

Black Holes as a Boundary Case for Emergence

An MNO-based Clarification of the Ontological Boundary of
Physical World-Capability

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DOI: 10.5281/zenodo.17974324
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Abstract

Black holes are regarded as paradigmatic boundary objects of modern physics. They simultaneously mark limits of empirical accessibility, theoretical inconsistencies, and metaphysical projection surfaces. In popular as well as speculative discourses, they are frequently interpreted as manifestations of a “nothing,” as cosmic singularities, or even as sources of emergent order.

This paper advances a deliberately countervailing thesis: black holes are not a case of application of emergence, but an extreme case of its failure.

On the basis of the MNO model (Minimal-Non-Object), which understands emergence not as an effect of energy or complexity but as the structural capacity to return into world-capable relation, black holes are analyzed as maximally indimergent systems. Their physical characteristics—event horizon, information paradox, observer-dependence, and the absence of reconstructable interior spaces—can be read consistently as expressions of a fully collapsed world-capability, without introducing new physical postulates.

The contribution does not aim to replace or extend existing astrophysical theories. Instead, it shows that the MNO model enables a conceptual clarification by strictly distinguishing physical conservation, informational coding, and relational accessibility. On this basis, black holes appear not as gateways to an ontological “nothing,” but as boundary markers at which emergence, perspective, and recursive opening come to an end.

In this way, black holes function within this approach as a negative foil for theories of emergence: they sharpen the concept of emergence itself by showing under which structural conditions world-formation is no longer possible.

This paper stands in direct context with:

Speed, T. (2025). MNO and Ontological Recurrence: A Non-Representational Account of Quantum Measurement and Conscious Experience (Version 1). Zenodo.
<https://doi.org/10.5281/zenodo.17913823>

1. Introduction: Black Holes Are Not Another Example

Black holes occupy a special position in contemporary physical and philosophical discourse. They are at once empirically well-substantiated astrophysical objects and theoretical boundary cases in which central assumptions of established models come under pressure. Event horizon, singularity, information paradox, and observer-dependence do not merely mark technical difficulties, but point to structural ruptures in the understanding of space, time, information, and causality.

Precisely because of this boundary position, black holes are frequently overextended. In popular, speculative, and in part also philosophical contexts, they function as projection surfaces for metaphysical meanings: as gateways to “nothing,” as cosmic places of origin, as generators of new realities, or as physical analogies for consciousness. Such interpretations usually share an implicit assumption: that black holes, precisely because of their extremity, constitute a privileged site of emergence.

This paper intervenes at exactly this point—however, with a deliberately countervailing perspective. It argues that black holes are not to be understood as paradigmatic examples of emergence, but as extreme cases in which emergence structurally fails. They are not sites of new world-formation, but markers of where world-capability collapses.

The analysis proposed here is based on the MNO model (Minimal-Non-Object), which understands emergence not as a function of energy, complexity, or scale transitions, but as the structural capacity of a system to return into open, relational world-relations. Emergence, in this sense, is not an effect of intensive dynamics, but a criterion of world-capability: the capacity to sustain perspective, relation, and openness.

Against this background, black holes are not read as ontological manifestations of “nothing,” but as maximally indimergent states. Their well-described physical properties—the causal closure through the event horizon, the inaccessibility of the interior, the reduction of external describability to a few parameters, as well as the problematic status of information—can be interpreted consistently as expressions of a complete condensation without a return path.

The explicit aim of this contribution is not to correct, replace, or supplement existing astrophysical theories by means of an alternative cosmology. Rather, it seeks to show that the MNO model allows for a conceptual sharpening by distinguishing where prevailing discourses tend to conflate levels: between physical conservation, informational coding, and relational accessibility. It is precisely in the case of black holes that it becomes visible that this distinction is not a philosophical add-on, but a necessity for correctly situating apparent paradoxes.

By treating black holes as boundary cases rather than as applications of emergence, they fulfill a precise methodological function in this context: they function as a negative foil. Through them, it becomes possible to show what emergence is not—and, at the same time, under which

structural conditions emergence can become possible at all. In this sense, black holes do not contribute to an expansion of the MNO model, but to its conceptual disciplining.

2. Emergence, Indimergence, and World-Capability (MNO in minimal form)

The concept of emergence is used inconsistently across different disciplines. In physics, it often denotes macroscopic properties that cannot be directly read off from microscopic equations. In systems theory, emergence is frequently associated with self-organization or nonlinearity, while in philosophical contexts, any form of novelty or surprise is sometimes regarded as emergent. This conceptual breadth is productive, but it leads to very different phenomena being subsumed under a single name.

The MNO model proposes a narrower, structurally more precise determination. Emergence is not defined here in terms of energy, complexity, or scale transitions, but in terms of the capacity of a system to return, after a phase of inner condensation, into open, relational world-relations. What is decisive is not that something new arises, but how this newness becomes world-capable.

To describe this dynamic, the MNO model distinguishes three structural phases: submergence, indimergence, and emergence. This triad does not describe a temporal sequence in a trivial sense, but a fundamental order of possible state-forms.

Submergence, in the MNO model, designates a state prior to the formation of object- and relation-structures. It is neither a physical initial state nor a temporal origin, but a structural situation of possibility. It is not an embeddedness within already existing fields, but the pre-relational openness from which such fields can first arise. In a submergent state, structure is present, but not yet located, not yet differentiated, not yet fixed as relation.

This primary submergence is not an emptiness in a negative sense, but a structure-bearing indeterminacy—a precondition for the very emergence of objects, relations, and fields. Only through indimergent condensation do locatable forms arise from this openness, which can then be embedded into relational contexts.

Submergence is therefore not to be equated with stability or order. It is the condition of possibility of order, not its execution.

Indimergence describes a phase of inner condensation. In indimergent states, systems withdraw structurally inward: degrees of freedom are reduced, relations are cut off or folded in, dynamics are concentrated. Indimergence is not necessarily destructive; it can be necessary in order to build up tension, stabilize form, or prepare transitions. It becomes problematic where it no longer possesses a return path.

Emergence, finally, does not merely denote the appearance of new properties, but the return of a system into world-capable relation under altered conditions. An emergent state is characterized by the fact that new structures are not only internally stable, but again possess connectivity: they can be carried, perceived, interpreted, or further developed. Emergence, in this sense, is always relational opening.

For a more precise account of this opening, the MNO model introduces the concept of world-capability. World-capability designates the structural possibility of a system to sustain

perspective, relation, and openness simultaneously. A world-capable system is not necessarily conscious, living, or complex, but it is connectable: it can be part of a shared order without being completely closed off.

This determination has an important consequence: not every intensive dynamic, not every increase in complexity, and not every energy transformation is emergent. Processes can be highly dynamic, eventful, or spectacular without generating world-capability. Conversely, seemingly unspectacular processes can be highly emergent if they stabilize new relational orders.

Within this conceptual apparatus, emergence becomes a clear structural criterion. It is neither mystical nor arbitrary, but bound to a specific condition: the possibility of return from condensation into open relation. It is precisely at this point that the analysis of black holes will take up its work in what follows. They will not be measured by their energy, their gravitation, or their mathematical description, but by the question of whether, and in what form, they carry or interrupt world-capability.

3. What We Actually Know About Black Holes (and What We Do Not)

Black holes belong to the best-confirmed, yet at the same time most theoretically problematic objects of modern physics. Their existence is today well secured by a variety of independent observations: through the dynamics of stars in galactic centers, through gravitational-wave events in the mergers of compact objects, as well as through direct imaging of the accretion environments of supermassive black holes. In this sense, black holes are not hypothetical constructs, but empirically robust phenomena.

At the same time, their theoretical description is marked by fundamental uncertainties. These uncertainties do not primarily concern peripheral details, but the core of central physical concepts such as space, time, information, and observation. Black holes thus do not mark a mere technical challenge, but a structural boundary of the current physical apparatus of description.

A central element of this boundary is the event horizon. It does not constitute a material surface, but a causal separation line: beyond a certain radius, events are in principle no longer accessible to external observers. What is decisive here is that locally nothing singular happens at the event horizon. For a freely falling observer, the transition across the horizon—at least in idealized models—is not distinguished by an immediately perceptible physical event. The radical change does not concern local physics, but the global structure of causality.

The interior of a black hole thus eludes not only empirical measurement, but also consistent theoretical reconstruction. Classical solutions of general relativity lead to singularities at which curvature invariants diverge and the theory loses its own applicability. These singularities are, however, to be understood less as real physical objects than as markers of a model failure. The absence of a consistent description of the interior is not a temporary deficit, but an expression of a deeper incoherence between relativity theory and quantum physics.

Closely linked to this problem is the so-called information paradox. While quantum-mechanical principles suggest that information cannot be lost, it appears, in the complete collapse of matter into a black hole, to disappear irretrievably for external observers. Different approaches to resolution—such as holographic principles, firewalls, or alternative interior structures—attempt to resolve this contradiction, without a generally accepted consensus having been

reached so far. What is noteworthy is that the paradox cannot be reduced solely to computational inconsistencies, but rests on a conceptual tension between conservation, accessibility, and observer-dependence.

Another frequent source of misunderstanding concerns the so-called jets of black holes. These highly energetic outflows are occasionally interpreted as expressions of inner dynamics or even as indications of an active interior. In fact, however, jets arise outside the event horizon, in the interplay of accretion disk, magnetic fields, and rotation. They provide no information about the state of the interior, but are boundary phenomena of an extreme gravitational environment.

In summary, it can be stated that black holes are physically well-defined objects with clearly describable external properties, yet at the same time sites of fundamental theoretical uncertainty. This uncertainty concerns less the question of whether black holes exist than what their interior means ontologically and how concepts such as information, observation, and causality are to be understood under extreme conditions. It is precisely at this point that the following analysis takes up its task—not with the claim of physically resolving these open questions, but in order to clarify which structural assumptions underlie them.

4. Black Holes as Maximally Indimergent Systems

From the physical starting point outlined in the previous section, a structural characterization of black holes can be derived that dispenses with additional assumptions. If black holes are considered not primarily as exotic objects, but as states of extreme condensation, their central property appears less as a “hole” than as a complete closure: causal, informational, and perspectival.

Within the framework of the MNO model, black holes can be described as maximally indimergent systems. Indimergence here does not simply denote high density or strong gravitation, but the structural withdrawal of all relational degrees of freedom into an enclosed interior state. The decisive feature of an indimergent system is not its intensity, but the absence of a return path into open relation.

Black holes fulfill this criterion in extreme form. With the event horizon, a boundary is established beyond which no interaction returns into the shared world-context. This boundary is not to be understood as a local wall, but as a structural severing of world-capability. The world, understood as a relational nexus of perspectives, does not end in the interior of the black hole, but at the impossibility of maintaining this nexus.

Particularly instructive in this context is the reduction of the external describability of black holes to a few parameters. Regardless of the diversity of the collapsed matter, black holes can be characterized by mass, angular momentum, and charge. This drastic simplification is not merely a computational result, but an expression of a far-reaching relational impoverishment. Different internal structures become indistinguishable from the perspective of the world because no relational degrees of freedom remain that could carry these differences.

What is crucial here is the clear distinction from the primary submergence of the MNO model. Black holes do not constitute a return to a pre-objective structure of possibility. They are not to be identified with the Minimal-Non-Object and are not to be understood as a productive void. Rather, they are states in which indimergent condensation fully dominates and all structural openness is suspended. The “interior” of a black hole is therefore not ontologically open, but structurally exhausted. Primary submergence is open because it precedes structural

determination; maximal indimergence is exhausted because all difference has already collapsed.

This reading makes it possible to avoid common misunderstandings. Neither the singularity nor the event horizon marks a site of creative emergence. They rather designate the point at which emergence becomes impossible, because no relation returns that could carry a new world. The dynamics of black holes are, in this sense, intensive but unfruitful: they produce events, radiation, and energy dissipation, but no new viable orders.

The characterization of black holes as maximally indimergent systems thus shifts the focus of the analysis. Instead of searching for hidden internal structures or transformative potentials, it becomes clear that their theoretical significance lies precisely in negation. Black holes are not the source of new world-formation, but the boundary at which world-capability collapses. In this negative function, they become analytically fruitful for the MNO model: they mark the point at which the triad of submergence, indimergence, and emergence becomes asymmetric and the return into open relation is structurally excluded.

5. Why Black Holes Cannot Carry Emergence

The preceding analysis now permits an explicit application of the emergence criterion of the MNO model to black holes. What is decisive here is not whether black holes are dynamic, energy-rich, or powerful in their effects, but whether they fulfill the structural condition of emergence: the possibility of returning, after indimergent condensation, into open, relational world-relations.

Precisely this possibility is systematically excluded in the case of black holes. With the crossing of the event horizon, every feedback into the shared world-context comes to an end. Regardless of which physical processes may take place in the interior, the structural precondition for the emergence of new world-capable orders is lacking. Emergence does not merely presuppose change, but connectivity. Where no relation returns, no new world can arise. The term “maximally indimergent” does not designate an extreme value on a scale of physical condensation, but a categorial transition in which relational feedback is in principle excluded.

In this context, the extreme gravitation of black holes must also be read anew. Although gravitation is often understood in everyday language as a form of “attraction,” it does not constitute relation in an ontological sense. Gravitation is not reciprocal openness, but a structural curvature that determines motion without enabling response. This distinction is meant conceptually, not physically; it does not aim at a redefinition of gravitation, but at a clarification of its ontological status in the context of emergence. The maximal gravitation of black holes is therefore not an expression of intensified relation, but the result of its complete loss. Where relational openness collapses, pure structural motion remains. The strength of gravitation thus marks not proximity, but the end of world-capability.

This diagnosis is not relativized by the fact that black holes exert significant effects on their surroundings. Accretion processes, radiation, and in particular relativistic jets show that black holes are not passive endpoints. They influence their cosmic environment in massive ways. Precisely here, however, a conceptual distinction is required that is frequently neglected in emergence discourse: the distinction between effect and emergence.

Jets of black holes arise outside the event horizon, in the interplay of accretion disk, magnetic fields, and rotation. They transport energy, particles, and under certain circumstances complex

molecules into interstellar space. In astrophysics, it is therefore occasionally discussed whether such processes could contribute to the distribution of the chemical building blocks from which biological complexity may develop under suitable conditions. These hypotheses concern transport, excitation, and catalysis—but not emergence in the strict sense.

From an MNO perspective, jets are vectors, not carriers of emergence. They possess no recursive openness of their own, no binding to spaces of possibility, and no capacity to stabilize new relational interiors. Their effect is one-sidedly directed outward and fully dependent on the open systems they encounter. Should new orders arise in such downstream environments, emergence takes place there—not in the black hole and not in the jet itself.

It is precisely this boundary effect that confirms the characterization of black holes as maximally indimergent systems. Because no emergence is possible in the interior, tension is discharged at the boundary. Energy, matter, and momentum are released without giving rise to a new world-capable structure. The dynamics of black holes are, in this sense, intensive but structurally unfruitful. They generate events, not worlds.

This also makes visible a widespread misinterpretation. The idea that black holes could function as cosmic creators rests on an equation of intensity with productivity. The MNO model explicitly contradicts this equation. Emergence is not a measure of strength or reach, but of relational return-capability. Where this is absent, even the greatest effect remains external.

Black holes therefore do not carry emergence, even if they influence conditions under which emergence may become possible elsewhere. They are not sources of new world-formation, but generators of extreme boundary conditions. Their theoretical significance does not lie in a hidden creative potential, but in the clarity with which they show that emergence is bound to structural preconditions that are suspended by maximal indimergence.

6. Rereading the Information Problem: Conservation versus Relational Capability

The so-called information paradox of black holes is regarded as one of the most persistent problems in modern theoretical physics. In its classical form, it arises from the tension between two basic assumptions: the quantum-mechanical requirement that information must in principle be conserved, and the apparent inaccessibility of all information that disappears beyond the event horizon of a black hole. The conflict is often formulated as if physics were faced with the alternative of either relinquishing information or revising central principles of quantum mechanics.

What is striking, however, is that this formulation already contains a conceptual reduction. It tacitly assumes that information is a unitary quantity whose conservation and accessibility coincide. Precisely at this point, the MNO model allows for a clarifying distinction that alters the character of the paradox without anticipating a physical solution.

From an MNO perspective, a strict distinction must be made between the formal conservation of information and the relational capability of information. Formal conservation refers to the principled continued existence of state differences within a physical system, regardless of whether these differences remain accessible, reconstructable, or meaning-bearing. Relational capability, by contrast, describes the possibility that information is embedded in a world-capable context: that it can be read, interpreted, transmitted, or integrated into new orders.

The information paradox arises when these two levels are conflated. From the fact that information is no longer accessible to external observers, its ontological loss is hastily inferred. Conversely, from the formal requirement of its conservation it is derived that it must in some form continue to be world-effective. Both conclusions presuppose that conservation and world-capability are identical—an assumption that the MNO model explicitly rejects.

Against this background, black holes can be understood as systems in which information may be formally conserved, while its relational capability has fully collapsed. With the event horizon, not necessarily the existence of state differences comes to an end, but rather the possibility of introducing these differences into a shared world-context. Information is not destroyed, but structurally decoupled. It remains without relational perspectival capability.

This reading shifts the weight of the problem. The central riddle is no longer where the information is located or how it is encoded, but for whom it can still carry meaning. The paradox concerns less the ontology of information than its relation to the world. In a maximally indimergent system, this relation is suspended, without this necessarily resulting in a physical contradiction.

It is important to note that this shift does not constitute a physical solution in the narrow sense. It replaces neither holographic approaches nor quantum-gravitational models. Its contribution lies at the conceptual level: it makes visible that part of the paradoxical intensification results from an insufficient separation of ontological levels. By separating formal conservation from relational world-capability, the MNO model renders the information problem legible as a boundary phenomenon of world-relation.

In this sense, black holes appear not as places where information “disappears,” but as systems in which information loses its world. This formulation is not a rhetorical intensification, but a structural diagnosis. It makes intelligible why attempts to resolve the information paradox solely through recoding, relocation, or mirroring of information repeatedly encounter limits: they address the question of conservation, not that of relation.

This once again confirms the function of black holes as a negative foil for emergence. Where information is no longer world-capable, no emergent order can arise. Black holes are not theoretically challenging because they contain too much information, but because they show that information without relation becomes ontologically empty.

7. Black Holes as a Negative Foil for Emergence

The preceding analysis suggests that black holes should be understood not as special cases of emergence, but as systematic counterexamples. It is precisely in this negative function that they gain theoretical significance beyond astrophysics. By showing under which conditions emergence becomes structurally impossible, they sharpen the concept of emergence itself.

Emergence, as determined in the MNO model, presupposes the capacity of a system to return, after phases of condensation, into open, relational world-relations. It requires not only dynamics, but recursive connectivity. Black holes mark the point at which this capacity is definitively suspended. They are not transitions, but end states with regard to world-capability.

This diagnosis allows for a precise distinction from other domains in which emergence is in fact observable. In biological systems, for example, condensation does not lead to closure, but to new differentiation. Morphogenetic processes build up tension without severing relation; on the

contrary, they stabilize new interiors precisely through their embedding in open field-relations. Emergence here is not an effect of maximal control, but the result of sustained openness.

The same applies to cognitive and social systems. Consciousness, learning, or collective organization do not arise through enclosure, but through the capacity to maintain difference while at the same time enabling relational integration. Systems that close themselves completely inward lose this capacity. They can be highly active, respond and exert effects, without bringing forth a new world. In this sense, black holes share a structural logic with other maximally indimergent systems, even though their physical manifestation is unique.

The negative foil of black holes thus helps to avoid a widespread confusion: the equation of intensity with productivity. High energy, strong effects, or great reach are not sufficient conditions for emergence. What is decisive is whether a system can stabilize new relational orders. Black holes negate this question in a radical way.

It is precisely this negation that makes them epistemically fruitful for a theory of emergence. They show that emergence is not a universal property of complex systems, but remains bound to specific structural preconditions. Where these preconditions fall away, there remains effect without world, dynamics without perspective, and information without relation.

In this sense, black holes do not function within the framework of the MNO model as cosmic special cases, but as boundary markers. They mark the point at which the triad of submergence, indimergence, and emergence becomes asymmetric: indimergence dominates, submergence is no longer reachable, and emergence remains structurally excluded. This asymmetry is not pathological, but instructive. It allows emergence to be determined precisely through its absence, rather than being positively hypostatized.

At the same time, this opens the view toward other fields. Wherever systems operate under maximal enclosure—whether technical, institutional, or algorithmic—it can be asked whether emergence actually takes place or is merely simulated. Black holes provide no analogy in a superficial sense, but a boundary measure. They show how far indimergence can be driven without a new world emerging.

In this sense, the analysis of black holes does not permit the transfer of physical models to other systems, but it does permit the transfer of a structural criterion: the question of whether a return into world-capable relation is possible or structurally blocked.

8. Conclusion: What This Paper Does—and What It Does Not Do

This paper has not pursued the aim of making new astrophysical claims about black holes. It neither replaces established theories of general relativity or quantum physics, nor does it offer alternative models of accretion, jets, or interior dynamics. Nor is it claimed that the MNO model solves physical problems such as the information paradox in a technical sense. Such an objective would exceed the scope of the approach presented here.

Instead, the aim has been a conceptual clarification. Black holes were examined as boundary objects at which it becomes visible where prevailing concepts of emergence run up against their structural limits. Through the application of the MNO model, it could be shown that many of the paradoxes associated with black holes result less from physical inconsistencies than from a conflation of ontological levels—in particular, the equation of effect with emergence and of formal information conservation with relational world-capability.

The central thesis of this contribution therefore does not claim that black holes embody a new ontological principle, but that they provide a negative criterion. They mark the point at which emergence becomes structurally impossible, because maximal indimergence excludes any return into open relation. In this sense, black holes function not as sources of new world-formation, but as boundary markers of failed world-capability.

It is precisely this negative function that renders them epistemically fruitful for the MNO model. By showing what emergence is not, the concept of emergence itself is sharpened. Emergence no longer appears as unspecific novelty or as a by-product of high energy, but as a strictly relational category: the capacity of a system to re-enter a shared world-context after condensation.

Beyond astrophysics, this clarification opens connections to other fields without black holes being misconstrued as analogies or explanatory models. Wherever systems operate under maximal enclosure—technical, institutional, or algorithmic—it can be asked with similar conceptual care whether emergence actually takes place or is merely simulated. Black holes provide no measure of magnitude here, but a measure of boundary.

In this way, the paper makes a double contribution: it disciplines the application of the MNO model by clearly delimiting its scope, and at the same time sharpens its profile as a theory of the boundaries of emergence. Within this framework, black holes appear neither as cosmic metaphors nor as ontological origins, but as precise markers of where world ends because relational relation ends.

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Black Holes, Event Horizon, Information Problem

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