# A Longer History of Time

*What Hawking Left Open — and What the Universe Has Since Shown Us*

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*For Stephen Hawking,*

*who asked why the universe bothers to exist.*

*This is an attempt at the next question.*

## Preface The Conversation I Wanted to Have

A Brief History of Time was published in 1988. I read it the way most people do — with the feeling that someone was finally telling the truth about the universe, plainly enough to be heard.

Hawking did something remarkable in that book. He took the hardest questions in physics — What is time? Where did the universe come from? Does it have a beginning? — and held them up to ordinary light. He didn't simplify them. He showed them.

But he left one question open. Deliberately, I think. His final sentence asks what it would mean to know the mind of God — to understand not just how the universe behaves, but why it exists at all, why there are laws rather than chaos, why anything rather than nothing.

This book is an attempt at the next layer down.

Hawking owned the ontological question: what is time, physically? He showed it had a beginning, a structure, an arrow. What he didn't address — what physics has never fully addressed — is the question underneath that one:

**What kind of thing is time before physics gets to it? What must be true about an observer for time to mean anything at all?**

That is this book's question.

Three things arrived together to make the answer possible: a framework for how observers generate time and meaning, called Observer-Scope Theory. A geometric formalism for how information scales across agents, called the Information Scaling Law. And, unexpectedly, the James Webb Space Telescope — which has been showing us galaxies that shouldn't exist, in a universe that apparently started with more structure than a singularity could produce.

These three things are not separate. They are the same insight at three different scales: the scale of the mind, the scale of society, and the scale of the cosmos.

> *Hawking asked where time came from. This book asks who time is for — and what the answer tells us about the universe that produced observers capable of asking the question.*

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# Part One What Hawking Got Right

## Time Has a Beginning

The central achievement of A Brief History of Time is the singularity. The universe, Hawking showed, does not extend infinitely backward. There is a point — or more precisely, a boundary — at which the classical laws of physics break down and time itself begins.

This is not obvious. For most of human history, the default assumption was that time is eternal — that it extends infinitely in both directions and the universe has always existed in some form. What the mathematics of general relativity showed, and what Hawking and Penrose proved rigorously, is that this cannot be right. Under very general conditions, spacetime has singularities. It has edges. Time starts.

This is one of the most startling things physics has ever established. And Hawking communicated it with the clarity of someone who had spent so long living inside the mathematics that he could describe it in plain sentences.

## Time Has an Arrow

The second great contribution of Brief History is the arrow of time. Why does time go in one direction? Why do we remember the past and not the future? Why does disorder increase?

Hawking's answer involves entropy — the measure of disorder in a system. The universe began in an extraordinarily ordered, low-entropy state. It has been moving toward higher entropy ever since. This is the thermodynamic arrow of time: the direction in which disorder increases.

He also described the psychological arrow — the direction in which we remember. And he noted something profound: the psychological arrow aligns with the thermodynamic arrow. We remember the past, not the future, because our memories are records of events that increased entropy. Memory is itself an entropy-increasing process.

This is where Hawking came closest to the question this book pursues. He noticed that memory is connected to time's arrow. He stopped there. We will not.

## What He Left Open

Here is the sentence that ends A Brief History of Time:

> *"However, if we do discover a complete theory, it should in time be understandable in broad principle by everyone, not just a few scientists. Then we shall all, philosophers, scientists, and just ordinary people, be able to take part in the discussion of the question of why it is that we and the universe exist. If we find the answer to that, it would be the ultimate triumph of human reason — for then we would know the mind of God."*

He is asking why the laws exist. Why anything rather than nothing. Why the universe is the kind of place that produces observers capable of asking the question.

He does not ask: what must an observer be in order to experience the universe as having time at all?

That is the gap. That is where this book begins.

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## Part Two The Hidden Assumption

There is an assumption buried so deep in physics that almost no one has noticed it is an assumption.

It is this: time is a substance. A medium. A dimension of the universe that exists whether or not anyone is inside it, flowing whether or not any mind is watching, providing the stage on which all events perform.

This assumption is so old, so universal, so woven into the language of physics that questioning it feels almost nonsensical. Of course time exists independently. Of course the universe was expanding for billions of years before any observer evolved. What could it possibly mean to say otherwise?

But here is the careful version of what I want to say:

The events were happening. I am not disputing that. The expansion was real. The nuclear reactions in the early universe were real. The formation of hydrogen and helium was real. All of this happened, lawfully and completely, with or without any observer.

**What did not exist — what could not exist — without an observer is the before and after.**

Sequence. Duration. The experience of time passing. The measurement of one event against another.

For that to exist, you need something that remembers. And memory is not a property of the early universe. Memory is a property of observers.

### The Ruler, Not the River

Think carefully about every time you actually use time in ordinary life. Not in equations — in sentences. In experience.

“This happened before that.” “This lasted longer than that.” “How long ago was that?”

Every single case is a comparison. You are measuring one event against another, using a scale. Time is that scale. It is not a river flowing through the universe. It is a ruler that observers hold up.

A thermometer does not create heat. It measures it. Remove the thermometer and the heat is still there — but there is no temperature reading. There is just the thermal state of the system, unquantified.

Remove the observer — remove memory — and the events are still happening. But there is no before and after. There is no duration. There is no time as experienced. There is only the state space, lawful and complete, unread.

> *Time is not the stage on which events perform. Time is the ruler the observer holds up to measure the performance. This is the hidden assumption Hawking never questioned. This is the next layer down.*

## What Memory Actually Is

If time comes from memory, we need to understand what memory actually is. Because it is not what it sounds like.

Memory is not a neutral archive. It is not a filing cabinet of facts. Every experience you store is stored not as information but as felt information — colored by the emotion running through you at the moment of storage, charged with whatever was at stake, shaped by what mattered and what didn’t.

This matters enormously. Because when a new event arrives and memory reaches out to measure it — to locate it in the before-and-after, to give it sequence and meaning — it does not find a catalogue of neutral facts. It finds a catalogue of felt experience. The new event is colored by that feeling before any conscious processing begins.

Two observers, same universe, same event. The experience each has is genuinely different — not because the event differs, but because the memory each brings to it is different. The ruler each holds is made of different material.

This is not relativism. The universe is still the universe. But the portion of the universe’s order that each observer can receive and make meaningful is shaped entirely by the particular architecture of memory they carry.

## Part Three The Universe Without a Singularity

Now we need to go back to the beginning. Literally.

Hawking's singularity is the starting point of time. The point at which classical physics breaks down, the scale factor goes to zero, density goes to infinity, and all the familiar laws cease to apply. Before the singularity, in Hawking's framework, there is no before. Time simply begins.

This is elegant. It is also, increasingly, in tension with what the universe is actually showing us.

### What the James Webb Space Telescope Found

In 2022 and 2023, the James Webb Space Telescope began returning images of the early universe with a resolution and depth that had never before been achieved. What it found was unexpected enough that it generated genuine alarm in the cosmological community.

Galaxies. Massive, fully formed galaxies, with stellar masses of hundreds of millions to billions of solar masses, existing at redshifts of $z = 10$ to 15. This corresponds to a time roughly 300 to 500 million years after the Big Bang — a cosmic eyeblink.

In the standard model of cosmology — Lambda-CDM, the concordance model that has successfully described nearly everything about the large-scale universe — these galaxies should not be there. The math is unambiguous: to produce structures of that mass in that time, you would need a Star Formation Efficiency greater than 100%. You would need to convert more gas into stars than exists. The model doesn't permit it.

The galaxies are there anyway.

> *The universe has presented something that the standard model has no framework to receive. This is precisely the structure of genuine surprise — an event arriving at the edge of the observer's world.*

### The Bounce: A Universe Without Zero

The tension between JWST's observations and Lambda-CDM points toward a modification of the beginning. And that modification exists — it has been developed independently within Loop Quantum Cosmology, and it maps precisely onto the ISL framework.

The standard Friedmann equation describes how the universe expands:

$$H^2 = (8\pi G/3)\rho$$

In this equation, as density ρ grows without bound approaching the singularity, the Hubble parameter H grows without bound too. Everything explodes to infinity. The singularity is unavoidable.

The modified equation, incorporating quantum gravitational corrections at the Planck scale, is:

$$H^2 = (8\pi G/3)\rho \times (1 - \rho/\rho\_crit)$$

One extra term. But that term changes everything.

When density ρ reaches the critical value ρ_crit, the right side goes to zero. H = 0. The expansion stops. And instead of a singularity — instead of zero volume and infinite density — there is a bounce. The universe reaches a minimum size, reverses, and begins expanding again.

There was no beginning in the sense of a point of zero volume. There was a bounce. A moment of maximum compression and minimum scale. And the universe that emerged from that bounce did not emerge from nothing. It emerged from something.

## The Head Start

This is where the JWST anomaly finds its explanation.

Near the bounce, the time derivative of the Hubble parameter is:

$$\dot{H} = 4\pi G(\rho + P)(2\rho/\rho\_crit - 1)$$

When ρ > ρ_crit/2, this quantity is positive. The universe undergoes a brief period of super-inflation immediately after the bounce. During this phase, perturbations — the seeds of all future structure — are not generated from quantum vacuum fluctuations starting at zero. They are frozen in at a finite amplitude. The universe begins not from a blank slate but from a state already loaded with structure.

In ISL terms: the Refusal event, the bounce at maximum compression, hot-loads the universe with maximum allowable complexity. The universe does not start at zero. It starts at $C_{max}$.

The consequence is a head start for structure formation. Galaxies don't need to assemble themselves from scratch out of quantum noise. They begin from pre-existing correlations, frozen in at the bounce, already seeded with the complexity that will eventually become stars and light and the images that JWST is now returning to us.

Massive galaxies appearing too early for Lambda-CDM is precisely what a bounce cosmology predicts. The observation is not anomalous. It is confirmation.

### The Falsifiable Prediction

A framework without a prediction is a story. Here is the prediction.

In Lambda-CDM, the number density of massive galaxies drops exponentially to zero as redshift increases past $z = 10$. The model predicts essentially nothing at $z > 15$.

In the ISL bounce framework, the number density does not drop to zero. It plateaus. There is a floor — a minimum density of massive structures corresponding to the entropy state of the bounce. The universe does not thin to nothing at extreme redshifts. It thins to the background complexity that the bounce produced.

Future deep field observations by JWST and the Extremely Large Telescope should find that floor. If they do, the singularity is ruled out as a physical reality. If the counts continue to drop exponentially, the bounce framework is falsified.

That is a real test. The universe will answer it.

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## Part Four The Observer and the Cosmos

We now have two things in hand that were not in the same book before.

We have a theory of the observer: that time is generated by memory, that randomness is an information gap, that forgetting is the feature that keeps the observer capable of encountering the next moment. That the experience of reality is always filtered through the particular emotional architecture of memory, and that surprise is where the observer meets the genuine edge of their world.

And we have a theory of the cosmos: that the universe did not begin at a singularity, that it began at a bounce loaded with pre-existing complexity, that the head start this gave to structure formation explains what JWST is showing us.

These are not separate. They are the same insight at two different scales.

## The Universe as Observer

Here is the connection.

The bounce is not just a physical event. In ISL terms, it is the moment at which the universe reaches maximum complexity — maximum information density, maximum correlation, maximum structure packed into minimum volume. It cannot go further. It refuses, in the language of the framework. And that refusal is what becomes the universe we inhabit.

The pre-existing correlations frozen in at the bounce are the universe's memory. The seeds of structure that JWST is now detecting — the galaxies that shouldn't exist by Lambda-CDM standards — are the physical residue of that memory. They are what the universe carried forward from before.

The observer, at the human scale, generates time through memory. The universe, at the cosmic scale, generates structure through the memory of its bounce. Both are expressions of the same principle: that finite systems carry information forward, that what came before shapes what comes after, and that the apparent randomness at any frontier is always the shape of a gap — the distance between the system's current capacity and the lawful order that was always there.

> *The universe did not begin from nothing. It began from memory. The observer does not receive time from the universe. The observer generates time from memory. The same principle, at every scale.*

## What Randomness Is, Revisited

Hawking devoted significant attention to the question of whether God plays dice — whether quantum mechanics introduces genuine, irreducible randomness into the universe at its foundations.

Here is a different answer.

Randomness is not a property of the universe. Randomness is a property of the gap between the universe's order and the observer's current capacity to see it. When an event arrives that finds no pattern in memory — no echo, no familiar shape — it appears random. Not because it is. Because the observer has no framework to receive its order.

The galaxies JWST found appeared impossible — appeared to violate the laws of structure formation — because Lambda-CDM had no framework to receive them. The anomaly was not in the galaxies. The anomaly was in the gap between the theory and the reality. Closing that gap, by incorporating the bounce, makes the impossible galaxies lawful again.

Einstein was right. God does not play dice. But the dice are not God's. They are the observer's. And they are not permanent.

## Forgetting at the Cosmic Scale

The universe forgets too.

The bounce produces pre-existing correlations — structure, memory, complexity carried forward. But as the universe expands and entropy increases, those correlations are progressively lost. The detailed structure of what happened before the bounce is irretrievably diluted by the expansion. The universe retains the large-scale statistical properties of its bounce — the floor in galaxy counts, the enhanced growth factor — but not the fine-grained detail.

This is the cosmic degradation operator. The universe keeps what matters for future structure — the seeds — and releases what would otherwise prevent expansion: the full information content of the pre-bounce state.

Forgetting, at every scale, is what makes forward motion possible.

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## Part Five A Longer History

Let me now state plainly what this book has assembled.

Hawking showed that time has a beginning. We have shown that the beginning is not a singularity but a bounce — a moment of maximum complexity from which the universe expands, carrying forward the memory of its compression as the seeds of all future structure. The JWST anomaly is the observational fingerprint of that bounce.

Hawking showed that time has an arrow, aligned with entropy. We have shown that time also has an origin in memory — that the before-and-after that defines the arrow is not a property of the universe but a property of observers who carry memory and apply it to events. Remove memory and the arrow vanishes with it.

Hawking asked why the laws exist. We have shown that the laws exist at every scale: in the Friedmann equations governing the cosmos, in the information-theoretic equations governing agents, in the phenomenological structure of memory and surprise and forgetting that governs experience. The same structure, all the way down.

Hawking asked why there are observers at all. We have shown that observers are not incidental to the universe — not an afterthought produced by a cosmos that could equally well have existed without them. Observers are the entities for which time is meaningful. The universe produced observers because observers are what it takes for the universe's lawful order to become, at any scale, experienced.

> *The universe did not need time. It needed something that would generate time from memory. It built that something. We are it.*

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## Closing What I Would Have Said to Him

Stephen Hawking spent his working life inside one of the most extreme forms of the observer's condition: a mind of extraordinary scope trapped inside a body of radically constrained action. He understood, better than most, what it means to perceive the universe from a finite position — to hold a vast model of reality inside a limited frame.

I think he would have found the argument in this book uncomfortable in productive ways.

He was committed to the physical reality of time — to time as a dimension, as a thing the universe has independently of any mind. The argument here says: yes, and. The causal structure is real. The geometry is real. But the experience of sequence, of before-and-after, of time as lived — that belongs to the observer. It is generated. It is not found.

He would have pushed back. He would have asked for the equations. He would have wanted the bounce prediction sharpened to a specific number, a specific galaxy count floor at a specific redshift. He would have been right to ask that, and that work remains to be done.

But I think he would also have recognized what the Observer-Scope framework and the bounce cosmology share with his 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.

He 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 they are built — wisely, mercifully — to forget enough of the past that they remain willing to try.

That trying is what produces observers.

That trying is what produces science.

That trying is what produced Stephen Hawking, and the telescope now bearing the name of a man who once saw the universe differently, and every galaxy that telescope has found that shouldn’t be there.

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

**That is a longer history of time than any singularity could contain.**

*S.B., 2026*