviation from its statistical predictions. But the rule specifies a *probability distribution*, not an outcome.

The specific outcome that occurs in any given measurement is not determined by anything in the formalism.

This is not a temporary gap awaiting better physics. The formalism is complete in the sense that no additional information *within* the theory selects the outcome. The theory predicts statistics perfectly; it does not predict individual events.

What this means for causal closure: Quantum theory provides **statistical closure** — the probability distributions are fixed, and the statistical regularities are perfectly reliable. But it does not provide **event-level closure** — which specific outcome actualizes in any given case is left undetermined. The equations constrain what *can* happen and with what frequency; they do not determine what *does* happen in any single instance.

This is a fundamental structural difference from classical mechanics. Under classical mechanics, knowing the laws and initial conditions gives you everything. Under quantum mechanics, knowing the laws and the initial state gives you the probabilities — but the individual outcomes are not determined by the physics.

III. Why This Matters for the Consciousness Debate

The significance of this structural difference is precise:

If classical deterministic closure held, the appeal to causal closure would be valid. There would genuinely be no room for consciousness to do causal work without violating physical law. Physicalism's claim that consciousness must be epiphenomenal, emergent, or identical to physical processes would follow from the physics.

Under quantum statistical closure, the appeal loses its force. The physics determines the probability distributions — and those distributions are perfectly preserved regardless of what fills the outcome-selection degree of freedom. Whether the specific outcomes are determined by brute randomness, by hidden variables, by consciousness, or by nothing at all is not a question the physics answers. It is a question the physics *leaves open*.

The term “degree of freedom” here is not a metaphor. Individual outcomes actualize — one result occurs, not another. The formalism constrains which outcomes are possible and with what frequency, but does not determine which one occurs in any given case. That is a structural feature of the theory: a variable the equations constrain but do not fix. Calling this an open degree of freedom names what the theory leaves unaddressed. The alternative — treating the gap as requiring no account at all, as “mere absence” rather than an unresolved question — is itself a metaphysical commitment, and an incoherent one: it declares that something happens (a specific outcome actualizes) while insisting that nothing accounts for its happening. If an outcome actualizes, either something accounts for that actualization or the theory is incomplete at precisely this point. Treating the gap as brute — as requiring no further explanation — is not a finding but a refusal to inquire. It is a philosophical choice to treat a gap in the theory as a feature of reality, and it is not delivered by the physics.

This does not mean consciousness *does* select outcomes. That is a further metaphysical claim that this essay does not make. What it means is that **the physics does not rule it out** — and that invoking “causal closure” as a defeater of consciousness-first frameworks is invoking a version of physics (classical deterministic closure) that quantum theory replaced over a century ago.

The Stochastic Closure Response

A sophisticated physicalist might respond: “Contemporary causal closure principles don’t require determinism. They require only *stochastic sufficiency* — that physical events have fully physical chances. Quantum randomness is physically complete; no nonphysical variable is needed to explain the statistics.”

This response deserves serious engagement. It is the strongest version of the closure argument.

But notice what it does: it *redefines* closure from “every physical event is determined by prior physical events” to “every physical event has a fully physical *chance*.” This reformulation preserves the word “closure” while conceding the structural point — that individual outcomes are not determined. The question then becomes: what does “fully physical chance” mean?

If it means “the probability distribution is specified by the physics” — yes, that is true, and no one disputes it. The Born rule probabilities are physical. But this establishes only *statistical* closure, not *event-level* closure. The probability distribution is complete; the individual outcome is not determined.

If it means “no nonphysical variable is needed to *account for* the outcome” — this presupposes exactly what is at issue. Under physicalism, brute randomness is the default account: the outcome is not determined by anything, physical or otherwise. Under idealism, the outcome-selection degree of freedom is where consciousness operates. Both accounts are compatible with the statistics. Declaring the physicalist account “sufficient” and the idealist account “unnecessary” is not a consequence of the physics — it is a restatement of physicalism. The stochastic reformulation of closure does not derive from quantum mechanics; it *assumes* physicalism and then declares the assumption satisfied.

The physics provides the probability distribution. What fills the undetermined degree of freedom is a metaphysical question the physics does not answer. Calling the randomness “physically complete” is not a finding — it is a label applied by one metaphysical framework to what another framework interprets differently.

What Is Preserved

To be clear about what quantum theory *does* close:

- **Conservation laws hold.** Energy, momentum, angular momentum, charge — all conserved quantities remain perfectly conserved under standard quantum mechanics. (Objective collapse models may introduce minute violations of energy conservation — a cost they bear, not the standard formalism.) Consciousness operating within the outcome-selection degree of freedom would not violate any conservation law, because the possible outcomes already satisfy all conservation constraints. The Born rule selects among outcomes that are all individually consistent with the conserved quantities.
- **Statistical distributions hold.** The Born rule probabilities are exact. If consciousness influenced outcome selection, it would do so in a way that preserves these statistics — or the influence would be empirically detectable (and has not been detected). This is a genuine constraint on any consciousness-involvement hypothesis.
- **All equations hold.** Every equation in physics — Schrödinger, Dirac, the Standard Model Lagrangian, general relativity — describes the deterministic evolution of the state

and the probabilistic structure of outcomes. None of these equations specifies which outcome actualizes. Consciousness-involvement operates in a degree of freedom the equations do not address.

What is *not* preserved is the claim that the physical world is causally closed in the classical sense — that every physical event is fully determined by prior physical events. That claim requires deterministic closure, and quantum theory does not provide it. The stochastic reformulation concedes this while attempting to preserve the word “closure” — but the philosophical work the word was doing depended on determinism, not on probability distributions.

IV. The Interpretive History: Asymmetry in Action

The structural observation above — that quantum theory leaves outcome-selection undetermined — was recognized immediately by the theory’s founders. What is remarkable about the subsequent interpretive history is not that better alternatives emerged, but that every alternative introduced its own ontological costs and open foundational problems — yet only the consciousness-involving reading was treated as disqualified by its difficulties.

The Founders’ Recognition

John von Neumann (1932) formalized the measurement chain in *Mathematical Foundations of Quantum Mechanics*. He demonstrated that the “cut” between the quantum system and the measuring apparatus could be pushed arbitrarily far — there is no point in the physical chain at which the formalism *requires* collapse. He noted that the chain terminates at the observer — at the point where a subject becomes aware of a result. Whether this observation *requires* consciousness as a causal agent or merely identifies the conventional location of the cut remains debated; what is not debated is that von Neumann’s formalism identified a structural feature that purely physical accounts do not resolve.

Eugene Wigner (1961) made the implication explicit: consciousness cannot be cleanly separated from the formalism. Physical processes alone, described by the Schrödinger equation, do not produce definite outcomes. Something outside the scope of unitary evolution must account for the transition from superposition to definite result. Wigner proposed that this something is consciousness. He later moderated this position, moving toward a view closer to Zeh’s decoherence program — an evolution worth noting honestly. But his moderation did not resolve the measurement problem; it deferred it. And his original observation — that the formalism alone does not produce definite outcomes — stands regardless of his later interpretive preferences.

Werner Heisenberg described quantum objects as existing in a state of *potentia* — abstract possibility that becomes concrete through measurement. He rejected the notion that quantum objects have definite properties prior to observation, treating the act of measurement as constitutive rather than merely revelatory. His framework was closer to Bohr’s complementarity than to explicit consciousness-collapse, but it shared the structural recognition that the observer cannot be eliminated from the physical story.

Niels Bohr — arguably the most influential of the founders — developed complementarity: the view that quantum objects have no definite properties independent of the measurement context, and that the classical/quantum boundary is irreducible. Bohr did not invoke consciousness explicitly; he insisted on the necessity of classical *language* for describing measurements. But his framework refused to provide a purely physical account of how definite outcomes arise —

it declared the question unanswerable within quantum mechanics and treated measurement as a primitive. Complementarity sidesteps the consciousness question rather than answering it; it does not provide the causal closure that physicalism needs.

Erwin Schrödinger found deep resonance between quantum mechanics and Vedantic philosophy, particularly the idea that consciousness is singular and universal. His cat paradox was designed to expose the incompleteness of purely physical accounts of measurement — to show that applying the Schrödinger equation without an observer-dependent collapse rule produces absurd macroscopic superpositions. Whether Schrödinger endorsed a consciousness-collapse view is debatable; that he recognized the formalism’s dependence on something beyond itself is not.

John Archibald Wheeler proposed the “participatory universe” — reality brought into being through acts of observation. His delayed-choice experiments showed that the choice of measurement can determine, retroactively, which physical description applies to a system — a result whose interpretation remains contested but whose structural implication (that observation is not passive) is widely acknowledged.

What These Founders Shared — and Where They Diverged

These were not fringe figures. They were the creators of the theory. They did not share a single interpretation — Bohr and Wigner disagreed profoundly, and Schrödinger and Heisenberg held incompatible views on many specifics. What they shared was a structural recognition:

1. The formalism does not produce definite outcomes without something that is not in the formalism
2. That “something” cannot be identified with any physical process without creating an infinite regress (the measurement chain can always be extended) or declaring the question unanswerable

On the first two points, all six figures agree — including Bohr. His complementarity framework refused to provide a purely physical account of definite outcomes and treated measurement as a primitive. But Bohr did not take the further step. He was operational and pragmatic: he declared the question of *what produces definite outcomes* unanswerable within quantum mechanics and stopped there. He did not invoke consciousness, did not endorse a consciousness-collapse reading, and would have resisted being grouped with Wigner on this point. His contribution to this essay’s argument is diagnostic, not constructive: complementarity confirms that the standard formalism does not deliver causal closure, but it does so by refusing to answer the question rather than by proposing consciousness as the answer.

The further step — identifying consciousness as what terminates the measurement chain — was taken explicitly by von Neumann and Wigner, resonated with Schrödinger’s philosophical commitments, and was implicit in aspects of Heisenberg’s and Wheeler’s frameworks. Among these figures, a natural observation emerged:

3. Consciousness is a candidate that terminates the chain without requiring further physical explanation — because it is the one element we know independently to exist

This reading does not add an exotic, unobservable, hypothetical entity. It identifies a role for the one thing we know most directly — conscious experience — in a formalism that demonstrably requires something beyond itself to produce the outcomes we observe. Whether this makes the reading *more* parsimonious than alternatives depends on how one counts costs — a contested

question this essay does not adjudicate. What is not in question is that the reading was a natural response to the formalism, not a mystical imposition on it.

The Shift Away

What followed was a systematic movement *away* from this reading, driven not by new empirical findings but by the cultural dynamics that *The Emergence of Physicalism* traces in the broader history of science: the progressive identification of “scientific” with “physicalist,” the institutional pressure to avoid anything that sounds like it grants consciousness a fundamental role, and the stigmatization of consciousness-involving interpretations as “mystical.”

This is not to deny that the alternatives were also motivated by genuine theoretical concerns — the desire for a universal equation, the pursuit of Lorentz invariance, the ambition for a precise ontology. These motivations are real and legitimate. The point is that they were applied *asymmetrically*: the consciousness-involving reading was held to standards (precise mechanism, formal specification) that the alternatives themselves do not meet (many-worlds does not solve the probability problem; decoherence does not solve the problem of outcomes; hidden variables add unobservable structure). The same tolerance extended to these alternatives was denied to the consciousness-involving reading — not because it failed where they succeeded, but because it named an element (consciousness) that the cultural trajectory had declared inadmissible.

The alternatives that replaced the founders’ reading each introduced their own ontological costs and open foundational problems:

Many-Worlds (Everett, 1957)

The move: Avoid the measurement problem by denying that collapse occurs. Apply the Schrödinger equation universally, without interruption. Every possible outcome of every measurement actualizes — in a separate branch of reality.

Everett’s parsimony claim and why it fails: Everettians argue that many-worlds is *dynamically* parsimonious: one equation (Schrödinger), no collapse postulate, one ontology (the universal wavefunction). This sounds like simplification. It is not. Removing the collapse postulate and replacing it with *universal branching* does not reduce ontological cost — it trades a process (collapse) for an infinity of unobservable structure (branches). The “one equation” claim hides the fact that the equation, applied universally without collapse, generates an inconceivably vast number of unobservable branches that do no empirical work. Moreover, many-worlds faces the **probability problem**: if all outcomes occur with equal ontological status, why do we observe Born-rule frequencies? This remains unsolved — the interpretation removes one postulate (collapse) but cannot derive the postulate it still needs (Born probabilities).

What it costs: An infinity of unobservable universes, plus an unsolved probability problem.

What it avoids: Any reference to consciousness or observation as playing a role in determining outcomes.

The comparison: Both readings carry costs. The founders’ reading invokes consciousness in a causal-structural role that requires further specification. Many-worlds removes consciousness by adding an infinity of unobservable branches plus an unsolved probability problem. The point is not that one is definitively cheaper — parsimony comparisons depend on contested judgments about how to weigh different kinds of costs. The point is that both carry open problems, yet only the consciousness-involving reading is routinely dismissed as unserious while many-worlds is

treated as bold and elegant. That differential treatment is not empirically motivated — both make the same predictions. It is an instance of the [asymmetric restraint](#) this project diagnoses.

Decoherence (Zeh, 1970; Zurek, 1981)

The move: Environmental entanglement rapidly suppresses interference terms in the density matrix, making superpositions *effectively* indistinguishable from classical mixtures for all practical purposes. This explains why macroscopic objects appear classical.

What it establishes: Decoherence is real, well-confirmed, and explains the *apparent* classicality of the macroscopic world. It is a genuine contribution to physics. The mechanism — quantum Darwinism, pointer-state stability, redundant environmental encoding — is technically sophisticated and experimentally supported.

What it does not establish: Decoherence does not solve the measurement problem. This is acknowledged by its architects — Zurek himself has been careful to distinguish the “problem of outcomes” (why one result rather than another?) from the “problem of classicality” (why does the macroscopic world look classical?). Decoherence addresses the second but not the first. After decoherence, the density matrix is diagonal — but a diagonal density matrix describes a *probabilistic mixture*, not a *definite outcome*. Something must still select which element of the mixture actualizes. Decoherence explains why the *menu* of possible outcomes looks classical; it does not explain why one item is *ordered*.

The misrepresentation: Despite these well-known limitations, decoherence is routinely presented — in textbooks, popular accounts, and even some philosophical discussions — as having *solved* the measurement problem. This misrepresentation is consequential: it creates the impression that physics has eliminated the role of the observer, when in fact it has explained the appearance of classicality while leaving the problem of outcomes untouched. The gap between what decoherence establishes (suppression of interference) and what it is claimed to establish (elimination of the measurement problem) is itself an instance of the asymmetric restraint this project diagnoses.

Objective Collapse (GRW, 1986; Penrose, 1996)

The move: Modify the Schrödinger equation by adding a physical collapse mechanism — spontaneous localization events (GRW) or gravitationally induced collapse (Penrose). These proposals give collapse a specific physical trigger, removing the need for an observer.

What it establishes: Objective collapse theories are the most scientifically serious alternatives because they make *different empirical predictions* from standard quantum mechanics. They are not merely interpretive reframings; they are genuinely different theories that can in principle be tested. Current experimental bounds have not yet ruled out all versions, though they increasingly constrain the parameter space.

What they cost: A modification of the most successful equation in physics — the Schrödinger equation — by adding a stochastic collapse term. GRW’s collapse parameters (rate, localization width) are not derived from any deeper principle; they are chosen to reproduce observed behavior. Penrose’s proposal claims independent motivation from quantum-gravity tensions — a stronger foundation, though the specific collapse mechanism remains speculative. In both cases, the modification introduces new free parameters and may involve minute violations of energy conservation — costs the standard formalism does not bear.

Why they matter for this essay: Objective collapse theories represent the most disciplined attempt to solve the measurement problem without invoking consciousness. They deserve respect for their empirical vulnerability — unlike many-worlds or consciousness-collapse, they can in principle be falsified. If future experiments confirm a specific collapse mechanism, they would specify *when* collapse occurs — at a gravitational threshold or spontaneous localization event. But they would not specify *which outcome* actualizes. The specific outcome within the Born-rule distribution would remain stochastic, not mechanistically determined. A confirmed physical trigger tells you when the outcome-selection degree of freedom is exercised; it does not close it. The essay’s core argument — that individual outcome-selection is not determined by the physics — survives even under confirmed objective collapse. That GRW/Penrose exist as serious research programs is evidence that the measurement problem is genuinely open — not that it has been solved.

Hidden Variables (Bohm, 1952)

The move: Restore determinism by adding unobservable “pilot wave” dynamics that guide particles along definite trajectories. The Born rule probabilities reflect our ignorance of initial conditions, not genuine indeterminacy.

What it achieves: Bohmian mechanics genuinely restores a form of causal closure. The theory is fully deterministic: given the universal wavefunction and the initial particle positions, every subsequent outcome is fixed. There is no outcome-selection degree of freedom — every measurement result is determined by the pilot wave dynamics. This is a real achievement, and this essay acknowledges it. If Bohmian mechanics is correct, the structural opening this essay identifies does not exist.

What it costs: This closure is purchased, not discovered. The pilot wave is an additional layer of unobservable dynamics that no current experiment can directly detect. The theory is empirically equivalent to standard quantum mechanics in its standard formulation but ontologically richer: it adds structure specifically to restore the determinism that quantum mechanics appeared to revoke. More significantly, the theory depends on the **quantum equilibrium hypothesis** — the assumption that particle positions are initially distributed according to the Born rule. This assumption is not derived from the theory’s dynamics; it is an additional postulate whose justification remains an open foundational problem, debated among Bohmian mechanics’ own proponents. The equilibrium hypothesis plays a role in Bohm’s theory structurally analogous to the questions consciousness-involvement faces (what counts as a measurement? how are Born statistics preserved?) — yet the former is treated as a normal open problem while the latter is treated as disqualifying.

What it avoids: Both the measurement problem (outcomes are determinate, we just don’t know which) and any role for consciousness.

The comparison: Bohm’s theory restores deterministic closure — but at the cost of introducing unobservable dynamics and an unjustified equilibrium postulate. The motivation is explicitly to restore the classical picture that quantum mechanics appeared to revoke. This is a *metaphysically motivated* addition, not an empirically required one. It demonstrates that closure *can* be recovered — but only by adding to the formalism, not by reading it as given. As with many-worlds, the point is not that Bohm is worse than the founders’ reading — it is that both carry open foundational problems, yet Bohm’s are treated as normal science while the founders’ are treated as grounds for dismissal.

QBism (Fuchs, 2002; Fuchs, Mermin, & Schack, 2014)

The move: Treat quantum probabilities as Bayesian degrees of belief held by individual agents, not as objective features of mind-independent reality. The wavefunction is not a description of the world — it is a tool agents use to organize their expectations about future experiences. “Measurement” is simply an agent updating their beliefs in light of a new experience. The measurement problem dissolves: there is no objective quantum state that needs to “collapse” into a definite outcome, because the quantum state was never a description of mind-independent reality to begin with.

What it costs: Observer-independent physical reality. Under QBism, the quantum formalism is explicitly agent-relative. There is no “view from nowhere” — no description of the world as it is independent of any agent’s perspective. This is a significant philosophical cost, though QBists argue it is a virtue: physics was never about describing a mind-independent world but about helping agents navigate their experience.

Why it matters for this essay: QBism is the most important recent development for two reasons. First, it returns the observer to center stage — agents and their experiences are irreducible elements of the story — demonstrating that observer-centrality is a live position in mainstream philosophy of physics, not a mystical relic. Second, and crucially, QBism does *not* restore causal closure. Under QBism there is no observer-independent physical story that determines outcomes; there are agents, experiences, and the probabilities agents assign. The classical closure picture — every physical event has a sufficient physical cause — is simply not available. QBism is observer-centric without being consciousness-causal. Its architects frame it as pragmatist, not idealist. But its structural commitments — irreducible agents, no observer-independent reality, experience as the basic currency of physics — are far more naturally at home within a consciousness-first ontology than within the physicalism that appeals to causal closure.

Relational Quantum Mechanics (Rovelli, 1996)

The move: Treat quantum states as relational properties — a system has definite values only relative to another system that has interacted with it. There is no absolute, observer-independent state of affairs. “Collapse” is simply the establishment of a correlation between systems — a relational fact, not a mysterious physical process requiring explanation.

What it costs: Absolute facts. If all physical properties are relative to interacting systems, there is no single objective description of reality. Different “observers” (which in relational QM need not be conscious — any physical system qualifies) may assign different quantum states to the same system, and both assignments are correct relative to their respective interactions.

What it shares with QBism: Both dissolve the measurement problem by abandoning the premise that produces it — the assumption of an observer-independent quantum state. Both remove the privileged observer without restoring the observer-free, causally closed picture physicalism requires. If facts are relative rather than absolute, there is no single causal chain to be “closed.”

Consistent (Decoherent) Histories (Griffiths, 1984; Omnès, 1988; Gell-Mann & Hartle, 1990)

The move: Extend decoherence into a framework for assigning probabilities to sequences of events — “histories” — without a collapse postulate. The formalism identifies families of his-

ories that are mutually consistent (no quantum interference between branches) and assigns Born-rule probabilities within each family. The claim is that this dissolves the measurement problem: the quantum formalism already provides probabilities for macroscopic histories without needing an additional collapse rule or observer.

What it costs: The framework permits *many* consistent families of histories, and no principle within the theory selects which family describes actuality. This is the **set-selection problem** — structurally analogous to the measurement problem it claims to dissolve. Why *this* consistent family rather than another? The question the formalism leaves unanswered is the same question, relocated. Decoherence narrows the range of consistent families (environmental interaction suppresses most of them), but does not reduce it to one.

What these three frameworks establish for this essay: None restores the classical causal closure that Section I identified as the foundation of the physicalist objection. QBism and relational QM explicitly abandon observer-independent physical closure. Consistent histories claims to dissolve the need for closure but inherits a selection problem structurally parallel to the one it claims to resolve. Their existence confirms, from three independent directions, the essay’s central point: the physics does not deliver what the causal-closure objection presupposes. The interpretive landscape has grown more sophisticated and more complex since the founders; it has not grown more parsimonious, and it has not grown more closed.

V. The Asymmetry Made Explicit

The interpretive history reveals a pattern:

Interpretation	Ontological addition	What it avoids
Founders’ reading	Consciousness terminates the measurement chain; requires further specification of role	Nothing — takes the formalism at face value
Complementarity (Bohr)	Declares measurement a primitive; refuses to analyze it further	The measurement problem (by fiat)
Many-worlds	Infinity of unobservable branches + unsolved probability problem	Reference to consciousness
Decoherence (as solution)	Conflates classicality with definiteness	The problem of outcomes
Objective collapse	Ad hoc modification of the Schrödinger equation	The observer
Hidden variables	Unobservable pilot wave dynamics + unjustified equilibrium postulate	Genuine indeterminacy — and restores deterministic closure
QBism	Subjectivizes the quantum state; abandons observer-independent reality	The measurement problem (by dissolution) — and causal closure with it
Relational QM	Relativizes all facts to interacting systems	The measurement problem (by relativization) — and absolute closure with it

Interpretation	Ontological addition	What it avoids
Consistent histories	Framework restriction to decoherent families + unsolved set-selection problem	Collapse — but relocates the selection problem

Every interpretation carries ontological costs — unobservable entities, ad hoc modifications, unsolved foundational problems, or refusal to analyze. The founders’ reading carries costs too: it invokes consciousness in a causal-structural role that requires further specification. The question is not which interpretation is cheapest — that depends on contested judgments about how to weigh different kinds of costs. The question is why only one set of costs is treated as disqualifying.

This is *Asymmetric Methodological Restraint* operating within the foundations of physics. The same double standard the project diagnoses in consciousness studies operates in the interpretation of quantum mechanics itself:

- **Many-worlds** posits an infinity of unobservable universes, cannot derive the Born rule, and is considered “bold and elegant”
- **Consciousness-involvement** invokes the one entity we know independently exists and is dismissed as “mysticism”
- **Decoherence** is credited with solving a problem it demonstrably does not solve, because the claimed solution removes consciousness from the story
- **Objective collapse** modifies the most successful equation in physics with ad hoc parameters, and this is treated as a legitimate research program
- **Hidden variables** add unobservable dynamics and an unjustified equilibrium postulate to restore a classical picture — and this is treated as a serious ontological proposal, its open foundational problems regarded as normal science rather than grounds for dismissal
- **QBism** centers the observer and is taken seriously — because it frames observer-involvement as epistemic rather than ontological

The differential treatment is not empirically motivated — these interpretations make the same predictions (objective collapse theories differ, which is to their credit). It is culturally motivated — by the dynamics *The Emergence of Physicalism* traces: the progressive identification of “scientific” with “consciousness-free.”

But the most important point for this essay’s argument is what the interpretive landscape reveals: **the standard formalism does not deliver causal closure, and restoring it requires adding to the formalism — not reading what is already there.** Bohmian mechanics genuinely restores deterministic closure, but only by introducing unobservable pilot wave dynamics and an unjustified equilibrium postulate. The other interpretations do not restore closure at all: they dissolve it (QBism, relational QM), relocate it (consistent histories), leave the outcome-selection problem open (many-worlds, decoherence, objective collapse), declare it unanswerable (Bohr), or assign consciousness a role (von Neumann, Wigner, and aspects of Heisenberg, Schrödinger, and Wheeler). The physics *as given* does not deliver a causally closed physical world. Closure can be purchased — but at ontological cost, through metaphysical commitment, not empirical discovery.

The Authority Inversion

This asymmetry has a specific consequence for the consciousness debate. Physicalism appeals to physics as its strongest authority — the hardest science, the most rigorous discipline, the gold standard of empirical success. But *within* that hardest science, at its most fundamental level, the consciousness-involving reading was discarded under cultural pressure, not empirical pressure — while alternatives carrying comparable or greater costs were embraced. The authority physicalism invokes does not support the closure physicalism claims.

This does not mean physics supports idealism. It means physics does not support the specific claim physicalism borrows from it — that causal closure forecloses a role for consciousness. The appeal to physics as a defeater of consciousness-first frameworks is an appeal to an interpretation of physics, not to the physics itself. And the interpretive history shows that the selection among interpretations has been shaped by the same cultural dynamics the project diagnoses everywhere else.

VI. What This Does Not Establish

This essay has argued that physics does not deliver deterministic causal closure, that the outcome-selection degree of freedom is real and open, that every interpretation carries ontological costs and open problems, and that only the consciousness-involving reading was treated as disqualified by its difficulties — driven by cultural rather than empirical pressure.

It has **not** argued:

That consciousness causes collapse. The essay establishes that the physics *permits* consciousness-involvement in outcome-selection. Whether consciousness actually plays that role is a further question — one the physics leaves open in both directions. This essay removes the false obstacle; it does not build the positive case.

That a “mechanism” for mental causation must be supplied before consciousness-involvement can be taken seriously. The outcome-selection degree of freedom is real — individual outcomes actualize, and the formalism does not determine which one. The demand for a mechanistic account of how consciousness operates within that degree of freedom may be not just premature but self-defeating: a mechanism for mental causation would be deterministic, which would mean it is not mental causation but physical causation redescribed. If consciousness genuinely operates in the outcome-selection degree of freedom — if that is what agency *is* — then the account terminates at the agent, not at a mechanism behind the agent. Demanding mechanism is demanding that the degree of freedom be closed, which is demanding precisely what the physics does not deliver. Even setting aside the category error, the demand is asymmetric: physicalism’s “brute randomness” provides no account of how specific outcomes actualize either — yet this is accepted as the default without comparable burden. Both positions face the same explanatory gap at the point of outcome-selection. Demanding mechanism only from consciousness-involvement is [asymmetric restraint](#).

That decoherence is wrong, or that objective collapse theories are wrong. Decoherence is a well-confirmed physical process; what is wrong is the claim that it solves the measurement problem. GRW and Penrose-type proposals are the most epistemically serious alternatives precisely because they are empirically vulnerable. If confirmed, they would specify *when* collapse occurs (at a gravitational threshold or spontaneous localization event) — but not *which outcome* actualizes. A confirmed physical trigger tells you when the outcome-selection degree of freedom

is exercised; it does not close it. The essay's core argument survives: the specific outcome remains stochastic, not mechanistically determined. This essay respects both contributions while noting that neither delivers what the causal-closure objection requires.

That the founders' interpretation is proven by this essay alone. This essay establishes that the founders' consciousness-involving reading was abandoned under cultural pressure, not empirical pressure, and that the alternatives carry comparable costs and open problems. The broader project argues that the founders were on the right track — but that constructive case rests on the full [argumentative structure](#), not on this essay in isolation.

That the measurement problem is solved. It is not — within the physicalist frame. This essay does not solve it. It shows that the most common implicit “solutions” — decoherence or many-worlds — depend on claims that do not survive scrutiny. It is worth noting that the measurement problem is itself a product of the physicalist default: it does not arise under consciousness-first ontologies, where the question is not how physics produces experience but how experience gives rise to what we call physics.

VII. What This Establishes

1. Classical causal closure is not a current physical constraint. It was a feature of Newtonian mechanics. Quantum theory replaced it with statistical closure — probability distributions are fixed, individual outcomes are not. The appeal to “causal closure” as a defeater of consciousness-first frameworks invokes a picture of physics that physics itself superseded.

2. Quantum theory provides statistical closure, not event-level determination. All conservation laws, all equations, all statistical predictions are perfectly preserved. What is not preserved is the deterministic claim that every physical event is fully determined by prior physical events.

3. Stochastic reformulations of closure presuppose what they claim to establish. Redefining closure as “physical events have fully physical chances” concedes the structural point (outcomes are not determined) while assuming the metaphysical answer (the undetermined degree of freedom requires no nonphysical account). This is a restatement of physicalism, not a consequence of the physics.

4. Therefore, physicalism cannot invoke causal closure as a defeater of mental causation. The physics leaves open whether consciousness plays a role in outcome selection. It does not mandate that it does; it does not mandate that it does not. The question is genuinely open — and closing it requires philosophical argument, not an appeal to physics.

5. The interpretive history exhibits asymmetric restraint. Every interpretation carries ontological costs and open foundational problems. Yet only the consciousness-involving reading was treated as disqualified by its difficulties, while alternatives with comparable or greater costs were embraced as serious research programs. Cultural pressure, not new evidence, drove the shift.

6. Whether mental causation occurs remains a further metaphysical question. This essay removes a false obstacle — the claim that physics forecloses the question. It does not answer the question itself. Even if objective collapse theories are experimentally confirmed, the outcome-level openness this essay identifies would remain: a confirmed physical trigger specifies *when* collapse occurs, not *which outcome* actualizes.

VIII. Connection to the Project

This essay connects to the project’s broader architecture at several points:

Asymmetric Methodological Restraint (amr): AMR diagnoses asymmetric skepticism in consciousness studies. This essay shows the same asymmetry operating within physics itself — at its most fundamental level, in the interpretation of quantum mechanics. The pattern is the same: consciousness-involving positions face a burden of skepticism that exotic alternatives do not, under identical evidential conditions.

The Generativity Question (tgq): TGQ addresses the causal closure objection briefly in its portability section. This essay provides the full treatment — showing precisely what quantum theory does and does not close, and why the objection rests on outdated physics. TGQ’s point that scientific methodology is ontologically portable is reinforced here: the equations are portable because they describe the statistical structure, which is preserved under any interpretation.

The Emergence of Physicalism (eop): EOP traces how physicalism became the invisible default through historical contingency rather than philosophical proof. This essay extends that genealogy into the interpretive history of quantum mechanics — showing that the shift from consciousness-involving to consciousness-free interpretations followed the same trajectory.

Where Explanation Stops (wes): WES maps where each framework places its brute facts. This essay adds a refinement: under quantum theory, “what determines which outcome actualizes” is a brute fact for every interpretation. Physicalism’s versions (brute randomness, brute branching, brute hidden variables, brute ad hoc collapse parameters) are no less metaphysically costly than idealism’s (consciousness operates in the outcome-selection degree of freedom).

Return to Consciousness (rtc): RTC mentions quantum measurement briefly as part of a broader convergence pattern. This essay provides the technical grounding — showing that the quantum formalism is not merely *compatible* with consciousness-first metaphysics but *leaves open precisely the degree of freedom* that such metaphysics would require.

Conclusion

The appeal to causal closure is the most common implicit argument against consciousness-first frameworks. It sounds like it is simply reporting what physics has established. It is not.

What physics has established is statistical closure: probability distributions are fixed, conservation laws hold, equations describe the deterministic evolution of the state. What physics has not established — and what quantum theory specifically does not provide — is event-level determination: the selection of specific outcomes in individual measurements. Reformulating closure in stochastic terms does not rescue the argument; it concedes the structural point while assuming the metaphysical answer.

This degree of freedom was recognized immediately by the theory’s founders, who saw that the formalism terminates at the observer and proposed that consciousness plays a constitutive role. That reading was abandoned not because new evidence refuted it but because the cultural trajectory traced throughout this project — the progressive identification of “scientific” with “consciousness-free” — made it unacceptable. Every alternative introduced its own costs and open problems. The consciousness-involving reading carries costs too. But the costs were not weighed symmetrically: the alternatives were treated as serious research programs with

normal open problems, while the founders' reading was dismissed as mysticism. More recent frameworks (QBism, relational quantum mechanics) have taken a different path, returning the observer to center stage while dissolving rather than solving the measurement problem. The standard formalism does not deliver causal closure; restoring it requires adding to the formalism. Bohmian mechanics achieves this — but only through unobservable pilot wave dynamics and an unjustified equilibrium postulate, purchasing closure through metaphysical commitment rather than empirical discovery. The remaining interpretations do not restore closure at all. The one alternative that differs empirically (objective collapse) remains unconfirmed; if confirmed, it would provide a physical trigger for collapse — but even confirmed objective collapse remains stochastic: which specific outcome actualizes would still not be mechanistically determined, leaving the outcome-level openness this essay identifies intact in its essentials.

The measurement problem remains open — within the physicalist frame. It is worth noting that the problem is itself a product of that frame: it does not arise under consciousness-first ontologies, where physics is not required to ground experience. What this essay closes is the appeal to physics as a defeater of consciousness-first frameworks — an appeal that rests on a version of physics (classical deterministic closure) that physics itself superseded, and on an interpretive history shaped by the same asymmetric restraint this project diagnoses across every domain it examines.

Physics does not mandate that consciousness is epiphenomenal. Physics does not mandate that the physical world is causally closed in the sense required by the objection. Physics leaves the question open — and the interpretive tradition that pretends otherwise is an artifact of culture, not of inquiry.

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Related Essays in This Project

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[Asymmetric Methodological Restraint \(amr\)](#) — The asymmetric restraint this essay diagnoses within physics

[The Generativity Question \(tgq\)](#) — Addresses the causal closure objection briefly; this essay provides the full treatment

[The Emergence of Physicalism \(eop\)](#) — The cultural trajectory this essay extends into quantum interpretive history

[Where Explanation Stops \(wes\)](#) — The brute-fact analysis this essay refines for quantum measurement

[Return to Consciousness \(rtc\)](#) — The foundational synthesis this essay supports

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