

# TIME AS SCALAR

*The Observer as the Origin of Temporal Measurement*

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| *The most important thing is not to stop questioning. — Einstein*

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## **Abstract**

This paper establishes the foundational claim of the Time as Scalar framework: time is not a constituent of nature but a measuring instrument that observers apply to nature. The universe operates through causal structure, fields, and geometry — none of which require a clock. What requires a clock is the observer: a finite system with memory that must compare events in order to generate meaning from them. Time is the scalar the observer holds up to make that comparison possible. Remove the observer, and the causal structure remains. Remove the memory, and time as experienced vanishes with it.

This claim is not a challenge to physics. It is a claim about what physics leaves unaddressed: the conditions under which a finite observer experiences causal structure as meaningful sequence. Three levels operate simultaneously and compatibly. The ontological level — causal structure, spacetime geometry — is the domain of physics and is not in dispute. The epistemological level — how observers know and sequence events — is where this paper operates. The phenomenological

level — how time feels, the texture of memory and surprise — is where the argument finds its grounding.

The central implication for physics: the time-independent Schrödinger equation is not a special case or approximation. It is the natural baseline. Stationary states — energy eigenstates with no temporal evolution — are the universe operating without requiring any clock. Time appears in quantum mechanics when observers measure deviations from that baseline. The scalar the observer applies is not fundamental. The geometry it measures is.

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## **I. The Claim and Its Scope**

### **1.1 What We Are Claiming**

The claim is simple, but must be stated with precision to avoid two common misreadings.

We are claiming: time is a scalar — a position on a measuring scale — that finite observers apply to events in order to sequence them and generate meaning. It is a tool, not a substance. It belongs to the observer, not to the universe.

We are not claiming: that spacetime geometry is unreal, that causal structure is observer-dependent, that physics is wrong, or that the universe has no temporal ordering. The causal ordering of events is real and observer-independent. What is observer-dependent is the experience of that ordering as sequence — as before and after, as duration, as the passage of time.

The distinction is between causal structure (ontological, physics' domain) and temporal measurement (epistemological, the observer's contribution). Both are real. They are not the same thing.

### **1.2 Three Levels, All Compatible**

Three levels of description operate simultaneously and do not contradict each other:

1. **Ontological** — Causal structure, spacetime geometry. Events stand in real causal relations independent of any observer. This is physics' domain and is not in dispute.
2. **Epistemological** — How observers know and sequence events. This is where time-as-scalar lives. The observer applies a measuring instrument to the causal structure and generates sequence, duration, and before-and-after.
3. **Phenomenological** — How time feels. The emotional texture of memory, the disorientation of surprise, the weight of duration. This is the lived experience that makes the epistemological account more than abstract.

These three levels do not compete. They are three layers of a complete account, each addressing questions the other layers leave open.

### 1.3 Why This Matters for Physics

The motivation for establishing this foundation is the time-independent Schrödinger equation:

$$H\psi = E\psi$$

This equation has no  $t$  in it. It describes energy eigenstates — stationary configurations of a quantum system where nothing evolves. These states are not approximations or idealizations. They are exact solutions. They describe the universe operating without any clock.

If time were fundamental to nature — if the universe genuinely required a clock to operate — these solutions would be conceptually problematic. They are not. They are among the most precisely verified results in all of physics.

What this suggests: stationary states are the natural baseline. The universe's geometry is the primary object. Time appears when observers measure deviations from that geometry. The scalar the observer applies is not baked into the foundation. It is brought to the foundation by the observer.

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## II. What Time Actually Is

### 2.1 Every Use of Time Is a Comparison

Consider every way time appears in ordinary life — not in equations, but in sentences, in experience, in practice.

“This happened before that.” “This lasted longer than that.” “How long ago was that?” “We’ve been waiting a long time.”

Every single case is a comparison. Two events are measured against each other using a scale. Time is that scale. It is not carrying anything. It is not flowing anywhere. It is being applied to locate events relative to one another.

A thermometer does not create heat. It does not carry heat anywhere. It gives a number that allows comparison: this is hotter than that. Remove the thermometer and the heat is still there — but there is no temperature reading. There is only the thermal state of the system, unmeasured.

Time is the thermometer of events. Remove the observer — remove the measuring instrument — and the events are still there. The causal structure is intact. But there is no before-and-after. There is no duration. There is only the state space, lawful and complete, unread.

### 2.2 Time as Scalar: A Formal Statement

A scalar is a quantity with magnitude but no direction — a number on a scale. Temperature is a scalar. Mass is a scalar. Pressure is a scalar.

Time, in its function as a measuring instrument, is a scalar: a position on an ordered scale that allows events to be located relative to one another. The apparent “flow” of time is not a property of nature. It is the observer’s experience of moving through correlations between events and memory.

Formally: let  $E$  be the set of events with a causal ordering  $\leq$ . The causal ordering is real and observer-independent. Time is a function:

$$t : E \rightarrow \mathbb{R}$$

that assigns a real number to each event, preserving the causal order. This function is not unique — many such assignments are possible. The observer’s memory and measurement apparatus select one. The function  $t$  is the observer’s instrument. The ordering  $\leq$  is nature’s structure.

## 2.3 The Stone and the Observer

A stone falls from a cliff. Simple enough. Now ask carefully: does the stone experience that fall as happening in time?

For the stone to experience time, it would have to compare where it is now to where it was a moment ago. It would have to have a “moment ago.” It would have to remember.

The stone remembers nothing. The fall simply happens — as an event in causal structure, complete and lawful, requiring no clock. There is no before-and-after for the stone. There is only the trajectory, unwitnessed.

An observer watching the fall does something the stone cannot: compares what they are seeing now to what they remember from a moment ago. They place the event in a sequence. They derive duration from that comparison. They generate before-and-after. That generation is where time appears — not in the stone’s fall, but in the observer’s act of witnessing it.

| *Time is not the stage on which events perform. Time is the ruler the observer brings to measure the performance.*

The stage is real — it is causal structure, geometry, the ordered set of events. The ruler is the observer’s contribution. Neither can do the other’s job.

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## III. Memory as the Other End of the Ruler

### 3.1 Without Memory, No Measurement

A ruler needs two ends. Time, as a measuring instrument, has one end at the current event and one end at memory. Remove memory and the ruler has nothing to anchor to. The measurement cannot be made.

Without memory, there is no before against which to measure the now. Without before and now, the scalar of time cannot be applied. Each moment would be an isolated event — real in the causal structure, but unreachable as sequence, unmeasurable as duration.

Memory is not merely a repository. It is the enabling condition of temporal measurement. This is why the time-independent Schrödinger equation has no memory in it: a stationary state is a configuration that makes no comparison to a previous state.  $H\psi = E\psi$  is memory-free. It is the natural baseline — the universe before the observer brings the ruler.

### **3.2 Memory Is Not Neutral**

Every measurement instrument has properties that affect what it measures. A ruler made of rubber stretches. A thermometer calibrated at one pressure reads differently at another. Memory, as the fixed end of the temporal ruler, is not neutral either.

Memory is soaked in emotion. Every stored experience carries not just information but felt information — charged with whatever was at stake when it was formed, colored by the context of its acquisition. When a new event arrives and memory reaches out to compare, it does not find a neutral catalogue of facts. It finds a catalogue of felt experience.

This means the measurement is always filtered. The same event, measured by two observers with different memory states, produces different experienced time. Not because the causal structure differs — it does not. But because the measuring instruments differ.

Two observers, same event, different memories: they do not inhabit the same experienced reality. Not relativism — the causal structure is still the causal structure. But the temporal measurement each produces is genuinely different, because the ruler each holds is made of different material.

### 3.3 Forgetting as Instrument Maintenance

A measuring instrument that never resets accumulates error. A ruler that stretches without bound eventually measures nothing reliably.

Memory, as the temporal ruler, requires maintenance. If every past experience remained at full emotional charge indefinitely, the comparison engine would be overwhelmed before any new event arrived. The instrument would be saturated. New measurements would be impossible.

Forgetting is instrument maintenance. It allows the emotional charge of past events to fade, creating space for new events to arrive and be measured without being immediately drowned in the accumulated weight of the past. The observer who forgets is not losing temporal capacity — they are maintaining it.

In the language of Scope Theory: the degradation operator  $D_a$  applied to memory  $M_a$  keeps the system operating below the saturation threshold  $C_{\max}$ . Without  $D_a$ ,  $M_a$  approaches  $C_{\max}$  and the logistic growth term  $(1 - X_a/K_a)$  goes to zero. The observer stops being able to expand their temporal scope — not because the universe stops presenting events, but because the instrument is full.

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## IV. What the Universe Needs vs. What the Observer Needs

### 4.1 What the Universe Needs

The universe needs: causal structure, physical laws, fields, geometry, conservation principles. It needs events to stand in ordered relations. It needs the Hamiltonian to generate evolution. It needs the metric tensor to encode curvature.

The universe does not need: a clock. A before-and-after that is experienced. A witness who sequences events. A memory that stores them. A scalar that locates them relative to each other.

Evidence: the time-independent Schrödinger equation. Energy eigenstates are exact solutions — not approximations — describing configurations in which there is no

temporal evolution at all. The universe at its most fundamental quantum level has stationary states as valid, exact descriptions. These states have no  $t$ . They are complete without it.

## 4.2 What the Observer Needs

The observer needs: to compare events. To locate the current event relative to remembered events. To generate sequence from what would otherwise be undifferentiated causal structure. To derive meaning from that sequence.

For all of this, the observer needs time — the scalar, the ruler, the measuring instrument. Without it, the observer cannot sequence, cannot compare, cannot generate meaning. The observer would encounter each event as an island with no connection to any other island.

The observer applies time to the universe's causal structure. The universe provides the structure to be measured. The observer provides the instrument of measurement. Neither is sufficient alone: the instrument without structure measures nothing, and the structure without the instrument is unread.

## 4.3 The Formal Separation

Let  $X$  be the state space of the universe with causal ordering  $\leq$ . This is the ontological layer. It exists without any observer.

Let  $\Pi_a$  be the perception operator of observer  $a$ , and  $M_a$  be their memory state. The temporal measurement by observer  $a$  is:

$$t_a : E \rightarrow \mathbb{R}, \text{ defined by } t_a(e) = f(\Pi_a(e), M_a)$$

The function  $f$  is the comparison operation: locate the current event  $e$  relative to what  $M_a$  contains. The result  $t_a(e)$  is the observed time — the number on the observer's scale.

The causal ordering  $\leq$  is not  $t_a$ . It is what  $t_a$  is measuring. Two different observers produce two different  $t$  functions over the same causal structure  $X$ . Both measurements are real. Neither is the structure itself.

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## V. Surprise, Randomness, and the Boundary of the Observer's Ruler

### 5.1 Surprise as Measurement Failure

When a new event arrives and memory finds no match — no correlation, no familiar shape, no echo from the past — the temporal measurement breaks down. The ruler has no fixed end. The comparison cannot be made.

This is surprise, in its precise structural sense: the failure of the temporal measuring instrument at the boundary of the observer's memory. The event is real, causal, lawful. But it exceeds the observer's current memory to provide the other end of the measurement.

Mathematically, in Scope Theory terms:

$$\Delta\Pi = I(X; \Pi^*) - I(X; \Pi_a) \text{ is large}$$

The information gap is large. The event falls into the gap between what nature presents and what the observer's memory can receive and measure.

### 5.2 Randomness as a Property of the Gap

An event appears random to observer  $a$  at time  $t$  if and only if it exceeds the observer's current memory to provide context for measurement. This is not a property of the event. It is a property of the gap between the event's causal structure and the observer's current measuring capacity.

Einstein's intuition was correct: God does not play dice. The universe is lawful throughout. What we call randomness is the shape of our own measurement gap, projected outward onto events that were always ordered, always lawful, always following the causal structure — but exceeding the observer's current ruler.

| *The dice are not in nature. They are in the gap between what nature presents and what the observer is currently equipped to measure.*

As the observer's memory expands — through learning, through repeated exposure, through tool-building — the gap shrinks. Events that were once surprising become predictable. What looked random reveals its order. The scalar becomes more accurate because the instrument improves.

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## VI. Connection to Time-Independent Quantum Mechanics

### 6.1 The Stationary State as Natural Baseline

The time-independent Schrödinger equation:

$$H\psi = E\psi$$

describes configurations of a quantum system where the probability distribution over states does not evolve. No change. No temporal evolution. No clock required.

Under the Time-as-Scalar framework, this is exactly what we should expect. If time is the observer's measuring instrument, then states in which nothing is changing are states in which the instrument measures nothing — or equivalently, states in which the instrument is not needed. The Hamiltonian  $H$  encodes the geometry of the system. The eigenvalue  $E$  encodes the energy. Neither requires a clock.

Stationary states are the universe's geometry, unread. They are what exists before the observer brings the ruler.

### 6.2 Time Appears as Deviation

Time-dependent quantum mechanics describes what happens when a system is not in a stationary state. The general solution is a superposition of energy eigenstates:

$$\Psi(x, t) = \sum c_n \psi_n(x) \exp(-iE_n t/\hbar)$$

The  $t$  in this expression is the observer's scalar — the parameter introduced to track how the superposition evolves as measured by an external clock. The eigenstates  $\psi_n$  are the geometry. The coefficients  $c_n$  are the observer's preparation. The

exponential factors are the observer's temporal measurement applied to the geometry.

Remove the observer's clock and you have the stationary states. Add the clock and you have time-dependent evolution. The clock belongs to the observer.

### 6.3 What This Opens

If stationary states are the natural baseline and time is the observer's measuring instrument, then the project of time-independent quantum mechanics is not the removal of something fundamental. It is the recovery of the underlying geometry before temporal measurement is applied.

This reframing opens several questions that are the subject of ongoing work:

4. What is the formal relationship between the Scope Theory manifold and the Hilbert space of quantum mechanics? Can the perception operator  $\Pi_a$  be identified with a measurement operator on Hilbert space?
5. In Scope Theory, an energy eigenstate corresponds to  $dS_a/dt = 0$  — zero scope change, zero temporal density. What is the scope-theoretic description of a superposition of eigenstates?
6. The ISL saturation principle produces a bounce at maximum complexity rather than a singularity. Does the same principle, applied to Hilbert space, produce a natural regularization of quantum measurement?
7. The Temporal Scope Theory result  $\tau(t_1, t_2) = \int \|dS_a/dt\|_G dt$  identifies experienced time with arc-length in cognitive scope space. What is the equivalent object in Hilbert space? Is it related to the quantum geometric tensor?

These are open questions. This document does not answer them. It establishes the foundation that makes them well-posed.

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## VII. Summary: The Foundation

The argument assembles into a clean chain:

8. **Time is a scalar.** It is a position on a measuring scale, applied by observers to locate events relative to each other. It is not a substance, not a dimension woven into nature, not a river flowing through the universe.
9. **Memory is the other end of the ruler.** Without memory, the temporal scalar has nothing to anchor to. The comparison that generates before-and-after, duration, and sequence cannot be made. Time as experienced disappears.
10. **The universe does not need time.** The universe needs causal structure, physical laws, and geometry. Stationary states — solutions to  $H\psi = E\psi$  — are exact descriptions of the universe operating without any clock. They are the baseline.
11. **The observer needs time.** The observer must sequence events, compare them to memory, and generate meaning from that comparison. For this, the observer requires the scalar. The ruler is the observer's contribution, not the universe's.
12. **Randomness is a gap property.** Events appear random when they exceed the observer's memory to provide the other end of the measurement. Reduce the gap through learning and tool-building, and the order that was always there becomes visible.
13. **Time-independent quantum mechanics is the natural baseline.** Energy eigenstates are the universe's geometry before the observer applies the temporal ruler. Time-dependent evolution is what the observer measures when they bring their clock to the geometry.

*The universe does not need time. The observer does. And the observer is built — wisely, mercifully — to forget enough of the past that the ruler remains usable, and the measurement remains possible.*

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## Status and Next Steps

This document is a foundation, not a conclusion. It establishes the conceptual ground on which the formal development proceeds. What remains:

- Formal identification of the Scope Theory manifold with Hilbert space substructures
- Derivation of the temporal density operator  $\rho\tau(t)$  in quantum-mechanical terms
- Connection between the ISL saturation principle and quantum measurement regularization
- Scale competence formalization:  $\Sigma_a(s)$  with determined functional form
- Experimental pilot: Temporal Scope Theory predictions tested against time perception data (N=15 protocol)