The Evolving Web: Darwinian Theory of Everything

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Abstract

This paper proposes a unified framework in which biology and physics are continuous manifestations of a single evolving causal web governed by two fundamental organizing principles: locality and relativity of local causalities. Local causal interactions constitute the elementary currency of change within this dynamic web. Persistence (memory) and stability emerge as relatively stable local interactions embedded in an ever-changing network. Apparent top-down or bottom-up causation does not represent a distinct causal category but arises from the accumulated history of local interactions.

Reconceptualizing biology as a causal network in which natural selection shows as an emergent effect allows us to view the physical world as a seamless continuation of the same web operating across different boundaries. Mass, forces, and motion are reinterpreted as manifestations and flows of causality governed by the same principles of locality, relationality, and historical embedding. In this framework, relativity is not primarily a theory of inertial frames or the measurement of clocks and rods, but a description of how local causality is dynamically organized and reassigned through relative motion within the network.

The quantum domain represents a further extension of this evolving causal web. Experimental choices and measurement outcomes are co-determined by the web's historical structure, eliminating the need for genuine nonlocality to explain quantum correlations. The universe is thus neither a sterile clockwork governed by eternal Platonic laws nor a collection of disconnected parts; it is a single, interconnected, evolving web.

Keywords: Evolution, Relativity, Causality, locality, superdetermination, randomness, gravity, memory, stability

Introduction

What scientists call a "theory of everything" is a single, coherent framework that explains all physical phenomena from the smallest particles to the largest cosmic structures using a unified set of principles and laws.

The principal goal of such a theory is not merely to list facts about nature, but to provide a minimal set of fundamental principles from which the behavior of matter, energy, space, time, and the emergence of structure can be derived.

In contemporary physics, this search is often framed as the problem of unifying general relativity, our best theory of gravity at large scales, with the Standard Model of quantum field theory, which successfully describes the electromagnetic, weak, and strong forces, as well as the particles that comprise ordinary matter.

Despite decades of progress, those two pillars remain formally incompatible: gravity is geometric and classical in general relativity, while the Standard Model is probabilistic and quantum. Resolving that tension, finding a single description that recovers both quantum phenomena and spacetime curvature, remains one of the central unsolved problems in science.

But a complete theory of everything should aspire to more than reconciling gravity with quantum fields. A genuinely universal theory would not only explain fundamental forces and the early evolution of the universe, but it would also account for the origin of complexity, why stable atoms combine into molecules, how self-replicating systems and life arise, and how minds, consciousness, and biological organization emerge and persist.

In other words, a final explanatory framework must bridge physics and life. It must show how the same underlying principles that govern particles and fields also give rise to the organized, adaptive systems observed in biology.

This article, Evolving Light, advances a bold thesis: the mechanisms identified by Darwinian evolutionary theory can be generalized beyond biology to provide a unifying explanatory framework. From this perspective, processes conventionally studied by physics and cosmology (particle interactions, phase transitions, pattern formation) are continuous with the processes that drive biological evolution.

Biology and physics thus become different scales and specializations of the same underlying theory rather than wholly separate domains. This view would recast apparent differences between living and nonliving systems as differences in structure and function rather than differences in principle.

It will be clear that the universe is not a sterile clockwork governed by eternal Platonic laws, with a few late-emerging accidents we label biology. It is a single, living, interconnected evolutionary web, vibrant, unbroken, and immortal in its capacity to create. Evolution is reality’s sole principle, and reality, in turn, is nothing but evolution made manifest.

Evolution

Darwin’s theory of evolution by natural selection established a general explanatory framework for biological change: populations vary, some variants reproduce more successfully than others, and advantageous differences accumulate over generations (Tanghe, 2019).

Although Darwin articulated the logic of selection and provided abundant natural history evidence, he did not know the molecular basis of heredity. The twentieth-century Modern Synthesis integrated Mendelian genetics with population genetics to provide a mechanistic account of variation, inheritance, and changes in allele frequencies.

In the late twentieth and early twenty-first centuries, empirical and conceptual work (evo-devo, niche construction, epigenetics, multilevel selection, cultural evolution) challenged some assumptions and broadened the explanatory vocabulary. This section summarizes Darwin’s core definitions and mechanisms, the principal postulates of the Modern Synthesis, and the central problems identified by later critics.

Charles Darwin formulated evolution by natural selection as an explanatory process that produces adaptive fit between organisms and their environments. In On the Origin of Species, Darwin emphasized three linked observations and two inferences often paraphrased as variation exists among individuals in a population; organisms produce more offspring than can survive; there is a struggle for existence; hence (inference A) individuals with traits conferring advantages in survival or reproduction will leave more descendants; and (inference B) cumulative selection over long periods produces adaptation and divergence.

Darwin’s account is descriptive and inferential rather than mechanistic in modern molecular terms. Between the 1920s and 1950s, population geneticists and evolutionary biologists synthesized Mendelian genetics with Darwinian selection to construct a mathematically explicit theory of evolutionary change, commonly known as the Modern Synthesis (Ayala and Fitch, 1997).

In this theory, Heredity is particulate and mediated by genes (discrete units) whose transmission across generations preserves variation in a manner compatible with cumulative selection. Evolutionary change can be modeled as changes in allele frequencies in populations under natural selection, mutation, migration, and genetic drift.

In the Modern Synthesis, the gene is known as the fundamental unit of heredity and a central explanatory focus, and selection is the process by which differential reproductive success changes the distribution of those genetic variants in populations.

From the 1970s onward, several empirical and conceptual developments revealed limitations or lacunae in the canonical Modern Synthesis. These developments did not overturn Darwinian logic, but they complicated the picture of how heredity, development, and selection interact.

Evolutionary developmental biology (evo-devo) emphasized that development constrains and channels the production of phenotypic variation: not all conceivable variants are equally likely because developmental processes bias variation in systematic ways (Gould and Lewontin, 1979a, West-Eberhard, 2003). Evo-devo shows that genotype–phenotype mapping is complex, many genes have pleiotropic effects, and developmental systems can both enable and constrain evolutionary trajectories; hence, explanations that treat genes as simple, independent causes of phenotypic variation can be incomplete (Bolker, 2014).

Work on niche construction argues that organisms modify their environments in ways that alter selective pressures, creating feedback loops where organismal activity becomes part of the selective context. This reciprocal causation challenges the idea that genes produce phenotypes, which then passively experience selection; instead, organisms and environments co-construct selection regimes (Scott-Phillips et al., 2014).

Empirical discoveries of epigenetic marks, maternal effects, and other non-DNA inheritance systems demonstrate that heritable phenotypic variation can be transmitted by mechanisms other than DNA sequence (Bonduriansky et al., 2012). While most epigenetic marks are transient relative to DNA, some can influence evolutionary dynamics and blur the exclusive focus on genes as replicators in explanatory accounts.

Philosophers and biologists debated whether selection acts primarily at the gene, individual, group, or multiple levels simultaneously (Okasha, 2006). The Modern Synthesis emphasized selection on individuals and genes, but multilevel selection theory formalized how selection can operate at and between levels, making explicit that units of selection depend on the level of variation that affects fitness and the level at which differential reproduction occurs.

Cultural transmission systems (languages, technologies, social norms) undergo variation, differential retention, and transmission processes formally analogous to biological selection (Mesoudi, 2011). The existence of non-genetic Darwinian processes supports a pluralistic view of what counts as a "replicator" or as an object of selection.

Richard Dawkins's popularization of the replicator concept provided a useful shorthand: entities that reliably copy themselves are natural loci of selection. However, philosophers and biologists distinguish between being a replicator and meeting the minimal Darwinian conditions.

Origin of life research explores how the first replicators might have emerged. Two broad classes of hypotheses are prominent: the RNA World and related scenarios propose that RNA molecules, capable of both storing information and catalyzing replication (ribozymes), populated early protocell systems and constituted primitive replicators on which natural selection acted (Joyce, 2002).

The metabolism first and compartmentalization hypotheses propose that self-sustaining chemical networks and compartmental aggregates produced persistence and differential reproduction before, or alongside, the emergence of coded replicators; in these accounts, selection could act on collective systems rather than only on single molecules (Ruiz-Mirazo et al., 2014).

There is no definitive empirical account of the first replicators; rather, multiple plausible mechanisms have been demonstrated in laboratory and theoretical work. Thus, while modern evolution depends centrally on genetic replicators within contemporary organisms, the origin of those replicators plausibly involved intermediate systems where selection operated on chemical networks, compartments, and proto-replicative molecules.

Randomness

Randomness is central to both physics and biology, rendering the origin and evolution of life a highly contingent and statistically improbable process from a scientific viewpoint. Randomness plays several distinct roles in evolutionary theory, from variation generation to modeling uncertainty. How scientists understand and deploy randomness has evolved as empirical knowledge and theoretical formalisms have advanced.

Early debates about inheritance, the emergence of population genetics, and later developments (molecular biology, neutral theory, evo-devo, and systems biology) have refined and pluralized the notion. Clarifying what kinds of randomness biologists mean and at which level of analysis it applies is crucial.

Biologists and philosophers typically use randomness in conceptually distinct senses. Random variation as unpredictability in individual outcomes. This is the everyday sense: variation among offspring or mutations whose specific instantiation cannot be predicted for any single event. For example, the specific nucleotide substituted in a single mutational event is effectively unpredictable, even if the overall mutation rate and spectrum are known (Gillespie, 2004).

Randomness in a Statistical sense or stochasticity in population processes refers to probabilistic descriptions of population-level outcomes due to different events and causes. Though each birth or death is a concrete event, population geneticists model such events as random draws from probability distributions to predict expected trajectories and variance.

In evolutionary biology, "stochastic randomness" is usually a model-level description of unpredictability, not a metaphysical claim that the world is fundamentally indeterminate. Scientists treat processes as stochastic either because individual outcomes are practically unpredictable, or because the system's micro-details are too complex or inaccessible to model deterministically.

A single mutation event, the exact nucleotide substituted during DNA replication, is not predictable in practice. We can measure average mutation rates and biases, but not which base will change in a single replication in advance. This randomness reflects a lack of predictive access to single events, knowledge about initial conditions, and ongoing change. These are representations of our ignorance or the impracticality of tracking microstates, and are known as epistemic randomness, a limit on our knowledge, not a claim about nature's fundamentality.

In the Modern Synthesis, Variation generation (mutation) is described as random with respect to fitness, claiming variation as a random process being filtered by nonrandom selection. This claim asserts that mutation biases are not goal-directed toward improved fitness. While not strictly true, this underscores evolution's lack of long-term foresight. Thus, adaptations emerge as an outcome (Fairbairn, 1998).

This simple, random-variation/selection framework was challenged by understanding that Developmental systems make some variants much more likely (developmental bias), so the phenotypic space that variation explores is constrained and non-random in systematic ways (Gould and Lewontin, 1979b). Also, reciprocal causation highlights that organisms change environments and thereby alter selection pressures (Odling-Smee et al., 2003).

What remains truly random in biological practice? Biology rarely requires invoking ontological randomness (a fundamental indeterminacy of nature) as in some interpretations of quantum mechanics (e.g., Copenhagen). Most stochastic models are pragmatically epistemic: they encode uncertainty from incomplete knowledge or complexity rather than a metaphysical claim that the world lacks underlying causes. Quantum processes are interpreted in some interpretations as ontically indeterminate, but for most evolutionary biology questions, this is considered irrelevant.

At the physical level, quantum effects, such as proton tunneling in DNA base pairs, thermal fluctuations, and cosmic ray-induced mutations, introduce genuine ontological randomness into mutation (Srivastava, 2019, Das and Kantz, 2021). While these are minor contributors to evolutionary change, they represent residual indeterminacy from fundamental physics.

Causality

Biological evolution, at its core, is a theory about change and causation. As Darwin recognized, evolutionary theory aims to explain why organisms change and by what mechanisms those changes are produced and transmitted. To explain evolution is therefore to give an account of causal processes: which factors act, how they act on entities, and how their actions propagate to produce sustained changes in populations and lineages. Because evolutionary outcomes are the consequences of networks of interacting processes, a clear theory of evolution must begin with a careful analysis of causation itself.

Causes in biology are not autonomous, isolated agents; they are nodes in a web of interdependence. An apparent cause, say, a mutation, an ecological perturbation, or a developmental constraint, has its effects only through relations with other components of a system. The same causal perturbation can produce qualitatively different outcomes depending on the network of relations into which it is introduced. Hence, causes should be defined relationally: a cause is an intervention or perturbation whose effect on a target depends on the local organization, connectivity, and dynamic state of the surrounding causal web.

The causal web itself is not a static backdrop but a history-laden, dynamical structure: its past configurations determine present boundaries and sensitivities, and its present structure constrains how new perturbations propagate. Recognizing evolution as the unfolding of a causal web reframes classic problems, the origin and role of replicators, the meaning of fitness, and the dynamics of multilevel selection as questions about how causal influence is transmitted, stabilized, and made persistent by the network.

Why start here? If the goal of evolutionary explanation is mainly causal, then we first need to define what qualifies as a cause in biological systems and how causal effects are bounded, amplified, or attenuated by network structure. Only with this foundation can we clearly examine how natural selection functions, how replicative and heritable patterns develop, and how higher-level organizational features (populations, developmental systems, ecological communities) gain causal power.

Framing evolution as a theory of causation emphasizes that evolutionary explanations aim to identify antecedent conditions and processes that reliably produce particular outcomes.

We should reconceive evolution as a process that is best understood through a causal network rather than by invoking isolated forces. Traditional accounts frequently treat natural selection and replication as primary causes of evolutionary change. To explain evolutionary change, we must first define causation, specifying the conditions under which one node of a system can be said to cause change in another or be affected.

Two intimately related aspects of causation are essential for understanding causality in the evolutionary web: locality and relativity. The consequences of these two emerge in the network as memory, or better said, relative stability.

Locality: A cause must act in the spatial vicinity of the affected entity. For an event in one part of a causal web to alter another part, its influence must reach the boundary of the affected subsystem and affect processes there. Local interactions are therefore the primary carriers of causal influence. This does not deny that distant events can eventually matter; rather, their effects must propagate through the network and alter the local causal structure and dynamics of the subsystem in question. Thus, local causal interactions provide the basic criterion for attributing causal responsibility in evolutionary systems.

Relativity of causalities: Causal effects act relative to the structure and state of the network that receives them. The same perturbation can have qualitatively different consequences depending on the local organization, connectivity, and dynamic regime of the subsystem. In other words, the significance of a cause is not absolute but determined by the local relational context: which connections it engages, how stable those connections are, and how the subsystem responds. This relativity explains why some perturbations produce durable, system-level change while others leave only transient effects.

Relational local causation and network dynamics together provide a simple mechanistic account of how memory and stability emerge in the web. The key idea is that persistence (memory) is a relatively stable local interaction embedded in a changing causal web.

Local causal interactions, direct influences that reach the boundary of a subsystem and modify its internal relations, are the basic currency of change. Different subnetworks experience different effective rates of change because their local connectivity and feedback vary. Subsystems with reinforcing interactions (mutual support, positive feedback, redundancy) change more slowly relative to surrounding parts. This relative slowness is not metaphysical immutability but comparative stability: such subnetworks resist perturbation longer and thus persist across change.

Because the causal impact of any perturbation is relative to the receiving network's structure, some configurations respond less to the same external perturbations. These relatively insensitive configurations act as anchors in the causal web. Over evolution, the history of interactions preferentially selects for relational configurations that are robust to the typical perturbations experienced within their context. In this way, the web's own dynamics bias future change toward a landscape of relatively stable relational patterns.

Relative Stability functions as memory: Persistence of a relational configuration constitutes a form of memory for the causal web. Memory here is not the copying of a molecule per se, but the sustained presence of a pattern of causal relations that continues to shape subsequent dynamics. Such "relational memory" enables path dependence: future states of the web are constrained by which relational patterns survived earlier perturbations. Thus, the web both records its history and uses that record to channel future dynamics.

Emergence of replicators and inheritance: Relational memory can give rise to replicative dynamics: clusters of relations that tend to re-form, be reconstructed, or be preferentially produced by the web's dynamics after perturbation. When such clusters persist and bias the generation of similar clusters in proximate contexts or times, they play the functional role of inheritance, transmitting relational structure across evolutionary and organizational boundaries. Importantly, such inheritance need not presuppose explicit, discrete replicators; it can be an emergent product of local interactions, relative stability, and the web's historical dynamics.

Boundaries of subsystems are produced by the network's own dynamics: relatively stable clusters of causal relations define where one subsystem ends and another begins. These boundaries are not metaphysically fundamental but are emergent features determined by local interactions and the relative stability of those interactions. A change in one part of the network can affect another only to the extent that the causal influence reaches the receiving subsystem's boundary and modifies its internal relations.

Viewing evolution as the unfolding of a causal web yields several conceptual shifts: Explanations should track causal propagation and boundary formation, not only changes in allele frequencies or fitness values.

Because memory and stability arise from local interaction and relativity in the surrounding web, natural selection and fitness must be understood as outcomes of how different relational configurations persist and influence the rest of the web. Fitness is best viewed as a real-time index of how a subsystem's causal relations confer relative persistence or efficacy within its local causal context. Natural selection is then a descriptive summary of differential persistence driven by the causal web, not an ontologically primitive force separated from the network of interactions that produces it. Thus, natural selection is an emergent effect in the web, not a stand-alone cause.

In summary, Memory and stability in evolution are not mysterious extras appended to a mechanism of selection; they are natural consequences of heterogeneity in local interactions and of the relativity of causal impact across a dynamical causal web. This relational account explains how durable structure, quasi-replication, and inheritance can arise from purely local processes and how selection emerges as an effect of those network dynamics. From this starting point, we can proceed to analyze in detail how boundaries form, when higher-level causal aggregates gain efficacy, and how the classical concepts of fitness and replicators are instantiated within a causally networked theory of evolution.

Multilevel causation in biology: a locality perspective

Contemporary biology and physics often invoke multilevel causation and multilevel selection to explain how processes at different scales, molecular, cellular, tissue, organismal, and ecological, interact. In this view, lower-level processes (for example, molecular interactions) cause higher-level phenomena (cellular behavior, organismal traits), and higher-level structures or selection regimes in turn impose constraints on and influence lower-level components (Wilson et al., 2008). This reciprocal relation is commonly described as bottom-up and top-down causation, and with cell-to-cell interactions described as types and mechanisms of causation (Wilson and Wilson, 2008).

I argue here that the standard claim of genuine top-down and even bottom-up causation is unnecessary and misleading. A careful causal analysis shows that effective top-down influences can be understood as networks of local causal interactions and boundary conditions created by the arrangement and history of lower-level components. In other words, what we call top-down causation is nothing more than an organized pattern of local causes operating within a structured environment. The appearance of higher-level agency or causal power arises from the coordinated activity of lower-level parts, not from additional causal forces operating at a different ontological level.

This argument does not deny emergence. Higher-level organizations and networks often exhibit novel functions, regularities, and explanatory usefulness that are not visible at the level of isolated components. These emergent properties are real and important. However, emergence does not require positing new, non-local causal powers. Emergent phenomena are implemented by and grounded in localized causal interactions within networks. Treating emergent properties as explanatory summaries of distributed local causation is sufficient and more parsimonious than postulating ontologically distinct levels of causes.

Multilevel selection is then the descriptive outcome of how causal relations at multiple nested boundaries differentially affect persistence and change. Higher-level effects exist to the extent that aggregated causal interactions at a larger boundary systematically influence the dynamics of their internal parts (and vice versa), through interactions that reach the relevant boundary and the surrounding network of each part.

Local causal interactions should be treated as the fundamental principle of biological and physical theories. When we attempt to trace evolutionary change or developmental dynamics, there is no prior, privileged higher level that deterministically causes the behavior of the lower levels. Instead, higher-level boundaries, constraints, and functional regularities arise from the history and organization of local interactions among parts.

These emergent boundaries then reshape the network of local causal relations, but they do so by changing local contexts and interactions, not by injecting nonlocal causal powers.

To put it another way: higher-level patterns are constituted by lower-level relations; when those patterns influence components, they do so by modifying the local conditions in which those components interact. Causation remains local; what changes is the network of local causal relations. Therefore, talk of top-down causation and causation levels should be interpreted, where useful, as shorthand for layered patterns of local causation and contextual constraints rather than as an ontologically distinct causal category. But this invokes a fundamental question: if there is no level of causation there, and consequently, one level of causation exists, local interaction of what, what is this network made of?

Implications for physics and the biological–physical interface

Reframing causation as fundamentally local and network-based has important consequences for how we interpret physical theories and for the interface between physics and biology.

Physical laws as descriptions of local interactions: rather than viewing physical laws as transcendent, metaphysically fundamental prescriptions that operate independently of material configuration, we should treat physical laws as effective, scale-relative descriptions of recurring patterns of local interaction. Classical mechanics, thermodynamics, quantum mechanics, and field theories each summarize regularities.

The existence of different, successful descriptions at different scales (quantum field theory at the subatomic level, statistical mechanics at mesoscales, continuum mechanics at macroscale, etc.) is best explained by the scale-dependence of network structures' stability rather than by positing different kinds of fundamental causal substances at each level.

Thus, laws should be interpreted primarily as compact models of recurring local causal patterns, not as metaphysical agents that impose top-down causal power on lower-level entities.

Effective theories capture how collections of local interactions give rise to collective variables and stable behaviors; these collective variables can be used for efficient prediction without implying new causal categories.

This view yields ontological economy: it preserves the causal primacy of local interactions while allowing for the practical higher-level descriptions. Higher-level laws are explanatory tools but are grounded in and implemented by the lowest-level causal networks.

Laws remain indispensable, but their role is descriptive and scale-relative; they summarize the stable patterns produced by local interactions and the constraints that those patterns impose in the network under study.

Quantum mechanics, thermodynamics, and gravitation are often treated as fundamental laws that sit above ordinary causal processes. I argue instead that these laws are best understood as descriptive summaries of local causal interactions and the evolutionary web histories.

Two connected puzzles need addressing. First, why does the microphysics (quantum theory) employ fundamentally probabilistic rules while our macroscopic descriptions often appear deterministic? Second, does quantum indeterminacy point to a metaphysically distinct, non-causal source of events, or can quantum probabilities be aligned with a causal picture of the world of biology?

Physical theories at different scales use different variables and approximations. An effective theory captures robust features of many microscopic degrees of freedom without representing every micro-detail. Systems with enormous numbers of microstates, typical microevolutions produce the same macroscopic behaviour; probabilities represent this statistical aspect, not necessarily a metaphysical propensity beyond the dynamics. The behaviour of any subsystem depends on local interactions and the system’s past; the network’s history establishes the constraints that shape present dynamics.

Quantum probabilities should be interpreted as part of an effective descriptive apparatus for networks of local interactions rather than as evidence of a separate ontological randomness hovering above causation. The quantum formalism gives rules for predicting distributions of measurement outcomes given preparations and interactions. Those distributions reflect structural complexity (entanglement, decoherence, system–environment structure) and the real-time evolution of local interactions, not an extra-causal propensity (Rovelli, 1996).

Our inability to predict an individual outcome parallels unpredictability in classical complex systems (e.g., chaotic dynamics, contingent evolutionary events). In both cases, sensitivity to precise local conditions and historical microstates makes single-event prediction impossible in practice. That epistemic unpredictability does not commit us to a distinct metaphysical randomness; it can instead point to fine-grained micro-dependence and effective coarse-graining.

Treating quantum probabilities as features of an effective, scale-dependent description preserves a broadly causal ontology: the causal relata are local interactions and the evolving network of causation; probabilities express our systematic information about ensembles defined by those networks.

Quantum mechanics' probabilistic structure need not force us into a dualistic picture of causation vs. randomness. Instead, it invites us to study how causal processes at the microscale produce reliable macroscopic regularities captured by probability calculus. Unpredictability reflects sensitivity to detailed local conditions and history, rather than the presence of a fundamentally separate causal realm (Palmer, 2024). At the same time, statistical regularities and expectation values remain robust and informative because they reflect stable patterns produced by many interacting components.

In summary, differences between levels do not compel a metaphysical divide where lower-level relations and dynamics float independently. They reflect methodological and epistemic understanding of how detailed, interacting systems behave.

Thermodynamic descriptions are effective, scale-dependent summaries of how many local interactions evolve under particular boundary and initial conditions (Goldstein and Lebowitz, 2004). They do not posit an independent metaphysical tendency toward disorder acting on systems.

What we should identify as the real, persistent tendency in material networks is toward relative stability; components interact and rearrange until they occupy configurations that are dynamically robust given their local interactions, constraints, and history. Stability, not disorder, is the explanatory target. Structures that persist do so because of relationships among parts and the network's evolutionary history.

The increase of entropy in an isolated system is best understood as a statistical consequence of starting in a special, atypical low-entropy macrostate and then evolving under local microscopic dynamics toward more typical macrostates, the states that are more stable. Entropy increase, therefore, reflects (1) the system's initial conditions, (2) the combinatorial predominance of higher-volume macrostates in phase space, and (3) the particular coarse-graining and boundary conditions used to describe the system (Albert, 2001). It is not a separate causal force that pushes systems toward disorder.

Entropy is an immensely useful explanatory and predictive tool because it compresses complex microscopic dynamics into tractable macroscopic regularities (equilibrium states, fluxes, response coefficients). But this utility should not be conflated with ontological primacy. The entropy function captures our coarse-grained ignorance about microstate detail and the resulting statistical tendencies; it does not stand apart from the network of interactions whose aggregated behavior it summarizes.

Precise, real-time tracking of all local interactions in a large system is practically impossible. Yet even when individual outcomes are unpredictable, stable statistical regularities emerge because many micro-processes collectively favor certain macrostates. Thus, thermodynamic laws rightly describe emergent behavior without introducing a mysterious extra property of nature that strives for disorder.

Importantly, this account preserves continuity between physical and biological processes. Thermodynamic reasoning applies to such systems through an analysis of aggregate constraints and flows, rather than as a statement that biological order contradicts some overall tendency toward disorder. Both the living organization and its eventual relaxation toward typical macrostates are outcomes of the same local causal processes evaluated at different scales and initial conditions.

Thus, Life's distinctiveness from physics is a matter of function and structure. Biological organizations are configurations of matter whose local causal interactions produce homeostasis, replication, and adaptive responses.

Gravity and long-range interactions: The standard descriptions of gravity (forces, fields, and spacetime curvature) are powerful and effective in explaining how mass–energy distributions influence the motion of other bodies. Philosophically, these descriptions can be read instrumentally: they summarize how local causal influences propagate through the web at larger scales.

A fruitful alternative emphasized in contemporary debates is to treat gravity as emergent from more fundamental, local processes. On this view, what we call gravitational attraction or spacetime curvature is a pattern produced by networks of local interactions and constraints (Verlinde, 2010). What looks like long-range action is the accumulated effect of locally propagated changes across the evolving web. The effective field or curvature is a compact representation of that propagation and the network's memory.

This position avoids reifying fields or curvature into independent substances acting on matter. Instead, forces and geometric relations are explanatorily useful codifications of how local causal interactions combine to produce stable, spatially extended structures and dynamics. The metric properties of space (spacetime) can be read as summaries of relational properties among constituents and their interaction histories.

Components of the causal network evolve toward relatively stable local configurations. Gravitational attraction can be understood as part of the network's tendency to reorganize toward locally stable patterns of relation, not as a metaphysical pulling force or curvature separate from those relations.

Forces (e.g., electromagnetic repulsion among electrons, gravitational attraction among masses) are best understood as local relational effects produced by the causal web. The pattern of attraction or repulsion that one subsystem exerts on another depends on the internal structure of both subsystems relative to each other and on their embedding network. Thus, force is not a primitive, separable entity but a shorthand for how local interactions, histories, and constraints make some relations dynamically stable and others unstable.

How local propagation produces apparently large-scale flows and gravity: The relevant substrate consists of related microstates, related structure, or other locally interacting elements. These local elements transmit causal influence to their immediate neighbours and, in doing so, record information about past interactions. Over evolution, the pattern of these local transmissions and recorded relations builds a persistent, large-scale structure: the metric, or the geometry, is therefore a coarse-grained record of the substrate's dynamical history.

A putative gravitational influence must have local contact; changes propagate through the substrate to nearby constituents in real time. The tendency we observe as attraction is the outcome of the substrate and its embedded parts reorganising toward locally stable patterns, and the network is doing that day and night. Two masses move toward one another or even the opposite case, not because a separate gravitational substance pulls them, but because the network of local interactions seeks relative stability in its evolving web.

When a subsystem stops moving with respect to its immediate surroundings, this does not mean it ceases to change or that it occupies an absolute state of rest. Rather, it has attained a configuration of relative stability within a network of local relations. Stability here is a comparative property: a part is stable relative to its neighbours because the pattern of local interactions makes that configuration dynamically favoured. To speak of rest without specifying the relevant network is, therefore, misleading: there is no meaningful notion of absolute rest independent of the causal web that defines relational reference frames.

The web itself evolves. Crucially, the network of relations that confers stability is itself changing. What appears to be stationary behaviour at one level can coexist with continual evolution at other levels of the web. Thus, a subsystem can be stable relative to a local neighbourhood while the global network drifts, reconfigures, or accelerates; its apparent immobility is simply the persistence of a local relational pattern amid broader evolution. Motion and acceleration must therefore be understood as statements about how local stability relations change through evolution in the embedding network.

Forces, motion, and gravitation are best understood as manifestations of an evolving causal web rather than as independent agents imposed on systems from outside. Attraction and repulsion reflect how the network's micro-interactions make certain relative configurations more robust than others. What we call a force is a compact description of the local tendency of relations to reconfigure toward relative stability.

Space, not as a static background container but as the evolving pattern of relations among local networks. The fabric of space is a shorthand for the network's relational architecture and its recorded history: geometry encodes how constituents have interacted and continue to interact. Time, in this picture, tracks the web's ongoing evolution; it does not exist as a separate entity and cause in the network, but just as the manifestation of the space as the evolving web.

Matter is a stabilized pattern of the space itself, not as distinct entities from the space. What we call matter can be understood as locally stable, maintained patterns of the evolution and its history. Particles and their properties (mass, charge, spin, etc.) are structural features of these patterns, regularities of relational configuration and memory in the evolving network, rather than ontologically independent, primordial substances. Their persistence and dynamical behaviour derive from how they are embedded in, and evolved by, the causal web.

The persistent empirical fact that nothing propagates faster than light can be read as a constraint that reflects the character of the relational web. The speed limit is not best understood primarily as a statement about the energy cost of acceleration, but as a structural constraint on how influences propagate through the web. If constituents of the network and their relations evolved in such a way that transmission of causal influence is bounded, then the constancy of a maximal signal speed becomes a feature of the evolving web's architecture and a hint to what the web is made of, and the one-level causation is causation in what, exactly?

That limit is thereby informative about the evolving web's structure: The universal light-speed bound suggests that the substrate by which causal influence propagates has a relation to light itself; whatever light is, it must be, or be deeply tied to space, and to the level at which causation fundamentally operates.

Another hint that helps us consider space and the true nature of the evolving web, as well as its relation to light, is complexity. Evolution produces increasing organizational complexity in the web, but not as the goal, as the consequence of its causal nature (Ekstig, 2015). Simple elements of the substrate combine and stabilize into more complex structures under local relative flows and constraints. The building blocks that serve as effective carriers of causal influence can be the fastest, least structured modes in the network, but their aggregation and repeated interaction give rise to complexity, inertia, and mass.

In contemporary physics, the notion of an invariant speed, including the familiar constant c, the speed of light in vacuum, carries operational significance but no intrinsic physical meaning**.** The numerical value assigned to c is not a fundamental metaphysical constant; rather, it derives its meaning solely from the choice of specific units and spacetime coordinate systems**.** Thus, in practice, its value is an artifact of our conventions.

This conclusion follows from two points. First, absolute motion is operationally undefinable and undetectable; no experiment can determine motion relative to an absolute space, only the relative motion of entities can be understood in space. Second, time does not exist as an independent background parameter separate from the evolving geometry of space; temporal relations are tied to the dynamical and geometric structure in which events occur, not as distinct phenomena.

Thus, only the relative motion of entities can be understood, and time does not exist on its own to define invariant speed. If light has the same speed in all inertial frames, it does not mean that c is the speed of causality, light, or the causal web. Rather, it shows that the structure of causality is the same in all frames and is affected locally; in short, the universe has a universal structure of causality.

These considerations suggest a useful reframing of the concept of relativity in physics; relativity is most fruitfully understood as a relativity of local causalities rather than primarily as a statement about laws of physics in inertial frames. It is fundamentally a statement about how events are causally connected in the causal web and how causality is propagated, and motion as a consequence of these relativized local causations. Relativity, in this sense, is the nature of local causality.

In Galilean relativity, the emphasis is that motion is relative (uniform motion is relative), there is no privileged frame, and no way to understand absolute evolution in the web. Motion as a manifestation of causes is relative to one another and can be understood relationally rather than absolutely.

Later, the concept of relativity was restated as the requirement that the laws of physics have the same form in all inertial reference frames, frames in which an object moves in a straight line at constant speed (or remains at rest) if no net force acts on it (Poincaré, 1905). In this restatement, the relativity of causality and motion became linked to frames with constant relative speed.

Einstein adopted this notion of the principle of relativity and added his second postulate, which identifies a universal invariant speed in all inertial frames. The shift introduced by special relativity is often presented as the replacement of Galilean velocity addition by an invariant speed and associated kinematic effects (time dilation, length contraction) (Einstein, 1905).

However, these mathematical results can be seen as corollaries of a deeper requirement: that the causal web be preserved for all observers and that the definitions of space and time be consistent with that causal structure. The flow of causality in the web constrains which events can influence which others locally, and the order of the local effect, and first requires the same causal web connectivity.

Observers perceive local causal effects (what reaches their region and acts locally on them) that result from causal propagation across the web; these perceived effects are not necessarily the original causes at the distant source, but rather updated, propagated relative effects within the web.

Length contraction and time dilation are locally perspectival consequences of causal propagation through a connected network and relative local registration processes and effects. Not as intrinsic, primitive changes to objects or time, or cause. But the propagation of the impact in the web and its relativistic local influences.

What different observers call a rod's length or a clock's rate are therefore locally instantiated facts about how those propagated influences arrive and are registered, not necessarily ontological changes in distant objects. In short, SR's effects are real as local, observer-dependent causal effects, but they are perspectival; they reflect the relation between propagation in the web and local registration rather than asserting a metaphysical shrinking of rods or slowing of clocks independent of local effect.

The deepest meaning of SR is not the relativity of clocks or rulers, but the relativity of local causality within a coherent causal web. Light functions as a causal structure, so its speed cannot be added to the speed of other objects in the Newtonian way.

The principle of relativity is best understood as a relativity of local causality. This single statement recovers the conclusions of Galilean relativity while explaining the consequences of Special relativity. The laws of physics in each frame and network are just descriptions of local causations, relations, and the sum of all local causal processes as the motion and flow, rather than explanations that posit absolute laws and inertial standards independently of causal relations. Relativity is not about frames; It is about how causality flows locally in a connected universe.

The common reasoning about the inertial frames caused us to think that the mass must be related to and a causal reason for gravity, not the gravity itself as the manifestation of causality and motion, and led us to think that there is no gravity in SR and flat space. General relativity closed the inertial-frame gap by equating acceleration with gravity via the equivalence principle, yet gravity, as the local causality of the structure itself, remained unknown (Bengtsson, 2012).

Consequently, the prohibition against exceeding the speed of light does not originate simply from a requirement of infinite energy. Rather, from the fact that massive particles and their interactions are already constrained and have emerged from light-mediated causal propagation. Their apparent motion is not an approach to c but a manifestation of their origin within the causal fabric woven by light itself.

In this deeper sense, all entities, matter, forces, and gravity, are not separate agencies acting across scales but unified expressions of a singular evolutionary causal web. From the quantum vacuum to biological systems to the large-scale structure of the cosmos, what we perceive as diversity in form and function is merely the self-differentiation of one coherent causal process, the same principle that Darwin captured as natural selection in biology and that Einstein sought in the architecture of the cosmos.

Scale is irrelevant; the evolving network or space is the reality and is absolute, not in the sense that the relational local causalities don't change, but the essence of the web is causation, and causality itself is absolute. Thus, the speed of light is not a barrier to be overcome but the very medium of becoming, the structure within which all physical entities unfold, even us and our consciousness as the manifestation of this unfolding.

Explaining consciousness is not the goal of this article. For a discussion of consciousness from the perspective of evolutionary causal flow, see “Universal Flux Theory, consciousness as a net stream of our evolution” (Yousefzadeh, 2025).

Superdetermination

The quantum world is widely regarded as intrinsically indeterministic, a view rooted in the apparent randomness of measurement outcomes and the probabilistic nature of the wave function. This perception originates from the Copenhagen interpretation, which posits that the act of measurement collapses the wave function into one of many possible states, with no underlying mechanism determining which outcome occurs.

Experimental confirmation of this indeterminism seemed to come from the violation of Bell’s inequalities, which were interpreted as proof that no local hidden variables can account for the correlations, thereby necessitating either nonlocality, action at a distance, or the abandonment of realism altogether.

Bell’s theorem assumes three key conditions: locality, realism, and statistical independence (the experimenter’s choice of measurement setting is independent of the hidden variables governing the system). The inequality derives a maximum correlation $S \leq 2$ under these constraints. When experiments consistently yield $S > 2$, the conclusion is that at least one assumption must be flawed (Bell, 1964). The prevailing interpretation discards locality, embracing nonlocal influences, as in Bohmian mechanics, or rejects realism via the many-worlds interpretation. However, the third assumption, statistical independence, has received far less scrutiny, despite being the most physically fragile.

Independence statistical requirements dictate that the choice of measurement means that what is happening on the biological scale and within the cells in the scientist's mind to choose a measurement setting is uncorrelated with the hidden state of the entangled pair. In a universe governed by a single, dynamical causal network, the scientist's mind is also the same web. Still, with different boundaries in space at the scale of the atom, molecule, and cell, each communicates within its own network, locally.

The assumption of statistical independence is impossible. Every neuron firing in a scientist's brain, every photonic state in the polarizer, and every fluctuation in the entangled photons are part of the same evolving web. Their configurations at the moment of measurement are not independent; they are joint outcomes of prior evolution under the same local causation. There is no external choice or selection on the web, only the system choosing itself, exactly like how natural selection manifests in biology, as just the effect.

Super determinism is rejected for philosophical and methodological discomfort. It eliminates the libertarian free will of the experimenter, reducing human choice to a physical process indistinguishable from a photon’s polarization. This offends the intuitive separation between observer and observed, a cornerstone of the scientific self-image since Galileo. Moreover, it renders the theory untestable in the traditional sense; any outcome can be attributed to the hidden correlations, offering no falsifiable prediction beyond consistency with quantum worlds (Hossenfelder and Palmer, 2020).

Yet this is not a defect; it is a feature. Super determinism restores locality, determinism, and realism without invoking collapse, many worlds, or hidden influences. It demands only that we abandon the anthropocentric fiction that the experimenter stands outside the universe.

Critics of super determinism assert, in the words of John Bell himself, that it “smells of a conspiracy”, that it is “untestable and thus unscientific”. Critics argue that for Alice’s angle choice and the photon pair’s state to be correlated, the universe must have been fine-tuned from the Big Bang to ensure every future experiment yields $S > 2$. This is labeled a conspiracy because it appears to anticipate human actions and requires a finely tuned initial state at the universe’s origin.

There is no conspiracy, only causality. In a unified web evolving under one local rule, correlation is not anticipation; it is inevitability. A unified, self-updating causal network governed by local causality and relativity requires no privileged initial condition; it may begin in any configuration. Each cell (the boundary, scale is not important) interacts only with its immediate neighbors, adjusting its state to achieve local relative stability. Through this iterative, deterministic update, the grid generates its own stable patterns, vortices, clusters, and memory-like structures entirely from the propagation of local influences.

The correlation emerges continuously from local updates. The grid does not know the future; it is the future. Memory in this framework is not a frozen record of a primordial state but an emergent transient resistance to change, a configuration that already satisfies the stability criterion with its surroundings, persisting across updates, but that persistence is local and transient, not global.

The concept of time does not exist in the web; every moment (state of the evolution) overwrites the previous, yet coherent structures endure because they are self-reinforcing under the same universal rule. Every initial condition, if assumed true, whatever it was, has long been overwritten by the web.

When an experimenter imposes a measurement setting, she does not act from outside the web but restructures a local region of the grid, an evolving pattern within it. The experimenter is woven into the fabric of the evolving space. There is no cosmic conspiracy but the natural outcome of a shared evolutionary web under one rule. Correlations persist across vast scales because the grid never ceases its self-consistent evolution.

The accusation of untestability misapplies science; science explains causality, not testability and prediction for its own sake. An untestable but logically consistent statement about nature is not weaker than a testable but logically incoherent one.

Super determinism, in this form, is not a retreat from science but its completion: a theory that explains not only what we observe, but why the observation itself is part of the same evolutionary web. The universe is a living, self-consistent, deterministic whole, and everything that emerges in it is just an effect of causes, not absolute wrong and right, but the transient relative existence of causes.

The universe can be viewed as a single network of relative causes in which every selection in it is itself a natural effect. In this picture, no experiment can produce a contradiction with the underlying dynamics, because every experimental outcome is the web itself unfolding.

In this sense, existence is light making memory for itself.

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