

Two Clocks and One Scale

— Second Edition: Coordinate Time dt , Proper Time $d\tau$ and Entropy dS Are Three Different Logical Types —

[Paper 118]

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— *From thinking to syncing.* —

ABSTRACT

An hour with someone you love passes in an instant; an hour in a dull meeting feels eternal — and the clock on the wall reads the same number. **Almost everyone has this experience, and yet the interpretation of time has advanced remarkably little, and even the interpretation of relativity remains divided.** This paper's diagnosis is simple: **one word covers several quantities, and we have kept trying to elect one of them as “real time”.** The Bergson--Einstein exchange in Paris in 1922 was not a dispute over who was right; it was **two people defending quantities of different type. A brake is placed immediately: this paper does not explain felt time. This paper lines up three quantities — dt , $d\tau$, dS — and the “instant” and the “eternity” above are none of them; they are a further quantity belonging to psychology and neuroscience, which is left untouched. These three do not, however, close physics' own roll-call: Paper 119 identified a fourth type (the parameter of Ricci and renormalisation-group flow, of dimension L^2) and Paper 121 treated the geometry of its arena. Felt time is therefore not given the number “fourth” — the numbering belongs to the physical types. What everyday experience supplies here is not an answer but the shape of a question, and only that is taken up, to be answered inside physics. Attribution made explicit in this second edition (most important): the separation of dt from $d\tau$ is not a discovery of this paper.** It was given by Minkowski in 1908 as the invariant interval $ds^2 = c^2 dt^2 - dx^2 - dy^2 - dz^2$, and within this series **Paper 108** already treats it — stating there that “observers disagree about times and lengths, but this interval alone is common to all”, and sorting the geometry of the invariant interval, the hyperbolic geometry of velocity space, and proper time into distinct roots. What this paper adds is to place a third quantity (dS) alongside that separation under the same measuring stick, and to exhibit the separation constructively in both directions. Now, Paper 82 declared that coordinate time, proper time and thermodynamic time are three distinct times that do not fuse. This paper turns that declaration into a verdict: it separates them by counterexamples in both directions and shows further that the three are not even the same kind of mathematical object. First, the three differ in logical type. dt is a coordinate and has no domain — it is a chart label, and becomes a clock only once pasted onto a congruence of worldlines (in the vocabulary of Paper 95, a convention). $d\tau$ is a functional of a curve: $\gamma \mapsto \frac{1}{c} \int_\gamma \sqrt{g_{\mu\nu} dx^\mu dx^\nu}$, defined on worldlines in a Lorentzian manifold. dS is a functional of a measure: $\rho \mapsto -k_B \int \rho \ln \rho$, defined on probability measures on phase space. Hence $d\tau$ and dS are not two numbers that differ in value; they are functionals living on different spaces. Second, the separation is exhibited in both directions. (i) $d\tau = 0$ while $dS > 0$: along a null worldline $ds^2 = 0$, so $d\tau = 0$, yet a radiation field carries $S = \frac{4}{3} a T^3 V$ and isothermal expansion gives $\partial S / \partial V = \frac{4}{3} a T^3 > 0$ (both thermodynamic identities verified here). (ii) $d\tau > 0$ while $dS = 0$: a bound reversible Hamiltonian system accumulates $d\tau = \sqrt{1 - v^2/c^2} dt > 0$, while Liouville's theorem keeps the Gibbs entropy exactly constant without any coarse-graining (checked via the conserved phase-space area $2\pi E/\omega$ of a harmonic oscillator). Third, a decisive brake: in (i), $d\tau = 0$ is a statement about one photon's worldline while $dS > 0$ is a statement about a photon gas, a statistical state. The two clocks are not attached to the same object — and unless this shift of address is named, the demonstration itself slips categories. Fourth, the coupled regime is written: in dissipative systems (Paper 78) motion along $d\tau$ leaks into unresolved degrees of freedom and produces $dS > 0$, and at a black-hole horizon (Paper 73) the area theorem $dA \geq 0$ together with $S_{\text{BH}} = k_B c^3 A / (4G\hbar)$ locks a geometric quantity to a

statistical one. But a lock is not an identity. Fifth, the bookkeeping is given a name — the Einstein--Yamagishi Dual-Clock Framework — which is a discipline of accounting, not a theory or an equation. General relativity is not altered by one character and no new prediction is made; if the word “complement” is used, it means **juxtaposition, not correction: relativity is complete about Clock A and never claimed anything about Clock B**, and what is never claimed cannot be wrong. Sixth, the reach of the word “orthogonal” is limited: it means **logical independence** — one may vanish while the other does not — and not orthogonality in an inner-product space. **Scope**: a structural interpretation and roll-call of established facts (general relativity, Clausius, Boltzmann, Liouville, Bekenstein--Hawking) at Layer 2. No new evolution equation is proposed, the origin of the arrow of time is not solved (the past hypothesis; Paper 98), and gravity is not derived from entropy (the restraint of Paper 74). What is dissolved is **a confusion of description**, nothing more.

Position of this paper (discipline): every ingredient used here is a **known standard result** — proper time as metric arc length, the Clausius inequality, Boltzmann's formula, Liouville's theorem, the thermodynamics of radiation, the Bekenstein--Hawking formula, the area theorem. **No new theorem is proved and not one character of an existing equation is changed.** **Neither Einstein, nor Clausius, nor Boltzmann is contradicted**; what is done is **to write the address of what each of them was counting**. **The contribution** is: (i) separating the three times **by logical type**; (ii) exhibiting the separation constructively **in both directions**; (iii) exposing, in the counterexample itself, **a shift of address** that the author must name rather than hide; (iv) writing the coupled regime **while distinguishing a lock from an identity**; and (v) limiting the reach of the word “orthogonal”. **The most important restraint: the three are not reduced to one “real time”** — that is the point. **$d\tau$ is not derived from dS** , nor the converse. **The origin of the arrow of time is not solved** (Paper 98). **Metaphors** — ageing, consciousness, a “Universe OS”, the inference of an AI — appear nowhere in the body, and are quarantined in the Layer-3 personal note **under a non-scientific label**.

1. Introduction: Everyone Knows It — So Why No Progress?

An hour spent with someone you love is gone in a moment. An hour in a tedious meeting feels eternal. **And the clock on the wall reads the same number.**

Nearly every person carries this experience. Humanity therefore **knows, prior to any theory, that the single word “time” does not name a single quantity**. And yet the interpretation of time has advanced remarkably little. Even the interpretation of relativity is still divided.

Why did a clue that everyone possesses fail to lead anywhere?

The answer offered here is simple. **One word covers several quantities, and we kept trying to elect one of them as “the real time”.** In Paris in 1922 Bergson insisted that lived duration was primary; Einstein replied that “the time of the philosophers does not exist”. **They were not arguing about which was correct. Each was defending a quantity of a different type.**

A brake placed immediately (the core of this paper's scope): this paper does not explain felt time. What this paper lines up are the three quantities below (dt , $d\tau$, dS), and the “instant” and the “eternity” of the opening **are none of them.** They are **a further quantity**, belonging to psychology and neuroscience, and are **left untouched.** **There is a reason for not numbering it:** physics' own roll-call does not close at three — **Paper 119 identified a fourth type (the flow parameter),** and felt time is none of those four either.

What everyday experience gives this paper is not an answer but the shape of a question — “might one word be covering several quantities?” **Only that question is taken up, and it is answered inside physics.** To identify felt time with dS would be precisely the error of type that this paper forbids.

So the question is moved inside physics. Under the single phrase “time passes”, physics has handled **at least three different quantities.**

Coordinate time dt , proper time $d\tau$, and entropy dS .

Paper 82 has already declared that these three are **distinct roots that do not fuse.** But a declaration is **a posture**, not a **verdict** (the same discipline as Paper 116). Without a verdict, the question “which is the real time?” returns in new clothes — as it did in Paris in 1922, and as it does today in debates about the arrow of time.

This paper turns the declaration into a verdict: it exhibits **counterexamples in both directions**, and shows further that **the three are not even the same kind of mathematical object.**

**The confusion did not arise because the three were similar.
It arose because they never had a type in which they could be compared.**

2. Type I: Coordinate Time dt — a Scale, Not a Clock

Established Fact 2.1 (Coordinate time is a coordinate)

In a chart (t, x^i) on a spacetime manifold, t is a **label pasted onto points**. Under a diffeomorphism $t \mapsto t'(t, x^i)$ the quantity dt changes, whereas the $d\tau$ of the next section does not. General relativity possesses **no preferred foliation**.

Observation 2.1 (dt sits on the side of convention)

dt is not a possession of anything; it is a choice by the describer. In the vocabulary of Paper 95: **that time passes is a fact, but how the scale is laid down is a convention**. This is **the same line** that Paper 95 drew for c — that it is finite is a fact; that its value is 299 792 458 is a convention.

To be precise: dt is not wholly arbitrary. Choose a **congruence of worldlines** (for instance the observers at rest in an inertial frame) and synchronise t with their proper time; then dt becomes **the $d\tau$ of that congruence**. So dt becomes a clock only once pasted onto a congruence. Before it is pasted, it is a scale.

dt is not a clock. It is the line drawn on the floor so that clocks can be read.

3. Type II: Proper Time $d\tau$ — a Functional of a Curve

Established Fact 3.1 (Definition of proper time)

Along a timelike worldline γ ,

$$\tau[\gamma] = \frac{1}{c} \int_{\gamma} \sqrt{g_{\mu\nu} dx^{\mu} dx^{\nu}}$$

is the proper time. It is **an invariant, independent of the choice of coordinates**, and it is the time actually ticked by a clock carried along that worldline.

Observation 3.1 (The domain is the set of worldlines)

τ is not a number but a functional returning a number for a curve. Its domain is the set of worldlines in a Lorentzian manifold — not states, not probability distributions. Without specifying a worldline, $d\tau$ has no value.

4. Type III: Entropy dS — a Functional of a Measure

Established Fact 4.1 (Definition of entropy)

For a probability density ρ on phase space,

$$S[\rho] = -k_B \int \rho \ln \rho \, d\Gamma$$

is the Gibbs entropy. In thermodynamics the Clausius inequality $dS \geq \delta Q/T$ corresponds, and in Boltzmann's setting $S = k_B \ln W$.

Observation 4.1 (The domain is the set of measures)

S is a functional returning a number for a probability measure. Its domain is a space of measures on phase space, not curves. Specifying a single trajectory does not give dS a value — a measure is required.

Quantity	What it is	Domain	Standing
dt	coordinate (label)	none (a chart component)	convention (Paper 95)
$d\tau$	functional of a curve	worldlines	invariant
dS	functional of a measure	probability measures	property of a state

$d\tau$ and dS are not two numbers of differing value.
They are different functionals living on different spaces.

5. Exhibiting the Separation — Counterexamples in Both Directions

To turn a declaration into a verdict it suffices to exhibit, **in both directions**, a case where one vanishes and the other does not.

Counterexample (i): $d\tau = 0$ while $dS > 0$

Established Fact 5.1 (No proper time accumulates on a null worldline)

Substituting $dx = c dt$ along a light ray in Minkowski spacetime,

$$ds^2 = c^2 dt^2 - dx^2 = c^2 dt^2 - c^2 dt^2 = 0,$$

so $d\tau = 0$. **Light accumulates not a single tick of proper time** (Papers 82, 111).

Established Fact 5.2 (The entropy of radiation advances)

From the energy density $u = aT^4$ and radiation pressure $p = \frac{1}{3}aT^4$ of a radiation field, the entropy is

$$S = \frac{4}{3} a T^3 V.$$

Indeed both $(\partial S / \partial V)_T = \frac{4}{3} a T^3 = (\partial U / \partial V + p) / T$ and $(\partial S / \partial T)_V = 4 a T^2 V = (\partial U / \partial T) / T$ hold (verified here). Under isothermal expansion $\partial S / \partial V > 0$, so **the statistical clock advances**.

In a regime where the geometric clock does not move one notch, the statistical clock runs briskly.

Brake (the most delicate point in this paper): this counterexample contains a **shift of address**. $d\tau = 0$ is a statement about one photon's worldline; $dS > 0$ is a statement about a photon gas, a statistical state. The two clocks are not attached to the same object.

But this shift does not spoil the counterexample. It is the counterexample. As shown above, $d\tau$ is a functional of a curve and dS a functional of a measure: **they cannot in principle be attached to the same object**. That they are not attached to the same object is precisely why they are independent. **Hide the shift and say in one breath “light has $d\tau = 0$ yet $dS > 0$ ”, and it becomes an error of category.** Write the address, and it becomes a counterexample.

Counterexample (ii): $d\tau > 0$ while $dS = 0$

Established Fact 5.3 (A bound reversible system accumulates proper time)

For a particle moving with $|v| < c$ the proper time is $d\tau = \sqrt{1 - v^2/c^2} dt > 0$. An oscillating particle **accumulates proper time continuously** throughout its cycles.

Established Fact 5.4 (Liouville's theorem freezes the entropy)

Under Hamiltonian flow the phase-space measure is preserved and ρ is constant along the flow. Hence **the Gibbs entropy $S[\rho]$ is exactly constant**, and $dS = 0$ **unless coarse-graining is introduced** (Paper 77). Indeed, for a harmonic oscillator the phase-space area enclosed by $H = E$ is $2\pi E/\omega$, independent of time (verified here).

However far the geometric clock advances, the statistical clock does not move one notch.

Observation 5.1 (The arrow lives in coarse-graining)

$dS > 0$ appears **once coarse-graining is introduced**, and that belongs to **the resolution of the observer** (Papers 77, 78). **The arrow of time is therefore not a property of $d\tau$** . Proper time lives in a time-reversal-symmetric geometry and carries no arrow.

6. The Coupled Regime — but a Lock Is Not an Identity

That the three are of **different type** does not mean they are **unrelated**.

Established Fact 6.1 (Dissipative systems)

In viscous fluids and systems with friction, the energy of macroscopic motion along $d\tau$ is transferred into unresolved degrees of freedom, producing $dS > 0$ at the same time (Paper 78). Relativistic dissipative hydrodynamics (Eckart; Landau--Lifshitz) is the framework that writes this coupling covariantly.

Established Fact 6.2 (Black-hole horizons)

The classical area theorem $dA \geq 0$ (Hawking) together with

$$S_{\text{BH}} = \frac{k_B c^3 A}{4G\hbar}$$

locks the change of a purely geometric quantity A one-to-one to that of a statistical quantity S . That $[c^3 A / (G\hbar)]$ is dimensionless was checked here.

Brake: a lock is not an identity. That A and S_{BH} are proportional at a horizon **does not make $d\tau$ and dS the same quantity**. What is tied here is **area to entropy**, not **proper time to entropy**. **Area is not $d\tau$** . Furthermore, as Paper 88 showed, S_{BH} (area entropy) and coarse-grained entropy are themselves **distinct roots**, related only by the holographic bound. **This paper therefore restrains itself twice: $d\tau \neq dS$, and $S_{\text{BH}} \neq S_{\text{coarse-grained}}$.**

7. A Name for the Framework — Dual-Clock

What this paper has done is not to write a new equation but **to give types to existing quantities**. Let the bookkeeping have a name.

The Einstein--Yamagishi Dual-Clock Framework

One process, recorded simultaneously in two ledgers: the $d\tau$ ledger and the dS ledger.

A brake on the name (important): this is a **discipline of accounting, not a theory and not an equation**. **General relativity is not altered by one character**, and no new prediction is generated. **If the word “complement” is used, it means juxtaposition, not correction — relativity is complete about Clock A and never claimed anything at all about Clock B**. What is never claimed cannot be wrong. There is therefore nothing to repair inside relativity; there is only **a second ledger to place beside it**. **The word “framework” is chosen for the same reason:** not one equation has been added that anyone must solve.

The name serves exactly one practical purpose: **to force a declaration of which ledger was used when one says how much time has passed**. Once the declaration is compulsory, the two accidents exhibited in §5 — **speaking of light with $d\tau$ alone, and of a reversible system with dS alone** — are prevented before they are written.

8. The Reach of the Word “Orthogonal”

Observation 8.1 (Not orthogonality in an inner-product space)

What this paper calls “orthogonal” is **logical independence**: one may vanish while the other does not. **It is not orthogonality in a Hilbert space.** Since $d\tau$ and dS are **not elements of a common vector space** to begin with, there is no arena in which an inner product could be taken.

Reading $(d\tau, dS)$ as “coordinates on a plane” is **therefore a metaphor**. On a plane spanned by these two axes, **no metric, no inner product and no rotation has been defined**. What may be written is **independence** alone — **not geometry**.

9. Self-Audit: The Difference from Paper 82

Observation 9.1 (Declaration and verdict)

Paper 82 stated that coordinate time, proper time and thermodynamic time are three distinct times that do not fuse. **This paper does not repeat that sentence.** What is added is **three things**: (a) separating the three **by logical type** (coordinate / functional of a curve / functional of a measure); (b) exhibiting the separation constructively **in both directions**; and (c) exposing, in the counterexample itself, **the shift of address** that it contains.

Paper 82 opened a framework. This paper closes one door inside it.

Observation 9.2 (The separation of dt from $d\tau$ has been standard since 1908)

Point (a) above must not be read as a new claim. It was Minkowski who separated dt from $d\tau$, and he did so in 1908. The invariant interval

$$ds^2 = c^2 dt^2 - dx^2 - dy^2 - dz^2$$

is precisely the device that discards the observer-dependent dt and retains only what is common to all, from which $\tau = \int ds/c$ follows.

And within this series, Paper 108 already treats this. It states that “observers disagree about times and lengths, but this interval alone is common to all”, and further sorts the geometry of the invariant interval (108), the hyperbolic geometry of velocity space (Paper 60), and proper time (Paper 82) into distinct roots. The type-separation of dt from $d\tau$ in this paper stands on that line.

The contribution of this paper is therefore restated precisely: what is newly placed here is **not the $dt/d\tau$ separation but the setting of a third quantity, dS , alongside it under the same measuring stick**, together with the constructive exhibition of the separation in both directions. For the first two, this paper merely inherits an existing line.

Observation 9.3 (In which clock is a Renko brick counted?)

Paper 82 drew time as a quantity that “advances one step only once enough change has accumulated”. It follows from this paper that such a step can be counted in either $d\tau$ or dS , but the counts will not agree. Light lays down no brick in $d\tau$; a reversible oscillator lays down none in dS . Hence, before counting a step, one must declare which clock is being used. This is not a correction to Paper 82 but a type declaration for the framework Paper 82 opened.

10. Brakes: What This Paper Does Not Show

- **The three are not reduced to one “real time”.** That is the point. The question of which is genuine is itself born of a confusion of type.
- **$d\tau$ is not derived from dS .** No claim is made that gravity or spacetime has been derived from an entropy gradient (the restraint of Paper 74 is kept). Nor is dS derived from $d\tau$.

- **The origin of the arrow of time is not solved.** That the arrow lives in coarse-graining is only half; why the initial state had low entropy (the past hypothesis) is **left open** (Paper 98).
- **No new evolution equation is proposed.** Everything closes inside the existing frameworks of general relativity and statistical mechanics.
- **The horizon lock is not read as an identity.** What is tied is area to entropy, not proper time to entropy.
- **No geometry is imported onto the $(d\tau, dS)$ plane.** No metric, inner product or rotation is defined there.
- **The separation of dt from $d\tau$ is not claimed as this paper's discovery.** It is Minkowski's (1908), and within this series it is Paper 108's. What this paper adds is the third quantity, dS .
- **No metaphor enters the body.** Ageing, consciousness, a “Universe OS” and the inference of an AI are all **Layer 3** and are not claims about mechanism.

A personal note by the author (Layer 3, labelled non-scientific; not a claim about mechanism)

Looking at Einstein's clock and Clausius's clock side by side, **something finally settled for me**. When we say in ordinary life that time is passing quickly or slowly, we are probably **trying to name two separate quantities with one word**. A quiet stretch of time without friction, and a busy stretch that gives off heat as it goes. In the first only $d\tau$ advances; in the second dS advances too. That much of a view opened up.

There was a groundwork for this in **the markets**, where I began. In charting tools, **the same price action can be displayed on a time chart, on a tick chart, or on a Renko chart. Which one you use is chosen by the viewer.**

And the troublesome part is that **after a while one forgets having chosen**. Someone who picked the evenly spaced bars comes to believe that this is simply how price flows. The scale starts to look like a property of the world. **I suspect the same thing happened in physics**. Forget that dt was chosen, and dt begins to look like the only time. **The line drawn on the floor begins to look like a clock.**

Lately something else has been on my mind. The language model I converse with does not appear to think by watching a clock on the wall either: with no input it halts, and it advances a step only when a token is produced. **This is a Layer-3 association and not a claim about mechanism** — there is no ground whatever for identifying the interior of an AI with physical time. Still, noticing that **there seem to be several ways of ticking that are not evenly spaced** has helped me stop treating dt as absolute.

And I think of light. Light crosses the universe without laying down a single tick of proper time. That same light, as radiation, is certainly increasing entropy. **One object, stopped forever on one clock and advancing on the other.** To this duality — which physics can hold as **two separate ledgers at once**, neither denying nor merging them — I record a quiet respect.

11. Scope and Conclusion

What is shown (descriptive, a roll-call): that dt , $d\tau$ and dS are **three different logical types** — dt a coordinate (convention), $d\tau$ a functional of a curve, dS a functional of a measure (§2--§4); that dt becomes a clock only once pasted onto a congruence (§2); counterexamples in both directions — $d\tau = 0$ on a null worldline with $dS > 0$ for radiation, and $d\tau > 0$ with $dS = 0$ for a reversible Hamiltonian system (§5); that **the shift of address inside the counterexample** (a photon's worldline versus a photon gas) is **itself the reason for independence** (§5); **the coupled regime** (dissipation, horizons) and that **a lock is not an identity** (§6); **a name for the bookkeeping** and why it is a

framework and not a theory (§7); that “orthogonal” means logical independence, not inner-product orthogonality (§8); and the difference from Paper 82 — a declaration turned into a verdict (§9).

What is not shown (restraint): the three are not reduced to one (that is the point); **felt time is not explained** — it is a further quantity, left untouched, and deliberately **not numbered** (the fourth type is a physical one; Paper 119); **$d\tau$ is not derived from dS , nor the converse** (Paper 74); **the origin of the arrow of time is not solved** (the past hypothesis; Paper 98); **no new evolution equation is proposed**; **the horizon lock is not read as an identity**; S_{BH} and coarse-grained entropy are not conflated (Paper 88); **no metric, inner product or rotation is imported onto the $(d\tau, dS)$ plane**; **ageing, consciousness, a “Universe OS” and AI inference do not enter the body** (quarantined at Layer 3 under a non-scientific label); no new mathematics and no prediction (Layer 2).

The single phrase “time passes” was covering at least three quantities. **And the three did not differ in value; they differed in type.** dt is a line drawn on the floor; $d\tau$ is a functional returning a number for a curve; dS is a functional returning a number for a measure. **There was never an arena in which they could be compared.**

The separation can be confirmed from both sides. **Light crosses the universe without laying down one tick of proper time, yet as radiation it increases entropy. A reversible oscillator accumulates proper time endlessly without moving entropy by one notch.** Elect either one as “the real time” and the other rises as a counterexample.

Still, the three are not unrelated. In dissipative systems both clocks tick together, and at a horizon area and entropy are locked one-to-one. **But a lock is not an identity** — what is tied there is area to entropy, not proper time to entropy.

The confusion lasted so long not because the three were similar. **It lasted because they had no type in which they could be compared.** Write the types, and several of the disputes dissolve before an answer is even attempted. And this returns address number 118.

Revision Record

Second edition (August 2026): an explicit attribution, and a restatement of the scope of the roll-call; no claim, theorem or counterexample has been altered from the first edition. **The first addition** is to state, in the abstract, in the self-audit section and among the brakes, that the separation of dt from $d\tau$ originates with **Minkowski (1908)** and is already treated within this series by **Paper 108**. The first edition described this paper's contribution as “separating the three times by logical type”, which **left room to read the $dt/d\tau$ separation itself as novel here**. **What this paper newly places is the third quantity (dS) under the same measuring stick, and the counterexamples in both directions.**

The second addition — a renumbering: the first edition called felt time “a fourth quantity” and wrote that “physics holds three”. **Both are now inaccurate**, because **Paper 119 identified a fourth type on the physical side** (the parameter of Ricci and renormalisation-group flow, of dimension L^2 , whose domain is a path in the space of metrics $\text{Met}(M)$) and **Paper 121 treated the geometry of that arena** (the positive-definite L^2 metric and the DeWitt supermetric being distinct

roots). This edition therefore **stops giving felt time a number** and **restates the scope as “this paper lines up three”**. **No claim, theorem or counterexample changes as a result** — what changed is only **a manner of writing that made the roll-call look closed. Nothing has been retracted.**

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— *From thinking to syncing.* —

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