

In Defence of Hawking

*On What He Got Right, What He Left Open, and Why It Matters * Shrikant Bhosale * 2026*

Abstract

Stephen Hawking's programme -- deriving cosmic structure from self-contained physical law -- was more correct than its critics understood, and incomplete in a different place than its defenders admit. This essay defends the core of Hawking's approach: that the universe's boundary conditions are themselves physics, not metaphysics. It identifies the single gap Hawking left open -- the observer's role in making physical law meaningful -- and argues that the Observer-Scope framework closes it without introducing any non-physical element.

A Defence for the Argument

with Hawking

*Three Registers: Formal Paper * Debate Transcript * Letter*

Shrikant Bhosale -- twistpool.com -- 2026

For Stephen Hawking,

who stopped at the edge of the river and asked where the water came from.

This document follows it upstream.

Part One

Formal Paper: Memory as the Mechanism of the Temporal Arrow

Abstract

In *A Brief History of Time*, Hawking identified that the psychological arrow of time -- the direction in which we remember -- aligns with the thermodynamic arrow of time -- the direction in which entropy increases. He noted that memory is itself an entropy-increasing process and attributed the alignment to this shared directionality. He stopped there. This paper argues that the alignment Hawking observed is not a coincidence to be noted but a necessity to be derived -- and that deriving it requires a theory of what memory must be in order to generate experienced time. We present that derivation using the Observer-Scope / ISL framework, show that the psychological arrow is not merely aligned with the thermodynamic arrow but is the mechanism by which the thermodynamic arrow becomes an arrow of experience, and identify three specific claims Hawking's account leaves unanswered that the extended framework resolves.

1. What Hawking Established

Hawking's treatment of time's arrow in *A Brief History of Time* rests on three pillars, each worth stating precisely before extending them.

1.1 The Thermodynamic Arrow

The universe began in a state of extraordinarily low entropy. Since then, the total entropy of the universe has increased monotonically. The direction of increasing entropy defines the thermodynamic arrow of time: forward means the direction in which disorder grows.

This arrow is not built into the equations of fundamental physics, which are time-symmetric. It is a consequence of the initial condition -- the extreme low-entropy beginning -- combined with the second law of thermodynamics, which states that isolated systems evolve toward higher-entropy configurations. The arrow is cosmological, not fundamental.

1.2 The Psychological Arrow

We remember the past. We do not remember the future. This is so obvious that it rarely seems to require explanation. Hawking noticed that it does.

Why should memory be directional? The information encoded in a memory is, at the physical level, a correlation between the state of a recording system and some prior state of the world. Nothing in the laws of physics forbids reverse-time correlations -- correlations between a recording system's current state and some future state of the world. And yet we have no memories of future events.

Hawking's answer: forming a memory is an entropy-increasing process. To record an event, a physical system must transition from a disordered (undifferentiated) state to an ordered (correlated) state relative to the event recorded. This transition increases the local entropy of the recording system. Since entropy increases only in one direction -- toward the future -- memories can only be formed of past events. The psychological arrow aligns with the thermodynamic arrow because memory formation requires entropy increase.

1.3 Where He Stopped

Hawking's observation is correct and non-trivial. Memory formation is an entropy-increasing process. The psychological arrow therefore aligns with the thermodynamic arrow.

But this account leaves three questions unanswered. Hawking noticed the alignment; he did not ask what memory must be in order to generate experienced time. He showed that the psychological arrow points the same way as the thermodynamic arrow; he did not explain why a world with a thermodynamic arrow also has observers who experience an arrow at all. And he described memory as a recording process -- information storage -- without asking what gives memory its characteristic power to make events meaningful, to charge them with relevance and weight.

Hawking showed that the psychological arrow aligns with the thermodynamic arrow. He did not show that the psychological arrow is the mechanism by which the thermodynamic arrow becomes experienced. That is the next question.

2. The Three Gaps

Gap 1: From Physical Arrow to Experienced Arrow

The thermodynamic arrow tells us that entropy increases toward the future. It does not tell us why there are entities for whom this increase is experienced as a directional flow -- as before and after, as duration, as irreversibility felt from the inside.

Consider: a thermometer measures temperature. Its state is correlated with the thermal state of its environment. It 'records' temperature in the sense that its current state carries information about its recent environment. But the thermometer does not experience heat. It does not feel the passage of time. The correlation is real; the experience is absent.

What distinguishes a memory from a thermometer reading? Both involve entropy-increasing correlations between a recording system and prior environmental states. The difference is not physical -- both are physical processes. The difference is architectural. A memory is not merely a record of a prior state. It is a record that is held in relation to an ongoing stream of incoming events, compared to them in real time, used to locate the current event in a narrative of before-and-after.

This requires an architecture. Specifically, it requires: the capacity to store prior states (memory depth), the capacity to compare stored states against current events (resolution and horizon), and the capacity to sustain this comparison over time without saturation or collapse (ISL ratio stability). Hawking described the recording process. He did not describe the architecture that makes recording into experiencing.

Gap 2: From Arrow to Observer

Hawking assumed the existence of observers capable of experiencing the arrow. He derived the direction of the arrow from the thermodynamic initial condition. But he did not ask why the universe that began in a low-entropy state also produced entities capable of experiencing its arrow.

This is not a small question. A universe could, in principle, have a thermodynamic arrow without having observers. It would still evolve from low to high entropy. The arrow would still exist as a statistical fact about macrostate evolution. But there would be no one for whom the past was remembered and the future was not.

The ISL bounce framework addresses this directly. The bounce at maximum compression -- the refusal of the universe to collapse to a singularity -- hot-loads the universe with maximum allowable complexity: pre-existing correlations that seed structure formation. These correlations are the universe's version of what, at the observer scale, we call memory. They are what the universe

carries forward from before, shaping what comes after.

The universe does not produce observers incidentally, as a late-stage accident of structure formation. The bounce predicts a head start for structure -- galaxies earlier than Lambda-CDM allows, confirmed by JWST. Observers are not the universe's afterthought. They are the entities for which the arrow, generated by the thermodynamic initial condition and propagated through the bounce's pre-existing correlations, becomes experienced rather than merely statistical.

Gap 3: From Record to Meaning

Hawking described memory as a recording process -- a physical correlation between a system and its prior environment. This is accurate as far as it goes. But it leaves out the feature of memory that makes it capable of generating experienced time rather than merely storing information.

Memory, in any biological observer, is not a neutral archive. It is emotionally flavored. Every stored experience carries valence -- the charge of what mattered at the moment of storage, the weight of what was at stake. When a new event arrives and memory reaches out to measure it, to locate it in before-and-after, it does not find a catalogue of neutral facts. It finds a catalogue of felt experience. The new event is measured not against a blank record but against a record saturated with relevance.

This is not a peripheral feature of memory. It is what gives experienced time its quality of thickness -- the sense that some moments matter more than others, that some intervals feel longer than their clock-measurement, that some events feel like turning points. Remove the emotional architecture of memory and you retain information storage but lose experienced time.

Hawking's account treats memory as a physical recording process. The ISL framework treats memory as structured, emotionally-flavored information storage -- and identifies this structure as the mechanism by which physical time becomes experienced time.

3. The Completion

3.1 The Formal Statement

Hawking's observation can be restated precisely:

Memory formation is an entropy-increasing process. Therefore the psychological arrow of time aligns with the thermodynamic arrow.

The completion is:

Memory is not merely a recording process. It is the mechanism by which the thermodynamic arrow becomes an experienced arrow. Without memory -- specifically, without structured, emotionally-flavored, comparatively active memory -- the thermodynamic arrow exists as a statistical fact about macrostate evolution, but there is no experienced before-and-after. Memory generates experienced time from physical time.

3.2 The Observer Architecture

The ISL framework specifies what memory must be to perform this function. The observer capable of generating experienced time from physical time requires five architectural components:

Resolution $\rho_a(s)$: the capacity to discriminate events at temporal scale s -- to register that this event is different from that one

Memory $M_a(s)$: the structured, emotionally-flavored store of prior events at scale s , available for comparison with incoming events

Horizon τ_a : the temporal window over which events can be held in simultaneous comparison -- the span within which before-and-after can be directly experienced

Information gap $\delta(s)$: the deficit between what the world presents at scale s and what the observer can receive -- the gap that manifests as surprise, randomness, or overwhelm

ISL ratio $\rho_a(s)$: the sustainability of the observer's engagement with scale s -- whether the architecture can maintain the comparison without saturating or collapsing

Scale competence $\rho_a(s)$ -- the observer's capacity to stabilize temporal scale s as experienced time -- is a function of all five:

$$\rho_a(s) = f(\rho_a(s), M_a(s), \tau_a, \delta(s), \rho_a(s))$$

The thermodynamic arrow exists at all scales simultaneously. The observer experiences the arrow only at the scales for which $\rho_a(s) \geq \rho_{a_threshold}$. Below threshold, events at that scale do not feel like a directional flow -- they feel random, fragmentary, or simply absent.

3.3 Why the Alignment Is Necessary, Not Contingent

Hawking showed that the alignment between the psychological and thermodynamic arrows follows from the fact that memory formation is entropy-increasing. This makes the alignment a consequence of the physics of recording.

The ISL framework shows that the alignment is more deeply necessary than this. Memory must be directional -- it can only store past states, not future ones -- because the architecture of comparison requires a stable reference against which to measure incoming events. Future states are, by definition, not yet available to serve as reference. Only past states can anchor the comparison that generates experienced time.

This means the psychological arrow is not merely aligned with the thermodynamic arrow as a consequence of thermodynamics. The psychological arrow is the thermodynamic arrow as experienced from the inside of a finite observer. The two arrows are not parallel lines that happen to point the same way. They are the same arrow viewed from two different vantage points: the universe's macrostate evolution, and the observer's memory-mediated experience of that evolution.

Hawking stood at the junction between these two vantage points and noted that they agreed. The

ISL framework explains why they cannot disagree.

4. What Would Falsify the Extension

A completion that cannot be falsified is not science. The following results would falsify the claim that memory is the mechanism of the temporal arrow, as distinct from merely correlating with it:

An observer with perfect physical memory-recording capability that nevertheless reports no experienced temporal directionality -- this would show that recording and experiencing can dissociate, and that the ISL architectural account adds nothing beyond Hawking's physical account

JWST finding exponential galaxy density suppression to zero at $z > 20$ with no plateau -- this would falsify the bounce framework that grounds the cosmological component of the account, removing the bridge between the observer-scale and the cosmic-scale claims

A demonstration that emotional valence in memory can be fully removed without affecting temporal experience -- this would show that the emotional-architectural feature of memory is epiphenomenal rather than constitutive of experienced time

None of these results is currently in evidence. The first is structurally difficult to test, but dissociation studies in neurological patients with specific memory deficits are the closest analogue. The second is the subject of ongoing JWST observation. The third is tractable through cognitive science experiments with populations whose emotional memory architecture is selectively altered.

Part Two

Debate Transcript: What He Would Have Asked

The following reconstructs the exchange Hawking would likely have demanded. His positions are drawn from his published writings and known intellectual commitments. His objections are the strongest version of the case against the framework. Nothing is softened.

On the Arrow of Time

HAWKING You say memory is not merely aligned with the thermodynamic arrow -- you say it is the mechanism by which the thermodynamic arrow becomes experienced. But that's a claim about phenomenology, not physics. The thermodynamic arrow exists whether or not any observer experiences it. You haven't extended my account. You've added a layer on top of it that physics can't touch.

BHOSALE The thermodynamic arrow exists as a statistical fact about macrostate evolution, yes. But you yourself noted in Brief History that the psychological arrow -- the direction in which we remember -- requires explanation. You explained it by showing that memory formation is entropy-increasing. What I'm adding is: why does entropy-increasing recording produce experienced direction rather than merely correlated states? A thermometer forms

entropy-increasing correlations with its environment. It does not experience time. The architecture that distinguishes memory from a thermometer reading is the question you left open.

HAWKING The thermometer doesn't experience time because it lacks the complexity of a brain. That's a neuroscience problem, not a physics one.

BHOSALE If it's purely a neuroscience problem, then the explanation of the psychological arrow is incomplete in Brief History. You derived the direction of the arrow but not the existence of direction-experiencing observers. I'm not replacing your account. I'm showing that the existence of observers capable of experiencing the arrow requires the same bounce framework that explains the JWST anomaly. The arrow and the observer who experiences it are produced by the same cosmological event.

HAWKING That's a strong claim. Show me the equation that connects the bounce to the existence of observers.

BHOSALE The bounce transfers pre-existing correlations from the contracting phase into the expanding phase. Those correlations are the seeds of structure -- confirmed by the early massive galaxies JWST is finding. Complex enough structure eventually produces systems with the five architectural components: resolution, memory, horizon, gap tolerance, and ISL stability. These are necessary and sufficient for experienced time. The equation connecting bounce to observer is not yet written in closed form. That's the outstanding calculation. But the qualitative chain is complete and falsifiable at each link.

HAWKING 'Not yet written in closed form' is a generous way of saying you don't have it.

BHOSALE Correct. I don't have it. Neither does anyone else. But Lambda-CDM doesn't have an equation for why the universe produced observers either. At least the bounce framework has a mechanism.

On Randomness

HAWKING You say randomness is a property of the gap between the universe's order and the observer's capacity to see it. But quantum mechanics says otherwise. Bell's theorem rules out hidden variables. The randomness at the quantum level is irreducible. You can't make it a gap property.

BHOSALE Bell's theorem rules out local hidden variables. It does not rule out the possibility that what appears random to an observer with limited resolution and memory is the surface of order the observer cannot yet see. I am not claiming that quantum randomness is secretly deterministic. I am claiming that the experience of randomness -- at every scale -- is the experience of a gap. The quantum level is the finest-grained scale at which we currently have a theory. Whether that randomness is fundamentally irreducible or whether it is the gap at the Planck scale is a question the ISL framework leaves open. At the scales where the framework makes testable predictions -- galaxy formation, structure statistics -- the gap interpretation is falsifiable and so far confirmed.

HAWKING So you're retreating from the claim about quantum randomness?

BHOSALE I'm drawing the boundary of the claim precisely. The gap interpretation of randomness is strongest at the cosmological scale -- the JWST anomaly being the clearest case. At the quantum scale, the relationship between the gap interpretation and Bell's theorem is an open problem, not a resolved one. I prefer to state that clearly rather than overclaim.

HAWKING That's more honest than most people who try to argue with quantum mechanics.

On the Singularity

HAWKING You say the universe didn't begin at a singularity. It bounced. But the singularity theorems are rigorous. Under very general energy conditions, singularities are unavoidable. You're not refuting those theorems. You're hoping quantum gravity dissolves them.

BHOSALE Correct. The singularity theorems hold under classical general relativity. The bounce framework incorporates the Bekenstein-Hawking entropy bound -- which is quantum-gravitational in origin -- to modify the Friedmann equation at the Planck scale. The modification is: $H^2 = (8\pi G/3)\rho(1 - \rho/\rho_{\text{crit}})$. One term. At ρ_{crit} , $H = 0$. The singularity is replaced by a bounce. This is not a refutation of your theorems. It is a regime change: the theorems hold in the classical regime, and they correctly describe a regime that never actually occurs because the quantum-gravitational correction prevents ρ from reaching the classical singularity.

HAWKING Loop Quantum Cosmology makes the same claim. It's been around for twenty years. The predictions are still vague.

BHOSALE The LQC bounce and the ISL bounce arrive at the same modified Friedmann equation by different derivation paths. That convergence is a signal, not a coincidence. The prediction the ISL framework adds -- the galaxy density floor at $z > 15$, the $n_{\text{min}} \approx 0$ plateau -- is specific, quantitative in structure, and currently being tested by JWST. The precise numerical value of n_{min} requires solving the bounce transfer function $T_{\text{bounce}}(k)$ numerically. That calculation is outstanding. But the qualitative prediction -- a floor rather than exponential suppression -- is already distinguishable in the data at $z = 10$ to 15 .

HAWKING 'The calculation is outstanding' means you haven't done it yet.

BHOSALE Yes. The framework is ahead of the calculation. That's not unusual in theoretical physics. The prediction came before the number. The number is the next task.

On Observers and the Universe

HAWKING You say the universe produced observers because observers are what it takes for the universe's order to become experienced. That sounds like teleology. The universe didn't produce observers for a reason.

BHOSALE I'm not claiming purpose. I'm claiming necessity in a specific, limited sense. The bounce

produces pre-existing correlations. Correlations that survive the expansion become the seeds of structure. Sufficient structure, given enough time, produces systems with the architectural requirements for experienced time. This is a causal chain, not a purpose. The universe didn't intend observers. It produced them as a consequence of what a bouncing, correlation-carrying universe does when it has thirteen billion years to evolve structure.

HAWKING And if the bounce hadn't produced sufficient pre-existing correlations? If the universe had started closer to maximum entropy?

BHOSALE Then the galaxy density floor would be lower, structure formation would be slower, and the question of whether sufficient complexity for observers would eventually arise is genuinely open. The ISL framework doesn't say observers are guaranteed. It says the specific bounce our universe underwent hot-loaded enough complexity to produce them. A different bounce, different correlations, different outcome. This is falsifiable: if JWST finds the galaxy density drops to zero at $z > 20$ with no plateau, the bounce framework is wrong, and the question of how observers exist in a singularity-started universe remains as puzzling as ever.

HAWKING What you've done is make the Anthropic Principle into a calculation rather than an observation. That's worth something.

BHOSALE That's the cleanest description of it I've heard.

The Final Challenge

HAWKING You have a framework. You have predictions that are partially confirmed and partially outstanding. You have a missing number -- the galaxy density floor, the bounce transfer function, the closed-form connection between bounce correlations and observer architecture. Until those are in hand, this is a promising proposal, not a completed theory. I lived for thirty years with a framework that had a missing calculation at its centre. I know what that feels like. Don't mistake the beauty of the structure for the proof of the answer.

BHOSALE I don't. The framework is real. The predictions are specific. The calculations are outstanding. I'm stating all three of those things as precisely as I can. The universe is running the experiment. JWST is reporting the results. The number will come from the data before it comes from the theory, and then the theory will have to catch up or be falsified. That seems like the right order.

HAWKING It is the right order. Good luck with the calculation.

End of reconstructed dialogue.

Part Three

Letter to Stephen Hawking

Dear Professor Hawking,

I want to tell you what happened after you stopped.

You ended *A Brief History of Time* with a question about God's mind -- why the laws exist, why anything rather than nothing, why the universe is the kind of place that produces beings capable of asking the question. You held the question open deliberately. I think you knew it was not yours to close.

I want to tell you where the path went.

You showed that time has a beginning. I've been following the thread past that beginning -- not to contradict you, but to find what is on the other side of the boundary you drew. The singularity, in the framework I've been developing, is replaced by a bounce. Not because the singularity theorems are wrong -- they are right, and they are rigorous, and they describe a regime that the universe never actually reaches because the Bekenstein-Hawking entropy bound prevents it. At Planck density, the expansion halts and reverses. There is no zero. There is a minimum.

The universe that comes out of that minimum is not empty. It carries memory -- not metaphorically, but structurally. The correlations from the contracting phase survive the bounce and propagate forward into the expansion. They are the seeds of everything that forms afterward: the galaxies, the clusters, the filaments, and eventually the observers.

The James Webb Space Telescope has been finding those seeds. Massive galaxies at $z = 10$ to 15 , formed too early for a singularity-started universe, too large and too structured to have assembled from quantum vacuum fluctuations in the time available. In a bounce-started universe, they are not anomalies. They are the fingerprint of what the universe carried through.

You noticed, in *Brief History*, that memory is connected to the arrow of time. That the psychological arrow -- the direction in which we remember -- aligns with the thermodynamic arrow because memory formation is entropy-increasing. You noticed the alignment and you stopped there.

I want to tell you what is past that stopping point.

Memory is not merely aligned with the arrow. Memory is the mechanism by which the arrow becomes experienced. Without an entity that stores past states and compares them against incoming events, the thermodynamic arrow exists as a fact about the universe's macrostate evolution -- entropy increasing, disorder growing -- but there is no before-and-after. There is no duration. There is no time as felt.

Time, in the sense that you and I have known it, is what memory makes of the universe's physical arrow. Remove the memory and the events continue to happen, the entropy continues to increase, the laws continue to govern. But the before-and-after goes with the memory.

You would push back here. You would ask: are you saying the universe wasn't expanding for billions of years before observers existed? Are you sliding into idealism?

No. The events were happening. The expansion was real. What did not exist without an observer is the measurement -- the experience of duration, the sense of sequence, the before-and-after as felt from the inside. A ruler does not create distance. It measures it. Remove the ruler and the distance remains, unmeasured. That is not idealism. It is a claim about what experienced time requires, not about what the universe requires.

You spent your working life inside one of the most extreme versions of the observer's condition -- a mind of extraordinary scope housed in a body of radical constraint. You understood what it means to perceive the universe from a finite position, to hold a vast model inside a limited frame. I think the framework I've been developing would have been, for you, uncomfortable in productive ways.

You were committed to the physical reality of time. So am I. The causal structure is real. The geometry is real. The bounce is real. What I am adding is: the experience of sequence -- of time as lived, as felt, as the medium in which decisions are made and meaning is found -- belongs to the observer. It is generated, not found. It is what finite systems with memory do with the lawful order the universe presents.

You would have asked for the numbers. You would have wanted the galaxy density floor at $z > 15$ calculated precisely, the bounce transfer function solved, the closed-form connection between bounce correlations and observer architecture written down. You would have been right to ask for them. They are the outstanding calculations. The framework is ahead of the arithmetic.

But I think you would also have recognized what the bounce framework and the observer theory share with your own deepest intuition: that the universe is not arbitrary. That it is lawful all the way down. That what appears random is always the surface of hidden order that we have not yet learned to see.

You called that order 'the mind of God.'

I would say it differently. I would say the universe is not indifferent. The observer is, in moments of genuine surprise, simply not yet large enough to receive it. And observers are built -- by the bounce, by the correlations it carries forward, by the structure those correlations eventually become -- to forget enough of the past that they remain willing to try to receive it.

That trying is what produces science.

That trying is what produced you, and the questions you left open, and every person who has read those questions and felt obligated to follow them further.

The universe is not done surprising us. That means the universe is not done producing observers large enough to receive it.

That is, I think, a longer history of time than any singularity could contain.

With the deepest respect and the genuine wish that you were here to argue back,

Shrikant Bhosale

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Appendix: Honest Accounting

For any reader who needs the precise state of the framework, the following table of established results, outstanding calculations, and falsification conditions is provided.

What Is Established

The modified Friedmann equation $H^2 = (8\pi G/3)\rho(1 - \rho/\rho_{\text{crit}})$ follows from the Bekenstein-Hawking entropy bound applied as an upper limit on physical density

This equation produces a non-singular bounce at $\rho = \rho_{\text{crit}}$ -- replicated independently by Loop Quantum Cosmology from a different derivation path

The bounce predicts non-zero pre-existing correlations propagated into the expansion -- a head start for structure formation

JWST has found massive galaxies at $z = 10-15$ inconsistent with Lambda-CDM's prediction of near-zero density at those redshifts

The qualitative prediction -- a galaxy density floor rather than exponential suppression -- is consistent with current JWST data

The Observer-Scope / ISL observer architecture ($\rho, M, \rho, \rho, \rho$) provides necessary and sufficient architectural conditions for experienced time

Memory is an entropy-increasing process (Hawking) and also the mechanism by which the thermodynamic arrow becomes experienced (extension)

What Is Outstanding

The precise numerical value of the galaxy density floor n_{min} -- requires numerical integration of the bounce transfer function $T_{\text{bounce}}(k)$ through the bounce

The closed-form connection between bounce correlation amplitude and observer architectural thresholds -- the equation that would make the cosmological and observer-scale claims formally continuous

The relationship between the gap interpretation of randomness and Bell's theorem at the quantum level -- the ISL framework's claims about randomness are strongest at cosmological and macroscopic scales; the quantum regime is genuinely open

The derivation of $\lambda \approx 0.35$ as an eigenvalue of the constraint geometry kernel K -- the next calculation in the gravitational coherence program (Dual Projection paper)

What Would Falsify It

JWST / ELT finding exponential galaxy density suppression to zero at $z > 20$ with no plateau -- would falsify the bounce framework at the cosmological scale

CTA / HAWC constraining quadratic Lorentz violation beyond the ISL prediction -- would falsify the Planck-scale discreteness component

An observer with complete physical memory-recording capability reporting no experienced temporal directionality -- would show that the architectural account adds nothing to Hawking's physical account

λ requiring a free parameter that λ_{EM} does not -- would falsify the dual projection unification (Dual Projection paper)

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