Cracks in the Projection: Black Holes, Reality, and the Hidden Order of Time

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Abstract

Contemporary theoretical physics suggests that spacetime and gravity might emerge from deeper informational structures, hinting that our universe could be *holographically* organized. In this speculative essay, we explore the idea that reality itself has a fundamentally holographic character, using black hole physics and quantum information as guiding clues. Black hole thermodynamics reveals a mysterious link between information and the geometry of space, inspiring the holographic principle that a region's content may be encoded on its boundary. We survey how this principle—and the notion of an informational universe—intersects with philosophical interpretations of time: from the eternalist **block universe** view of an unchanging 4D spacetime, to **informational realism** which posits information as the substrate of existence. Against this backdrop, we introduce **Existential Realism** (*ER*), a two-tier ontology distinguishing transient existence from enduring reality. We argue that ER's framework provides a novel lens for these questions. In ER, the present "now" is like a projection of an underlying informational reality; black holes then appear as ontological *cracks* where that projection falters, raising profound questions about time, causality, and hidden order. We show how ER's emphasis on an evolving present and an informationally rich

reality can reframe puzzles such as the black hole information paradox and the nature of temporal entropy. **This work is intended as a frontier-level exploration**: it sketches a consonance between cutting-edge cosmology and a new metaphysical model of time, suggesting that what we call "reality" might indeed be a projection from a deeper order of information and existence.

Note on Speculative Approach

The following paper is a speculative, early-stage exploration at the intersection of cosmology and metaphysics. The hypotheses and interpretations offered here reach beyond established theory, aiming to synthesize insights from frontier physics with a novel ontological framework. As such, our proposals are conjectural and intended to stimulate discussion. We explicitly acknowledge that many ideas herein—concerning holographic reality, black holes as "cracks" in existence, and the Existential Realism framework—are tentative and conceptual. The goal is to chart a plausible, philosophically informed perspective on unresolved problems, rather than to claim any definitive theory. We proceed in an academic tone, but readers should keep in mind the provisional status of the arguments. By treating bold assumptions as working premises, we hope to illuminate new questions and potential connections. This is a **theoretical preprint** meant to inspire further investigation at the cosmology–metaphysics frontier.

Meta-Note on Scope

While most applications of Existential Realism focus on time — distinguishing what exists now from what is real beyond the present — this paper extends the framework to a domain that is **not explicitly time-bound**. Black hole horizons demonstrate that the split between reality and existence can also arise from *spatial or causal inaccessibility*: something may remain real without being present-existent for any observer, regardless of when it occurs. This shows that ER's two-tier ontology is not limited to temporal becoming, but offers a general structure for understanding cases where reality and existence diverge.

The Holographic Universe: Black Holes and Informational Boundaries

The holographic principle suggests that everything falling into a black hole is not truly lost, but rather encoded as information on the event horizon. Within the framework of Existential Realism, this aligns strikingly with the distinction between existence and reality. What was once existent — present and empirical — crosses a threshold where it can no longer be observed or interacted with. Yet its **reality remains**, not as a ghost of presence, but as structured information shaping the boundary conditions of the system. Reality persists even as existence vanishes. ER thus interprets the horizon not as a line of ontological erasure, but of **migration**: the existent collapses, while the real survives in a different form — informational, causally latent, and still part of the world's structure. This echoes the broader holographic idea: that **the depth of space may ultimately be encoded at its edge**.

Modern physics has uncovered striking links between **black holes** – regions of extreme gravity – and the deep structure of information in our universe. In the 1970s, Jacob Bekenstein famously conjectured that a black hole carries an **entropy** (a measure of information or disorder) proportional not to its volume, but to the **area** of its event horizon – the spherical boundary beyond which nothing escapes. This idea, soon supported by Stephen Hawking's discovery that black holes radiate like warm objects, revolutionized our understanding of gravity.[1] The Bekenstein–Hawking formula showed that a black hole's entropy S_{BH} is given by $S_{BH} = k_B \frac{A}{4 \ell_P^2}$ (with A the horizon area), implying that the *information content* of a black hole scales with its surface area, not its volume.[2] This was a profound clue: it suggested that all the degrees of freedom (bits of information) contained inside a region of space might be encoded on the region's boundary. In other words, our three-dimensional reality could be akin to a *holographic projection* of information defined on a distant two-dimensional surface. Gerard 't Hooft and Leonard Susskind formalized this insight in the **holographic principle**, proposing that any physically allowed region can be described by information on its boundary, with at most one binary degree of freedom per Planck-scale area unit.[3] In Susskind's words, the world could be "a hologram" – our experienced volume is a projection of more fundamental data inscribed on a distant surface.[4]

This holographic conjecture remained speculative until a concrete realization emerged in theoretical physics: the **AdS/CFT correspondence** (also known as gauge/gravity duality). First proposed by Juan Maldacena in 1997, AdS/CFT is a duality between two

[1] Bekenstein, J. D. (1973). "Black holes and entropy." Physical Review D, 7(8), 2333–2346. doi:10.1103/PhysRevD.7.2333
[2] Hawking, S. W. (1975). "Particle creation by black holes." Communications in Mathematical Physics, 43, 199–220. doi:10.1007/BF02345020
[3] 't Hooft, Gerard (1993). "Dimensional Reduction in Quantum Gravity." Unpublished preprint.; Leonard Susskind (1995). "The World as a Hologram." Journal of Mathematical Physics 36: 6377.
[4] Susskind, L. (1995). "The world as a hologram." Journal of Mathematical Physics, 36(11), 6377–6396. doi:10.1063/1.531249

radically different types of theories.[5] On one side stands a higher-dimensional spacetime with gravity (specifically an Anti-de Sitter universe containing black holes), and on the other side, a lower-dimensional quantum field theory without gravity defined on that spacetime's boundary.[6] Maldacena's discovery showed that every entity and process occurring in the "bulk" 5-dimensional AdS space can be equivalently described by information on the 4-dimensional boundary (a conformal field theory) – and vice versa. This is widely seen as the **most successful realization of the holographic principle** to date. It provides striking evidence that spacetime geometry and gravitational physics *emerge* from underlying informational degrees of freedom: the boundary theory encodes the bulk spacetime, much like a hologram's thin film encodes a three-dimensional image. In such models, a black hole in the AdS bulk corresponds to a high-temperature state in the boundary field theory, and the growth of the black hole's horizon area (its entropy) reflects the increase of information/entropy in the dual field system. AdS/CFT has not only exemplified holography in a precise way, but has reinforced the notion that the fabric of reality might be *iterally composed of informational relations*. Indeed, some researchers speculate that the spacetime we inhabit is an emergent phenomenon born from more fundamental entanglement or information networks – a view captured by John A. Wheeler's famous slogan **"it from bit,"** meaning that every physical "it" (object or event) ultimately derives from bits of information.[7]

One immediate implication of the holographic paradigm is a novel perspective on **what is "real"** in physics. If the content of a volume of space can be fully described by information on a surface, then the **boundary** (or an abstract space of information states) might be more foundational than the tangible volumetric world we experience. This inversion challenges our intuitions: it is as if the universe we live in were the *projection* of an unseen film of information. Black holes epitomize this puzzle. According to conventional relativity, anything that falls into a black hole is lost forever to the outside world – it passes through the horizon and, classically, cannot return. Yet quantum theory insists that information cannot be destroyed without trace. This tension is the essence of the **black hole information paradox**.[8] A black hole that completely evaporates (via Hawking radiation) seems to eliminate distinctions between different things that fell in, leading to a loss of information about the initial state. The holographic principle offers a potential resolution: all the information of the infalling objects is somehow *encoded on the horizon surface* (often visualized as encoded in microscopic "bits" on the horizon area). As the black hole radiates and shrinks, the information is gradually released in subtle correlations within the Hawking radiation, maintaining

[5] Maldacena, J. (1999). "The large-N limit of superconformal field theories and supergravity." International Journal of Theoretical Physics, 38, 1113–1133. doi:10.1023/A:1026654312961
[6] Peskin, M. E., & Schroeder, D. V. (1995). An Introduction to Quantum Field Theory. Addison–Wesley.
[7] Wheeler, John A. (1990). "Information, Physics, Quantum: The Search for Links." In Complexity, Entropy and the Physics of Information, ed. W. Zurek. Addison-Wesley.
[8] Preskill, J. (1992). "Do black holes destroy information?" arXiv:hep-th/9209058.

overall conservation. In this picture, the event horizon behaves like a **cosmic information membrane** – a dynamic screen that stores and processes the data of whatever has fallen in. The true state of a black hole may be described by this halo of information at its boundary, rather than by unseen conditions deep in its interior. While a full solution to the paradox remains under debate, most physicists believe that *unitarity* (information conservation in quantum mechanics) is upheld: a black hole does not irretrievably erase information, but hides it in highly scrambled form. Notably, Raphael Bousso's covariant holographic bound and related formalisms have generalized these ideas, suggesting that any region's information content (entropy) is limited by the area of an encompassing surface.[9] Thus, black holes have become central to a new way of thinking about reality's architecture: the fundamental *bits of reality* might reside on shifting boundaries and screens.

In summary, black hole physics motivates a radical hypothesis: **perhaps "reality" itself is holographically structured**. Our familiar 3D world could be an emergent projection from a deeper 2D (or otherwise lower-dimensional) order – an order where information and quantum entanglement knit the cosmos together. This raises philosophical questions that go beyond physics: If the universe is a kind of projection, what does that imply about *time*, *existence*, and what is ultimately "real"? To approach these questions, we next consider several interpretative frameworks—from the metaphysics of time to information-centric ontology—that offer different answers about the nature of reality and its relation to what we observe.

Interpreting the Cosmos: Block Time, Eternalism, and Informational Realism

The notion of a holographic reality forces us to re-examine our assumptions about time and existence. Traditionally, philosophers of time have been divided between **presentist** views (only the present exists in an absolute sense) and **eternalist** views (past, present, and future are equally real within a static spacetime block). The idea of the world as a pre-written hologram might seem to favor an eternalist or "block universe" picture, whereas the experience of a flowing projection might resonate with presentist intuitions. Here we survey three relevant perspectives – the block universe (eternalism), its opposite and complement in theories of time, and informational realism – to set the stage for Existential Realism.

[9] Bousso, Raphael (2002). "The Holographic Principle." Reviews of Modern Physics 74(3): 825–874

Block Universe / Eternalism: In physics and philosophy, **eternalism** is the view that all points in time are just as real as all points in space; temporal reality is a four-dimensional *block* containing past, present, and future events all at once.[10] There is no objective "now" that slices the universe; the flow of time or the coming-into-being of events is often regarded as an illusion under this view. Many thinkers have argued that Einstein's theory of relativity strongly supports a block universe: since simultaneity is relative and different observers can disagree on what events are "now," one is hard-pressed to single out a unique present.[11] Hilary Putnam's influential argument in 1967 concluded that, given relativity, "any future event *X* is already real" – making eternalism the only tenable ontology of time in a relativistic cosmos.[12] In a block universe, the entire history of the universe can be thought of as a static 4D structure – often analogized to a film reel or a book, where every frame or page exists simultaneously, even though we read them in sequence. This view has a certain resonance with the **holographic principle**: if all of spacetime (with all events past and future) is encompassed in a timeless 4D block, one might imagine that the information describing that block could be "projected" or coded on a boundary. Indeed, some have speculated that the *boundary of the universe in time* (for instance, a cosmological horizon) might encode the entire 4D history inside. In such a fully deterministic block view, puzzles like the black hole information paradox might be seen in a different light: if the universe's history is fixed, information is never truly lost – it is simply located in different regions of the block (for example, inside the black hole during some interval, and in the radiation at a later interval). In fact, physicist Hrvoje Nikolić has argued that treating time as just another dimension (on par with space) can *resolve* the paradox: from a "God's-eye" perspective in the block, no information is missing; it's only an apparent paradox from a within-time perspective.[13] Eternalism's strength is its logical completeness – nothing ever "disappears" or "becomes" since everything simply *is* – but this is also its primary philosophical weakness. It struggles to account for why we experience a flowing present or how to make sense of causation and change. Critics like Lucas and Popper have called the block universe *ontologically inadequate* for precisely these reasons, arguing that it cannot capture the reality of the **passage of time** or the openness of an uncertain future.[14] The block universe, while compatible with relativity and possibly with a fully pre-coded "holographic" reality, leaves something out: the *becoming* of events that is so fundamental to our world.

Presentism and Becoming (a counterpoint): At the opposite pole from eternalism is **presentism**, the doctrine that only present entities and events truly exist.[15] Past things

[10] Putnam, H. (1967). "Time and physical geometry." The Journal of Philosophy, 64(8), 240–247. doi:10.2307/2024493
[11] Einstein, A. (1905). "On the electrodynamics of moving bodies." Annalen der Physik, 17, 891–921. doi:10.1002/andp.19053221004
[12] Putnam, Hilary (1967). "Time and Physical Geometry." Journal of Philosophy 64(8): 240–247.
[13] Nikolić, Hrvoje (2009). "Resolving the black-hole information paradox by treating time on an equal footing with space." Physics Letters B 678: 218–221.
[14] Lucas, John (1989). "The Future." Basil Blackwell.; Karl R. Popper & Albert Einstein (1972
[15] Markosian, N. (2004). "A defense of presentism." Oxford Studies in Metaphysics, 1, 47–82.

have *been* and future things will *be*, but only the now is real. Presentism accords strongly with our intuitive sense of time's flow but faces notorious difficulties, especially in light of modern physics. Since presentists deny reality to the past and future, they must explain how true statements about past events (like "dinosaurs existed") are grounded, or how to reconcile an absolute present with relativity's relativity-of-simultaneity. We mention presentism here because our later framework (Existential Realism) can be viewed as an evolution of presentist ideas – one that tries to capture the *becoming* aspect while avoiding presentism's pitfalls. In a naive presentist cosmos, a black hole's interior after an object falls in might be problematic: if one says "only the present exists," what of the object that has passed inside the horizon? Is it now non-existent? If so, how does its mass still exert gravity? Such questions illustrate the tension between presentism and physics. Furthermore, a strict presentist might dismiss the holographic principle's grand claim ("the information of the whole spacetime could sit on a boundary") on grounds that the future and distant past are not real to host that information. In practice, few philosophers cling to an unqualified presentism given these issues, and variants like the **growing block theory** (where past and present exist, but not the future) have been proposed to allow reality to "accumulate" over time. The growing block idea reintroduces a kind of holographic **accumulation** of reality: as time passes, more pages are **migrated** into the record of the cosmos. This is closer in spirit to the framework we will develop, except we will separate the notion of "existence" (what is present) from "reality" (the wider ontology that grows). Before developing that, however, we should consider a third perspective that connects more directly with the holographic and informational themes.

Informational Realism: If the holographic principle suggests that *information* underlies physical reality, one might take this idea to its logical conclusion: **reality = information**. This is the stance of *informational realism*, a philosophical view in which information, rather than matter or energy, is the fundamental stuff of the world. In one formulation, informational realism asserts that what it means for something to be real is that it has causal and communicative efficacy in the network of information exchange.[16] William Dembski, for example, describes informational realism as the thesis that "the ability to exchange information is the defining feature of reality, of what it means, at the most fundamental level, for any entity to be real." [17] In this relational ontology, *to exist is to inform*. Every "thing" is not a static substance but a node in a web of signals; entities are determined by the information they embody and convey. This perspective aligns neatly with the direction physics has taken: quantum mechanics already teaches us that what we can know (information) plays a role in defining what *is* (reality), and quantum entanglement ties objects together via information-like correlations. Pioneers of digital physics like John Wheeler (mentioned above) and Edwin Fredkin speculated that the

[16] Floridi, L. (2011). The Philosophy of Information. Oxford University Press.
[17] Wheeler, J. A. (1990). "Information, physics, quantum: The search for links." In W. H. Zurek (Ed.), Complexity, Entropy and the Physics of Information (pp. 3–28). Addison–Wesley.

universe might literally be a giant computer or cellular automaton processing bits. More formally, Luciano Floridi's *Informational Structural Realism* has argued that the world's ontology is comprised of informational relations or "structured information," of which matter and energy are emergent abstractions.[18] From this standpoint, the holographic principle is not so surprising: if everything is information, of course it can be encoded on surfaces or transmitted through fields – physical locality and geometry are secondary. **Informational realism** would thus interpret a black hole as fundamentally an information processor or repository. The disappearance of an object into a black hole is not the loss of a material body, but the transformation of that body's information into a new form (quantum degrees on the horizon, perhaps). Likewise, the expansion of the universe or the passage of time could be seen as the unfolding of a cosmic computation. One attractive feature of informational realism is its ability to bridge physics and metaphysics: it provides a common language for discussing brains and bits, matter and data. However, a pure information ontology can seem abstract to the point of emptiness – one must be careful to explain why certain information is experienced as concrete physical reality by us. Nonetheless, as we push toward a holographic vision, informational realism serves as an inspiration. It urges us to treat "the real" not as a collection of static things but as *the sum-total of information and its transformations*. This will harmonize with our forthcoming Existential Realism framework, which likewise emphasizes an informational substrate (reality) and dynamic updates (existence).

Having set the stage with these interpretations, we see a spectrum of possibilities. The **eternalist block** stresses a fixed cosmic information content (perhaps pre-recorded on some boundary or readily available to a 4D omniscient view), but it sacrifices a sense of flow. **Presentist/growing-block views** capture the immediate reality of the present and the coming into being of new events, but risk disconnecting from the physical insights of relativity and holography. **Informational realism** aligns with the holographic ethos, recasting ontology in informational terms, yet by itself it does not explain the *why* of time's directedness or the difference between past and future. We now turn to **Existential Realism**, a framework that attempts to integrate the strengths of these views. ER distinguishes between *existence* (what is concretely present) and *reality* (what is ontologically real, including past causes and future potentials), offering a two-tiered model that can accommodate a holographic information picture *and* a genuine temporal flow. We will argue that ER provides a fruitful way to think about the "projection" of reality, the special status of the present, and phenomena like black holes that challenge naive ontologies.

[18] Floridi, Luciano (2011). The Philosophy of Information. Oxford University Press.

Existential Realism: Existence, Reality, and the Projection of the Present

Existential Realism (ER) is a recently proposed ontological framework aimed at resolving the tension between presentism and eternalism by *separating the concepts of existence and reality*.[19] In ER's two-tier ontology, **existence** is defined narrowly: something *exists* if and only if it is present and empirically accessible (in principle) at the current time. **Reality**, by contrast, is a broader category: it includes anything that is part of the world's total causal or informational structure, even if not present or observable now. In short, *all existents are real, but not all real things are currently existent*. This simple distinction allows ER to say, without contradiction: *"Only the present exists, but much more than the present is real."* Past events and entities, for example, are not existing now, yet they are real in ER because they have left causal traces and structured the world we inhabit. Likewise, future events (insofar as they are reliably predictable or already entailed by current conditions) can be said to have a sort of reality – they are part of the world's unfolding structure – even though they do not yet exist. By decoupling reality from instantaneous existence, ER manages to *"keep the ontological economy of presentism and the explanatory breadth of eternalism."*[20] We do not populate the universe with an infinite array of ghostly objects for every time (as a naive eternalist might), but we also do not dismiss anything outside the present as unreal (as a strict presentist would). Reality becomes an ever-growing, information-rich web, while existence is a flickering spotlight on the latest page being written.

Existence as the Projected "Now"

This ontology naturally lends itself to a **projection metaphor**. We can think of *Reality* (capital R) as akin to the **encoded informational substrate** – analogous to a film reel or a holographic plate containing a full record or interference pattern – and *Existence* (the present moment) as the **projected image** that appears on the screen *now*. At any given instant, only one frame of the film is illuminated (the present existent world), yet the film as a whole (past frames, and even future frames insofar as the story's structure is laid out or being written) represents the broader reality. The metaphor is not perfect, but it provides intuition. In a classic hologram, a 2D plate with encoded information can project a 3D image when light shines on it; similarly, we might imagine the high-dimensional informational structure of reality "projects" the lived 3D world we

[19] Trepp, T. C. (2025). "Existential Realism: A Distinct Ontological Framework Beyond Presentism." (Preprint). – Introduces the ER framework and its core distinction between existence and reality, aiming to reconcile presentism's appeal with eternalism's inclusiveness. https://philpapers.org/archive/TENERM.pdf

[20] Trepp, T. C. (2025). "Existence ≠ Reality: What Exists, What's Real, and Why It Matters." (Preprint). – Expands on ER, illustrating how it preserves presentism's "ontological economy" (only present exists) while capturing eternalism's continuity (past/future are real), and discusses implications like truthmakers for past events.

experience moment-to-moment. ER suggests that what exists for us right now is just the currently projected cross-section of the total information structure. This resonates strongly with the **holographic universe hypothesis** discussed earlier. If indeed the universe's state is fundamentally recorded on some boundary or in some informational matrix, then what we call the "present universe" could be a kind of **momentary view or transition point** within that recording. ER provides a way to articulate this: The present is ontologically special (it's where existence is), but it is not ontologically exhaustive (reality contains more than what is visible now). Importantly, ER doesn't claim the future is fully predetermined or etched in the film from the start – rather, it holds that the **future consists of real possibilities** which become definite as the present advances. In the projection analogy, one might say the film is still being made or edited as we go — a progressive migration from possibility into actuality — not pre-shot in its entirety. The key point is that ER can embrace a **dynamical projection**: reality is an underlying repository of information (including records of the past and structured tendencies toward the future), and existence is the emergent "frame" that is currently actualized.

Under this view, **time** is no longer an illusion as in the strict block universe, but neither is it an absolute metaphysical gulf that deletes what came before. Instead, time is the process of *becoming real* – the continual **encoding of new events into reality** and the **revelation of reality in the form of new existents**. We can say that *reality accumulates while existence continually updates*. This neatly parallels how a hologram might be constructed: piece by piece, information is added (or revealed) which alters the resulting image. It also mirrors how a computation unfolds in time: each tick of a clock irreversibly records new bits (the past grows) and yields a new state (the present moment) based on previous states. The "hidden order of time" in this picture is the idea that there is a deeper continuity and conservation running through the succession of moments. Even as we experience only the present, the structure of reality retains and integrates the past and charts possibilities for the future. Thus, ER offers a way to conceptualize the **flow of time** without giving up a robust underlying structure: the flow is the *projection mechanism* moving from one encoded state to the next.

Black Holes as Ontological "Cracks"

If reality is like a recorded film or a holographic slate and the present is its projection, then what is a **black hole** in this analogy? We propose that black holes can be thought of as places where the projection mechanism encounters a pathological limit – *ontological "cracks"* where the usual correspondence between reality and existence breaks down. In more concrete terms, a black hole's event horizon marks a boundary beyond which events are cut off from the view of any external observer. Information that falls into a black hole, in classical general relativity, cannot influence an outside

observer's experience anymore; it is as if those bits of reality have vanished from existence (from the observable world) despite still "being there" in some inaccessible form. This is precisely the kind of situation ER is built to address, and it casts the black hole in a new light metaphorically.

Consider that in ER, to **exist** means to be accessible in the present. Once a astronaut, say, passes the horizon from our perspective, her subsequent fate is no longer something that can have any effect on *our* present or future observations (barring speculative outcomes like wormholes or future evaporation). In ER terms, after crossing the horizon, that astronaut is no longer an existent in our world – she has effectively stepped out of existence (for us). Yet, we do not want to say she became nothing or unreal. She still has a reality, but it is now *hidden behind the horizon*. The information that makes up her physical being is presumably still in the world (perhaps stretched across the horizon or inside the black hole's quantum state). Thus, a black hole creates a crack between reality and existence: something can be real (it has not magically ceased to be part of the cosmos) but is no longer existent for any observers outside. The **projection of reality into existence falters** at the horizon – what lies beyond cannot be projected out. In our metaphor, it is as if part of the film has been sealed off in a vault, or a portion of the holographic plate has become unreadable to the projector. We see only a dark void (the "silhouette" of the black hole) where that information would be projected.

This viewpoint helps articulate why black holes are so puzzling: they challenge the assumption that reality and existence always coincide for all observers. Normally, if something is real, we expect that under the right circumstances it could be observed or could affect experience. Black holes force us to accept that vast realms of what we take to be real might be forever insulated from exerting any influence on us. In ER's language, black holes harbor *real entities that lack existence-for-us*. They are extreme examples of **ontological ambiguity** – are the infallen things "still there" or not? ER answers: they are there in reality (their mass-energy, their causal contributions are accounted for in the gravity of the hole), but they do not exist in any present that we can access. This is not just philosophical hair-splitting; it has practical implications for physics. The black hole information paradox essentially asks: does the information really disappear or not? ER would frame this as: does the information remain part of reality (even when it's not part of anyone's present existence), or is it truly annihilated, meaning it was never encoded into reality to persist? ER inclines toward preserving reality – i.e. the information must remain real in some form, even if temporarily removed from existents' reach. Indeed, from the standpoint of many physicists, the resolution of the paradox lies in subtle correlations that ensure the information is *there* (in reality) even when it looks lost (from the perspective of existence). For example, in **black hole complementarity** or related hypotheses, infalling information is neither duplicated nor destroyed: it exists *on the horizon* (from an outside description) even as it passes through (from an infaller's

description). There is a kind of dual description where the information is both reflected at the horizon and absorbed – such that no observer sees a violation of physical laws, but overall the information is not destroyed. This strange situation is reminiscent of ER's two-tier view. We can imagine that what fails to exist in one frame of reference (falling inside from outside) might still be accounted for as real in another manner (imprinted on the horizon in a highly redshifted form). The horizon itself, coated with degrees of freedom proportional to its area, becomes a *tangible realization of reality apart from direct existence*. An external observer never sees the infalling astronaut cross the horizon; instead, her image asymptotically freezes and fades (encoded on the horizon). In a sense, the astronaut's fate *from the outside perspective* is to become part of the information cloud on the black hole's boundary – part of reality, but not an active existent anymore.

By viewing black holes as cracks in the projection, we highlight an important lesson: **our usual equations between what is real, what exists, and what can be observed may break down in extreme regimes**. ER predicts such breakdowns are precisely where new physics or new understanding is needed. The hidden order of time might include conditions like horizons where reality's order is preserved in ways that existence can't penetrate. Later, when Hawking radiation slowly releases energy, one might say existence is "picking up the threads" of reality that were hidden, as the black hole gradually evaporates and reveals (in principle) the information it held. Whether Hawking radiation indeed carries out all the hidden information is an open question, but if it does, then what was a crack may be healed over long times: the projection eventually re-displays what was temporarily lost, albeit in a highly scrambled form. If not—if information is truly lost into a singularity—then ER would face a deep puzzle, since that would mean something real (the information) ceased to be real without any trace, defying conservation. Most believe that quantum gravity won't allow that; something like ER's intuition, that reality *accumulates* and does not delete, should hold.

Becoming and the Unfolding of Information

A cornerstone of Existential Realism is the notion of **becoming**: reality is not a static collection of facts but an ongoing process of events "coming into existence." ER asserts an objective difference between past, present, and future. The **present** is the frontier where new existents appear; the **past** consists of events that *were present* and have left reality richer (with records, memories, causal impacts); the **future** consists of events that *may become present* (real possibilities structured by current reality). This dynamic picture contrasts with the eternalist block (where all events simply are), and also with many-worlds interpretations (where all possible events exist in parallel trajectories, so nothing truly new ever happens – it has happened in some trajectory already). In ER,

when an event happens now, that is a genuine *addition* to the ontology of the world – something that was not real before becomes real (and existent, momentarily). This accounts for the intuition of *time's flow* or *the advance of the now* in a rigorous way.

How does this process look when we incorporate the holographic, informational perspective? It looks like an **unfolding of information**. With each moment, new information is instantiated in reality – new bits that weren't there prior (or new specific values chosen from prior possibilities). The "hidden order" here refers to the principle that while entropy (disorder) tends to increase in the second-law sense, the total information content of reality does not vanish; instead it continually grows or at least transforms in lawful ways. ER can be seen as an *information bookkeeping ontology*: it keeps track of what has become actual. For instance, consider a simple event like the decay of a particle, which is inherently probabilistic. Before decay, there was a real possibility that at time t the particle would decay (and alternatively, a possibility it would not, or would decay later). Until t, these outcomes were not yet decided – they were part of reality as an open set of possibilities encoded in the quantum state. At time t (the moment of decay), one outcome becomes present: say the particle decays and emits a photon. That outcome *enters existence* and thus enters reality fully. The other possibility (no decay at t) ceases to be a live possibility (it is now counterfactual and no longer part of reality's structure except perhaps as a record of "what could have been" in the past state). After t, reality now contains the fact that a photon was emitted (which may be recorded in various traces), and the world's informational state has been updated. In ER, this is not merely an update of observers' knowledge, but an actual ontological update – reality *did not include that photon before, and now it does*. Such a view dovetails with certain interpretations of quantum mechanics that emphasize the definiteness conferred by measurement or collapse: *the present is when indeterminate potentials resolve into a single actual state*. Some quantum cosmologists and philosophers (e.g. George Ellis, Lee Smolin) have similarly argued that time is real and creative, bringing about new facts that were not previously determined.[21] ER provides a formal metaphysical scaffolding for this: at each "now," the world's reality gains content.

This emphasis on becoming is crucial for reconciling with the **second law of thermodynamics** and the growth of entropy. Entropy can be thought of as missing information (uncertainty about microstates). As entropy increases, one might say the *details* of reality become harder to recover (order is lost), yet the **overall information** in reality (considering all correlations and records) might still be conserved or even increasing when one counts new independent degrees of freedom. ER would say that when entropy increases, it reflects that the present introduces new outcomes (hence

[21] Smolin, Lee & Unger, Roberto Mangabeira (2015). The Singular Universe and the Reality of Time. Cambridge University Press. – An argument for the objective reality of time and a critique of the block universe, from a physicist and philosopher, suggesting that law and state evolve together and time's passage is fundamental.

new information) but often in forms that are dispersed and not easily usable. For example, burning a log increases entropy by turning structured chemical energy into dispersed heat and ash; information-wise, the precise arrangement of molecules in the log is lost to us, but the total information isn't destroyed – it's now in the correlations between myriad particles in the smoke, air, and so on (practically irretrievable, hence "lost" for us, but still existent in principle). ER's distinction helps here: *the fine-grained details might no longer exist for any accessible observation (they're too scrambled to reconstruct, effectively not present), but they remain part of reality's microstructure.* In a sense, reality holds a hidden order that existence does not reveal to us directly. Nowhere is this more dramatic than in black holes: when a black hole swallows a highly ordered object, from the outside all that order seems to be thermalized into a few parameters (mass, charge, spin). Entropy skyrockets, and the information about the object's detailed structure is *hidden*. According to ER, that structure did not cease to be real; it became part of the black hole's internal (or horizon) degrees of freedom, i.e. part of reality inaccessible to existence outside. The *order* is hidden, perhaps maximally so. As the black hole evaporates, that hidden order should in principle re-emerge in subtle correlations among the Hawking quanta. ER would interpret the completion of evaporation as the release of information from reality into new present existents at that later time — not a return of the original object, but the emergence of effects and records that can now be part of existence for observers in that future moment.

Information Paradoxes and the Hidden Order of Reality

By applying ER's lens, we can offer fresh perspectives on longstanding debates such as the black hole information paradox and more generally on how **order and disorder** are understood in cosmology:

- **Conservation of information:** In quantum theory, unitarity demands that information is never destroyed; it can be scrambled but in principle is recoverable. ER naturally accommodates this: because reality is defined by the total causal/informational structure, one cannot simply have chunks of reality disappearing. If something were truly destroyed in the sense of no longer being part of reality *and* leaving no trace, ER would deem it unreal to begin with (similar to how ER dismisses "undetectable objects" as not real). Thus, for ER to remain coherent in a universe with black holes, it must be that black holes *do not* destroy information in the absolute sense. Instead, information might temporarily exit the stage of existence but remain written in reality's ledger. This provides a metaphysical rationale for why physicists have confidence that some resolution (whether via holography, hidden correlations, or new physics) preserves information: reality, as we conceive it, doesn't blink things out of

existence for good. Here ER aligns with the intuition behind black hole complementarity and holography – the information is *somewhere* in reality, even if no single observer can see it all at once.

- **Entropy and hidden order:** The "hidden order of time" in our title refers to the idea that increasing entropy (growing disorder in the observable world) may conceal a deeper order that isn't apparent in the present but exists at the global level. ER's reality can harbor extensive structure that is not manifest to any given observer's existence. For instance, two particles in an entangled state have a joint reality (their quantum correlation) that no single local observation reveals; only by considering them together (or by hindsight after communication) can one see the order (the perfect anti-correlation, say). In time, as entropy grows, the universe's state may become highly entangled and information widely dispersed. From within any local, present perspective, things look random – but the total state may have intricate patterns. ER suggests thinking of reality as *including those holistic patterns*, even if they are beyond the horizon of what exists for an observer here-and-now. Philosophically, this resonates with ideas of a block universe, yet without freezing the dynamics: the patterns can be built up over time. One might say that **reality has an algorithmic or informational compression** that preserves these patterns, whereas each present moment only shows a tiny excerpt. In this way, ER could potentially contribute to understanding why the universe started in a low-entropy (high-order) state and how order flows into disorder: the order is never lost, it just becomes *non-local* (spread across reality's web).
- **Causality and temporal order:** ER maintains a strong sense of causation across time because past events, though no longer existent, remain real and thus can serve as definite causes of present effects. This is how ER solved the truthmaker problem for past-tense statements in its original formulation: by allowing past entities to be real, it provided "truthmakers" for claims about them. In the black hole context, this means even after something falls in (past event), it can still be the real cause of, say, the black hole's increased mass or a particular pattern in the Hawking radiation later. We don't have to invoke mysterious present entities to account for those effects; the past entity itself (now real but not existent) can be the source. The chain of reality is unbroken even if existence flickers on and off for various pieces. This continuity is a kind of hidden order: a conservation law in ontology.
- **ER vs. block vs. informational realism:** It is worth contrasting how ER handles these issues differently. A pure block universe would say all the information is just there in the 4D spacetime – no paradox, but also no mechanism of becoming or resolution needed. Informational realism might say information is always

conserved by definition, but it doesn't highlight the role of the present or how information manifests gradually. ER sits in between: like the block view it posits an underlying continuity of reality (hence it expects consistency and conservation), but like presentism it asserts a special creative role for the present (hence it deals in how information *enters* reality). In doing so, it provides a narrative for how information **flows**: from being merely possible to becoming actual, from being hidden to becoming revealed, and sometimes (in black holes) being *temporarily sequestered* only to reappear in another form.

Finally, let us speculate on a grander picture suggested by ER when combined with holography. If the universe is holographically encoded, one might imagine the ultimate "boundary" that records reality is something like the cosmic horizon or the quantum gravity degrees of freedom of spacetime itself. ER would then imply that this boundary record *grows* with time – much like a growing film reel that is recording the history of the universe. Black holes, which are like sub-horizons, are complications in the record: they segment off portions of the information for a while. But from the godlike view of the universal boundary, perhaps even those portions eventually reintegrate (when black holes evaporate or when one considers the entirety of space including the interior as a part of the hologram). The hidden order of time could then be literal: the boundary might exhibit a pattern or an order that is not obvious from within spacetime, encoding every nuance of the story that unfolds. In this sense, the distinction between existence and reality maps to two "views" of the universe: the interior view where we experience an ephemeral now and incomplete information, and the exterior (or transcendent) view where all information is laid out (but not statically as in a block, rather cumulatively as on a growing sheet). ER doesn't claim we can actually attain the transcendent view – but it allows us to reason *as if* there is a consistent reality that such a view would see, without denying the specialness of the present for those inside.

Conclusion

Cracks in the Projection has attempted to weave together cutting-edge physical theories with a novel metaphysical framework to illuminate the nature of reality, time, and information. We began by examining how black hole physics and the holographic principle challenge our naïve notions of space and reality, suggesting that the universe may fundamentally be an information structure that projects the world of appearances we inhabit. We then surveyed how different philosophies of time – eternalism's block universe, the process of becoming in presentism, and ontologies like informational realism – interpret these discoveries, each capturing part of the truth but missing aspects that others emphasize. Finally, we introduced Existential Realism as a two-tier ontology that distinguishes existence (the present, experienced world) from reality (the

underlying informational cosmos), and we explored how this view can uniquely accommodate the holographic, "projected" universe idea.

In the ER perspective, the present is the ever-moving spotlight that renders reality's information into concrete existence. Black holes in this picture are not just astrophysical curiosities but profound ontological laboratories: they reveal where our normal projection of reality reaches its limits, hinting at a deeper order beyond. By seeing black holes as cracks in the projection, we underscore how they expose the gap between what is real and what is accessible or existent. ER's framework suggests that even if a part of the universe is out of sight (beyond a horizon or in the deep past or far future), it remains part of reality's totality. This helps reframe the information paradox and similar puzzles – not as absolute paradoxes, but as signs that we need to broaden our concept of reality to include the unseen and the not-yet. The hidden order of time, as ER portrays it, is that the world *makes sense as a whole* even if locally we perceive disorder and loss. Every event that *becomes* leaves an imprint in reality's fabric; every bit of information has a place in the accounting, though we may never decode the full ledger.

We emphasize again that the ideas presented here are *highly speculative*. Many strands remain loose. For instance, a full synthesis of ER with a precise holographic model of the universe is beyond our scope – it would require a detailed matching of ER's "reality" to a physical information repository (be it a holographic screen or the quantum state of the universe), and "existence" to something like an emergent classical world or observational slice. Similarly, the treatment of black hole interiors and the fate of information pushes at the boundaries of known physics; our ER interpretation is at best an analogy awaiting a rigorous theory of quantum gravity to confirm or refute it. Nonetheless, by engaging in this interdisciplinary thought experiment, we hope to have shown the *plausible coherence* of the narrative: that one can imagine a cosmos where **black holes, holographic information, and an evolving present** all fit together in a single ontological picture.

In closing, if reality is indeed a projection, then understanding the projector (the hidden mechanisms and structures that produce the world of our experience) becomes a paramount scientific and philosophical task. Existential Realism offers one possible conceptual toolkit for this task. It reminds us that reality might far exceed existence – that much of what is real is not immediately visible in the now, yet is no less important. As we advance in both theoretical physics and metaphysical inquiry, frameworks like ER can help translate between the language of quantum information and the language of human temporal experience. They allow us to ask meaningfully: *Where (and when) are we in the grand scheme of things?* The answers remain elusive, but the questions guide us toward a deeper understanding. The cracks in the projection – those edge-cases like black holes and quantum mysteries – are not flaws to be lamented; they are windows

into the fundamental workings of the universe. By studying them under a dual lens of physics and philosophy, we inch closer to glimpsing the hidden order that underlies time and reality.

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Further Reading: A comprehensive treatment of this framework, with expanded arguments and interdisciplinary case studies, is presented in the monograph *Existential Realism* (2025). It examines applications in classical physics, quantum physics, relativity, and cognitive science, showing how the ontology can address persistent conceptual challenges across these fields. Available at: www.tenz.in/mono