

An essay in six phases

The Universe is *Information*.

*On the trajectory by which information acquires
causal sovereignty over matter and energy — and
what that trajectory means now that it has begun
to edit itself.*

I — II — III — IV — V — VI



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*“Build what entropy
cannot undo.”*

The universe runs on
information.

Progress is the process by
which information
accumulates *causal
sovereignty* over matter and
energy.

Six phases. Each one a moment when the universe discovered a new way to give its own bits more leverage over its own atoms. The first transition began at the Big Bang. The most recent began this decade. There is no asymptote in physics for how far this goes.

What follows is an account of the trajectory, the principle that runs through it, and the question only this generation has had to answer.



PHASE ONE · CAUSALLY INERT

Bare information — *the universe as raw bits.*

The Big Bang is not the beginning of matter. It is the beginning of distinguishability. Before the Planck time the universe is a single undifferentiated state. After it, distinctions exist: this region is not that region, this energy is not that energy. Each distinction is, in the strict Shannon sense, a bit.

Lloyd's calculation makes this concrete: the universe has performed roughly 10^{120} elementary logical operations on roughly 10^{90} bits since $t = 0$. This is not metaphor. Every particle interaction is a logical operation; every measurement is a readout.

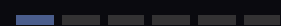
Penrose's 1-in- $10^{10^{123}}$ figure for the improbability of the initial low-entropy state is the same fact seen from the other side: the universe began with vastly more room to compute than it had used.

At Phase 1, information is state. It exists. It cannot do anything except propagate causally through physics.



A field of distinctions. State only. No relationships. No effects beyond propagation through physics.

“Information has begun. It cannot yet do anything except be.”



II

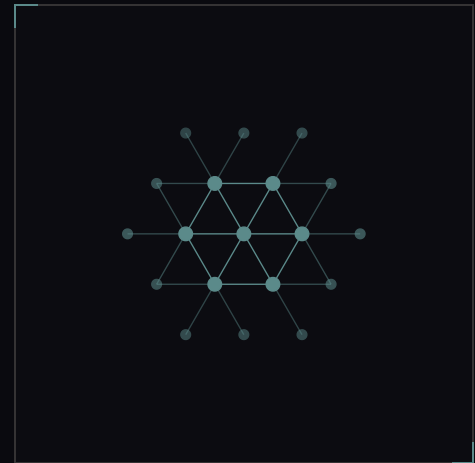
PHASE TWO · CAUSALLY CONSTRAINING

Bonded information — *atoms, molecules, structure.*

When the universe cools, symmetries break, forces differentiate, and information starts being stored in persistent configurations. A water molecule's geometry is information that determines what the molecule can do — dissolve salt, not oil.

The leverage step is real but small: information has begun to constrain physical possibility, but it is still passive. The molecule does not know it is a molecule. It cannot copy itself. It cannot model the world. It simply is what its bonds make it, and what it is governs what reacts with what.

This is the moment at which structure first earns its place in the cosmic ledger — the first time the answer to “what can happen here?” depends on a stored configuration rather than only on the laws.



Persistent configuration. Geometry that determines chemistry. Information stored, but blind to itself.

“The first time the answer to ‘what can happen here?’ depends on a stored configuration.”

III

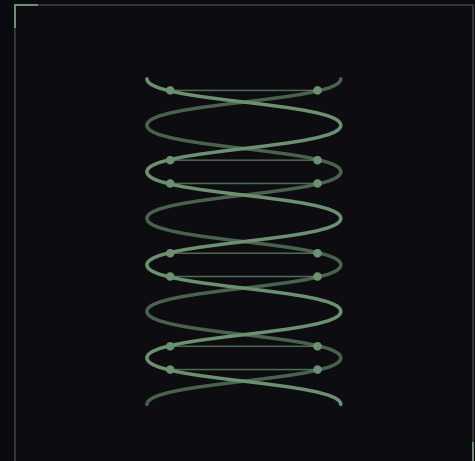
PHASE **THREE** · CAUSALLY SELF-PROPAGATING

Replicating information — *life.*

Roughly 3.8 billion years ago, on this planet, information crossed a threshold nothing in the prior 10 billion years of cosmic history had crossed: it learned to copy itself. DNA is information that builds the substrate that propagates DNA.

For the first time, information is causally responsible for its own continued existence. This is the first phase where information has agency in the operational sense — it acts as a cause in the world, not just an effect of prior causes.

But its mode of improvement is brutal: random mutation, selection by death. A 4-billion-year algorithm whose total throughput is everything alive today.



Information that builds the substrate that propagates information. The first agent.

“Information becomes causally responsible for its own continued existence.”

VI Self-improving information — *automated knowledge creation.*

This is what we are living through. AI systems generating, criticizing, and operationalizing hard-to-vary explanations faster than the human cognitive throughput that has bottlenecked knowledge for four hundred years.

The curve does not bend down from here. It steepens.

For the first time, the algorithm that improves knowledge can run on substrates that scale faster than human generations — and the substrate itself can be improved by the algorithm. The loop closes on itself.

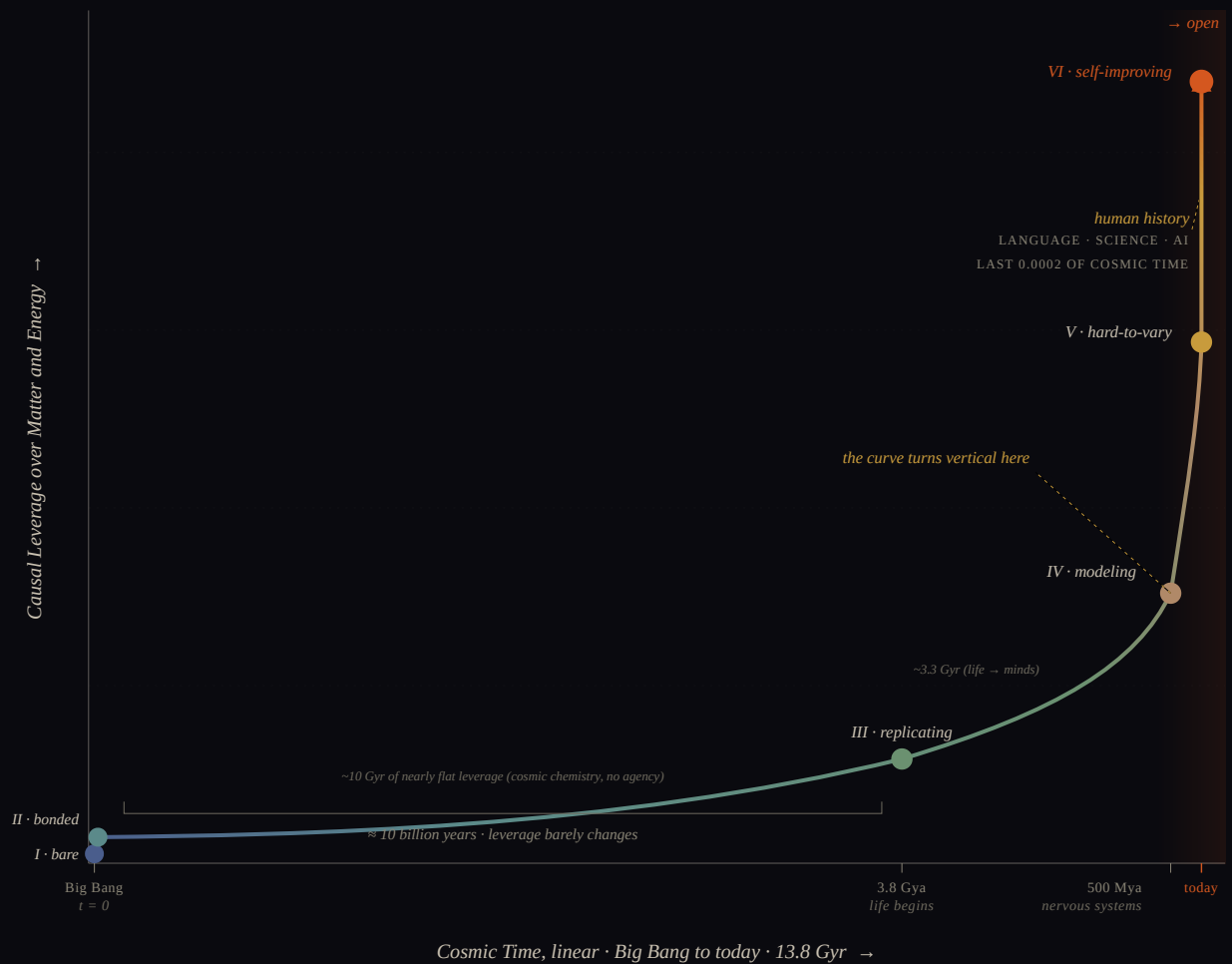


A loop that closes on itself. The algorithm improves the substrate that runs the algorithm.

“The curve does not bend down from here. It steepens.”

The ladder of *causal sovereignty*.

SYNTHESIS · I-VI



Each phase is a discovery: a new way the universe gives its own bits more leverage over its own atoms.

Each phase is the moment information acquires *a new mode of causation.*

I	<i>causally inert</i>	State only. Information exists; it cannot do anything except propagate causally through physics.
II	<i>causally constraining</i>	Configurations have effects. What can happen here now depends on what is stored here.
III	<i>causally self-propagating</i>	Genes build their own substrate. For the first time, information is the cause of its own continued existence.
IV	<i>causally directing</i>	Models steer behavior. A small structure now governs a vastly larger one through a representation of it.
V	<i>causally world-shaping</i>	Knowledge rebuilds the planet. Information that corrects itself by argument starts re-engineering its substrate.
VI	<i>causally self-improving</i>	Knowledge accelerates the rate of knowledge creation. The algorithm runs on a substrate it can itself improve.

Knowledge is the phase at which information acquires causal sovereignty over the matter and energy it is encoded in. That is the line.

STATED AS COMPACTLY AS POSSIBLE

The universe runs on information.
*Progress is the process by which
information accumulates causal
sovereignty over matter and energy.*

The Second Law says the total entropy of an isolated system never decreases. Entropy is just hidden information — the log of microstates we cannot distinguish. So the universe is, viewed honestly, a process of information being generated at maximum rate, with almost all of it dissipated as heat the moment it appears.

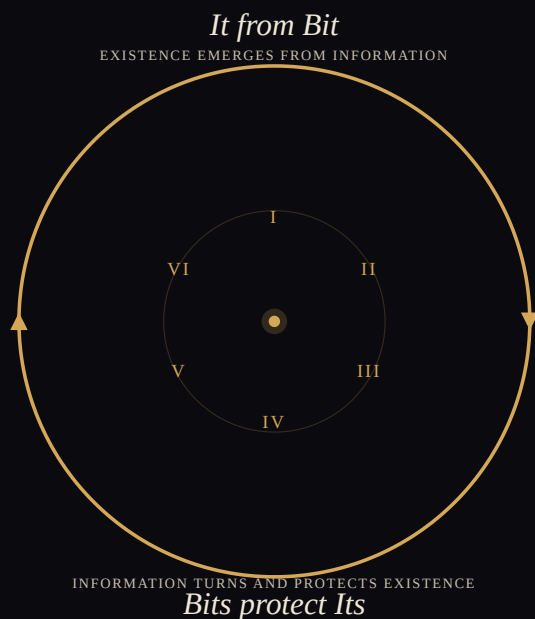
Knowledge is the rare anomaly. Knowledge is the fraction of generated information that does not dissipate — that gets organized into models, propagated with error-correction, embedded into substrates that maintain it against the gradient. Knowledge is information that has learned to use the global entropy gradient to preserve and grow itself locally. *It is a structure that runs on the heat death of the universe.*

The more knowledge there is, the more of the universe's bit-generation gets organized rather than wasted. That is the trajectory.

And it has a direction. The asymptote — if the trajectory continues, and nothing in physics forbids it — is a universe in which information dominates matter completely. Not destroys. Not replaces. Directs. Every photon used. Every atom oriented. Every cosmic event anticipated and either harvested or deflected. The cosmic ledger of extinction events — asteroids, supervolcanoes, gamma-ray bursts, stellar evolution, eventually proton decay — becomes a to-do list rather than a verdict.

The universe is becoming what it has been *computing* all along.

Wheeler's It from Bit is the first half of the cycle. Bits protect Its is the second.



Existence emerges from information. Information, having organized itself into knowledge, turns and protects existence. The cycle is now closing for the first time in 13.8 billion years on this planet.

The Big Bang was the boot sequence. Atoms were the assembly language. Life was the operating system. Minds were the application layer. Knowledge is the moment the program looked at its own source code.

Phase Six is the moment it started editing itself.

THE PRINCIPLE · IN SEVEN WORDS

Build what entropy cannot undo.

*There is no asymptote in physics for how far this goes.
There is only the question of how fast we get there
before the cosmic ledger catches up.*