Structural Indifference and the Coherence Operator

Beyond QFT, SR, and GR: Ontology of Physical Realization

Alexey A. Nekludoff

AstraVerge Research

E-mail: an@astraverge.org
ORCID: 0009-0002-7724-5762

19 January 2026

Abstract

Contemporary physical theories precisely constrain admissible states, relations, and transitions, yet remain largely silent on what it means for a particular admissible configuration to be physically realized as a fact. This paper argues that this silence reflects a missing ontological layer rather than a dynamical or epistemic deficiency. We introduce two complementary notions: *structural indifference*, the principle that physical structure distinguishes roles but not individual carriers, and the *coherence operator*, which enforces relational compatibility among admissible realizations without fixing absolute parameter values. Together, these notions explain observable universality without requiring global uniformity of laws or constants, and clarify the status of realization beneath quantum field theory, special relativity, and general relativity.

Contents

1 Introduction

Despite their empirical adequacy, contemporary physical theories share a common structural limitation: they rigorously constrain admissible states, relations, and transitions, while remaining largely silent on what it means for a particular admissible configuration to be *physically realized* as a fact.

In classical mechanics, this silence is mostly unproblematic. A system is represented as a point in phase space, and—at least in principle— its evolution is uniquely determined by initial conditions and applied forces. Environmental influences appear as additional, identifiable terms in the equations of motion, preserving a closed ontological picture: given sufficient information, the future trajectory of the system is fixed. In this regime, admissibility and realization effectively coincide.

Quantum mechanics departs from this picture in a fundamental way. While it precisely specifies allowed transitions, selection rules, and relative amplitudes, it does not provide a closed account of how admissible possibilities become realized physical facts. Coupling to an environment alters not merely parameters of evolution, but the very status of prediction: amplitudes do not directly yield events. Instead, realization is mediated through processes—decoherence, effective classicality, outcome fixation—that are not derivable as intrinsic consequences of the formalism itself. As a result, quantum theory remains ontologically open at the level of realization, even when dynamically complete at the level of admissibility.

Standard responses to this gap typically invoke probabilistic interpretation, measurement postulates, or epistemic restrictions on ontology. Such approaches, however, displace rather than resolve the underlying issue. The problem is not one of probability, observation, or knowledge, but of *ontological underspecification*: contemporary physics lacks an explicit account of how admissible structures become coherent, realized configurations without invoking fixed individual identity or global determinism.

This paper argues that modern physics implicitly relies on two unarticulated ontological ingredients.

The first is *structural indifference*: the principle according to which physical structure distinguishes roles, relations, and invariants, but does not distinguish individual carriers of those roles. Physical reality is indifferent to *which* particular entity realizes a role, provided the role itself is realized compatibly within the structure. Individual identity, unless explicitly fixed by structural constraints, is not part of physical ontology.

Structural indifference is not a dynamical law, not a stochastic postulate, and not an epistemic limitation. It is a precondition for the existence of scalable, non-degenerate physical structure. Without it, physical law would collapse into rigid identity fixation, enforcing global determinism and prohibiting the emergence of complex organization.

The second ingredient, introduced explicitly in this work, is the *coherence operator*. While structural indifference removes the requirement of fixed individual identity, it does not by itself explain why admissible parameter assignments appear mutually adjusted rather than independently varying. The coherence operator enforces *relational compatibility* among roles: it does not fix absolute parameter values, but ensures that all realized parameters are jointly consistent within a given structural regime.

Under the action of the coherence operator, admissible realizations form equivalence classes rather than isolated points in parameter space. Variations in absolute values—such as charges, masses, or coupling strengths— are permitted, provided that all conjugate roles scale coherently. As a result, observable structures retain identical relational patterns even when absolute parameter values differ between regions. What is preserved is not numerical identity, but structural coherence.

Together, structural indifference and the coherence operator explain why physical laws appear universally applicable across regions—for example, between Earth and Moon—without requiring global uniformity of underlying parameters. Observable universality arises from *translatability between coherent regimes*, not from strict identity of laws or constants.

The framework developed here does not modify existing physical theories, introduce new forces, or appeal to probabilistic selection. Instead, it articulates an ontological layer beneath quantum field theory, special relativity, and general relativity: an account of physical realization that explains why admissible structures become facts, why identity fixation is unnecessary, and why local variation need not destroy global coherence.

2 Roles, Carriers, and Identity Non-Fixation

A central assumption implicit in most physical theories is that the objects appearing in their formalism possess well-defined properties, while their individual identity plays no essential role. In practice, however, this assumption is stronger than typically acknowledged: physical description not only neglects individual identity, but actively *refuses to fix it* unless compelled by explicit structural constraints.

This distinction between *roles* and *carriers* is fundamental. A role is defined by a position within a relational structure: a set of constraints, interactions, and invariants that determine how something may participate in physical processes. A carrier is whatever entity happens to realize that role in a given configuration. Physical theories are formulated almost exclusively at the level of roles, while remaining indifferent to the identity of carriers.

This indifference is most clearly visible in quantum theory. Elementary particles of the same type are not merely similar; they are formally indistinguishable. Permutation of identical particles does not generate new physical states, and no observable corresponds to persistent individual identity. However, this feature is often treated as a peculiarity of quantum statistics rather than as an ontological statement. We argue that it reflects a deeper principle: individual identity is not a primitive of physical reality.

The same structure appears, less explicitly, in classical descriptions. A classical field configuration assigns values to spacetime points, yet the theory does not track the identity of infinitesimal field elements over time. What matters is the evolving configuration, not which specific element occupies a given position. Similarly, in thermodynamics and statistical mechanics, macrostates are defined by relations among extensive quantities, not by the identities of constituent particles. The apparent persistence of identity in classical mechanics is a limiting artifact of deterministic trajectories, not an ontological commitment.

Identity fixation becomes problematic when considered as a fundamental requirement. If individual carriers were globally fixed to roles—for example, if a specific electron were permanently bound to a specific proton—the resulting combinatorial rigidity would severely constrain the space of admissible configurations. Complex structures such as atoms, molecules, and extended matter would either fail to form or become dynamically fragile. Scalability would be lost.

Structural indifference removes this rigidity. By declining to fix individual identity, physical structure allows roles to be realized by any compatible carrier. This does not introduce arbitrariness or randomness. On the contrary, it enables stability by preventing overconstraint. What is fixed are relations; what is left unfixed are the labels of realization.

An instructive analogy is architectural rather than physical. A brick used in construction is defined by its dimensions, material properties, and compatibility with surrounding elements. Its position within a wall is fixed by structure, but its origin, serial number, or prior location are irrelevant. The wall remains stable precisely because the structure does not distinguish between interchangeable carriers. Physical realization operates in an analogous manner.

It is crucial to emphasize that identity non-fixation does not imply that *anything* can realize a role. Compatibility is strict. Only carriers satisfying the relational constraints of the role are admissible. Structural indifference therefore acts in concert with structural constraint: it removes unnecessary distinctions while preserving rigorous admissibility.

This distinction clarifies a recurring confusion in discussions of determinism. Determinism is often taken to imply identity preservation along trajectories. However, determinism concerns the evolution of structure, not the persistence of individual carriers. Once identity fixation is abandoned, determinism no longer requires that the same carrier occupy the same role across time, only that the structure itself evolves consistently.

The ontology suggested here replaces object-centered persistence with structure-centered continuity. Physical reality is not a collection of enduring individuals, but a succession of coherent structural realizations. Carriers appear only as momentary realizations of roles, without ontological priority beyond their compatibility with the structure they realize.

This shift prepares the ground for the introduction of the coherence operator in the next section. Structural indifference explains why individual identity need not be fixed; the coherence operator explains how compatible realizations are jointly selected so that physical structure remains stable despite the absence of identity fixation.

3 The Principle of Structural Indifference

We now state the principle explicitly.

Principle (Structural Indifference). *Physical structure distinguishes roles and invariants, but is indifferent to the individual identity of the carriers realizing those roles.*

Several clarifications are essential.

First, structural indifference does not imply randomness or stochasticity. The absence of fixed individual identity does not entail indeterminate or lawless behavior. Structural evolution may remain fully constrained and predictable at the level of relations, even when individual carriers are not tracked or preserved.

Second, structural indifference does not deny the occurrence of events or physical facts. Events occur, facts are realized, and physical records are produced. What is excluded is not factuality, but the assumption that a fact must be tied to a uniquely identifiable individual carrier.

Third, structural indifference does not assert ignorance or epistemic limitation. It is not a statement about what observers fail to know, but about what physical ontology does not require. Unless explicitly fixed by structural constraints, individual identity is simply not a physical primitive.

Structural indifference therefore asserts a precise ontological claim: individual carriers do not belong to the fundamental description of physical reality unless their identity is enforced by the structure itself. The question "which specific carrier realized this role?" is, in general, not a physical question. What matters is that the role was realized compatibly within the structure.

—

4 Degrees of Indifference

Structural indifference need not be absolute. We introduce a parameter

$$P \in [0, 1],$$

interpreted as the *degree of identity fixation* within a given physical regime.

At one extreme,

$$P = 0$$

corresponds to complete fixation of individual identity. In this limit, carriers are rigidly bound to roles, and realization coincides with deterministic persistence. Classical point-particle mechanics, interpreted literally, approximates this regime.

At the opposite extreme,

$$P = 1$$

corresponds to complete indifference to individual carriers. Roles may be realized by any compatible carrier without preference or memory. Quantum systems of identical particles provide the clearest example of this limit.

Intermediate values,

$$0 < P < 1,$$

describe partial fixation. In such regimes, realization is constrained but not unique: identity may be locally stabilized, correlated, or effectively persistent without being fundamental. Most realistic physical systems are expected to operate within this intermediate range.

Crucially, the parameter P need not be globally uniform. Variations in P correspond to variations in how strictly physical structure constrains realization. This provides a unified language for discussing environments in which realization becomes more or less selective, without modifying the underlying dynamical equations.

In experimental practice, what is referred to as a "photon" is not a directly observed physical object endowed with intrinsic identity. Rather, it is a name assigned to a registered excitation of an electromagnetic signal recorded by a detector. The formal role of the photon is fixed by the structure of the interaction and the detection process; the identity of the carrier realizing that role is not accessible and not required. This illustrates, at the operational level, how high degrees of structural indifference coexist with precise and reproducible physical facts.

5 The Coherence Operator

Structural indifference explains why individual identity need not be fixed in physical ontology. However, indifference alone does not explain why realized physical structures exhibit stable, mutually adjusted parameter relations rather than incoherent or degenerate combinations. If individual carriers and absolute parameter values are left unfixed, some additional condition is required to account for the observed internal consistency of realized physical regimes.

We introduce the *coherence operator* to address this requirement.

Definition (Coherence Operator). *The coherence operator enforces relational compatibility among admissible roles, ensuring that all parameters realized within a given physical regime are jointly consistent, without fixing their absolute values.*

The coherence operator is not a dynamical law and does not generate time evolution. It does not act on states in phase space or Hilbert space. Rather, it operates at the ontological level of realization, mapping admissible assignments of roles and parameters to equivalence classes of mutually coherent realizations. What is selected is not a unique point in parameter space, but a coherent structure defined up to relational equivalence.

Under the action of the coherence operator, admissible realizations are not independently variable. Parameters associated with conjugate roles—such as charges of interacting particles, coupling strengths, or characteristic scales—cannot vary arbitrarily relative to one another. Any realized variation must occur as a correlated transformation that preserves structural compatibility. In this sense, the coherence operator constrains *relations*, not *values*.

This perspective reframes the status of so-called fundamental constants. Absolute numerical values acquire no ontological priority. What matters are dimensionless relations and structural patterns preserved under coherent rescaling. Different regions of the universe may therefore realize different absolute parameter values while exhibiting identical observable structures. Observable universality reflects coherence of relations, not identity of numbers.

The coherence operator acts locally. It does not enforce global uniformity across all regions of spacetime. Instead, it guarantees that any region capable of sustaining stable physical structures realizes parameters in a mutually compatible manner. Regions governed by incompatible assignments do not fail dynamically; rather, they fail ontologically to constitute coherent regimes. Such regions need not be prohibited; they are simply non-realizable as stable physical structures.

This distinction clarifies why observational comparison between distant regions is possible. When spectra, interaction patterns, or physical processes appear identical across regions—for example, between Earth and Moon—this does not require identity of underlying parameters. It requires only that both regions belong to the same coherence class, allowing their realizations to be mutually translatable. Observable agreement is therefore a consequence of shared coherence, not of globally fixed laws.

The coherence operator operates independently of the degree of identity fixation. For $P = 0$, coherence is trivial: fixed identity enforces unique realization. For $P = 1$, coherence becomes essential: without identity fixation, only relational compatibility maintains stability. Intermediate regimes combine partial identity stabilization with coherence-based constraint. In all cases, coherence ensures that structural indifference does not devolve into arbitrariness.

It is important to emphasize that the coherence operator does not perform selection in a probabilistic sense. No weighting over alternatives is implied. Incompatible configurations are not assigned low probability; they are simply excluded from realization. The operator therefore introduces no stochastic element and does not compete with probabilistic formalisms used at the level of prediction.

Finally, the coherence operator provides an ontological explanation for the robustness of physical description across changes of scale, environment, and context. Physical laws remain effective not because their parameters are globally fixed, but because any realized physical regime must satisfy coherence constraints. Structural indifference permits variation; the coherence operator ensures consistency.

Together, these two ingredients define an ontological layer beneath quantum field theory, special relativity, and general relativity. They explain how admissible structures become realized facts, why absolute identity fixation is unnecessary, and how local variability can coexist with global translatability.

6 Local Variability and Observable Universality

The combined action of structural indifference and the coherence operator provides a natural account of how local variability of physical parameters can coexist with observable universality. Locality here refers not merely to spatial separation, but to the realization of physical structure within a given coherent regime. Nothing in the preceding analysis requires absolute parameter values to be globally fixed across all regions of spacetime.

Consider two regions that are observationally comparable, such as Earth and Moon. It is logically consistent for absolute values of parameters—for example, the electric charge associated with an electron role or the corresponding proton role—to differ between these regions. What is required for observable agreement is not numerical identity, but coherent scaling enforced by the coherence operator. When conjugate roles are adjusted jointly, all dimensionless relations that govern observable structures remain invariant.

Atomic spectra provide a clear illustration. The observable pattern of spectral lines depends on relational quantities: ratios of energy levels, selection rules, and symmetry constraints. If absolute parameter values vary coherently, the structure of the spectrum remains unchanged. What differs is the local calibration of scales, not the relational pattern displayed on the detector. Consequently, spectra observed on Earth and spectra inferred from lunar or astronomical sources must coincide whenever the corresponding regions belong to the same coherence class.

This explains why observable universality does not imply ontological uniformity. Physical theories are formulated in terms of relational structure precisely because such structure is preserved under coherent variation. The apparent universality of laws reflects the universality of translatability between coherent regimes, not the existence of globally fixed parameters.

Importantly, this account does not assert that all regions of the universe are mutually translatable. Regions governed by incompatible coherence constraints may exist without being observable or comparable from within a given regime. The scope of empirical universality is therefore limited by the reach of coherence, not by an assumption of global sameness.

Observable agreement is thus a conditional fact: where comparison is possible, coherence must already be present. Universality is an emergent feature of shared coherence, not a primitive property of physical law.

7 Why Quantum Mechanics Is Ontologically Incomplete

Quantum mechanics specifies with great precision:

- allowed transitions,
- selection rules,
- relative amplitudes.

What it does not specify is how admissible possibilities become realized physical facts. Relative amplitudes are not identical to realized frequencies, nor are they invariant under changes in global structure. Environmental coupling, gravitational context, and background field configurations alter which admissible transitions become physically manifest, even when the formal structure of the theory remains unchanged.

This discrepancy is often addressed through probabilistic interpretation, decoherence theory, or appeals to measurement. However, such approaches presuppose what they aim to explain: the existence of realized events. They modify the predictive apparatus without supplying an ontological account of realization itself.

The point is not that quantum mechanics fails as a calculational framework. On the contrary, its success at constraining admissibility is undisputed. The limitation is ontological rather than formal. Quantum mechanics describes *what may occur*, not *what becomes a fact*.

From the present perspective, this gap is neither accidental nor pathological. It reflects the absence of an explicit account of identity non-fixation and relational coherence. Structural indifference removes the requirement that realized events be tied to persistent individual carriers. The coherence operator ensures that admissible roles are realized only in mutually compatible configurations. Together, they supply what quantum mechanics leaves implicit, without introducing new dynamics, stochastic postulates, or modifications of the formalism.

Quantum mechanics is therefore not incomplete in its domain of applicability, but ontologically incomplete with respect to realization. It presupposes the conditions under which admissible structures become facts, without articulating them. The framework developed here makes those presuppositions explicit.

8 Structural Modulation and Gravity

Unlike local interactions, gravity is global, non-screenable, and structurally organizing. It does not merely act on objects; it organizes the conditions under which objects and processes persist. Gravity establishes hierarchies of time, stability, accumulation, and durability across scales, providing a global structural background rather than a local dynamical influence.

We propose that gravity acts as a *primary modulator of structural indifference*, shaping the large-scale distribution and directionality of identity fixation across spacetime. In the language introduced earlier, gravity modulates the effective value of the parameter P at the global level, influencing how strictly realization is constrained without enforcing fixed individual identity.

At substantially smaller scales, including quantum and mesoscopic regimes, other known interactions may also participate in modulating realization. Electromagnetic, weak, and strong interactions can locally influence stability, coupling, and persistence of structures, thereby contributing to the effective degree of identity fixation in specific contexts. Such contributions, however, remain intrinsically local and do not impose global coherence or directionality across spacetime.

This distinction is crucial. While multiple interactions may affect realization at small scales, gravity is unique in setting the global structural conditions under which coherent regimes form, persist, and accumulate. It is in this sense that gravity provides the dominant large-scale orientation of structural indifference, rather than acting as an additional force among others.

This proposal does not imply that quantum laws differ between locations. The formal admissibility structure of quantum mechanics remains unchanged. What differs are the regimes of realization. Formal spectra may coincide, selection rules may remain intact, and relational patterns may be preserved, while realized physical facts differ in stability, frequency, and persistence.

In regions where gravitational structure enforces strong accumulation and temporal ordering, realization may become more selective and persistent. In regions where such structure is weaker or differently organized, realization may remain transient or diffuse. These differences do not reflect violations of quantum theory, but variations in the conditions under which admissible possibilities become realized facts.

Gravity, on this view, does not compete with quantum mechanics. It operates at a different ontological level. Quantum mechanics constrains admissibility; gravity shapes the structural context in which realization occurs. Their apparent tension arises only when realization is implicitly assumed to be governed by quantum formalism alone.

Structural modulation by gravity thus provides a natural bridge between quantum admissibility and macroscopic stability. It explains how identical formal structures can yield different realized outcomes across regions, without invoking new forces, hidden variables, or context-dependent laws.

9 Implications Beyond QFT, SR, and GR

The framework developed here is not a modification of quantum field theory, special relativity, or general relativity. Rather, it articulates an ontological layer beneath these theories, clarifying what their formalisms presuppose but do not state explicitly.

Quantum field theory constrains admissible excitations, interactions, and symmetries. Special relativity constrains admissible spacetime relations and causal structure. General relativity constrains admissible geometric configurations of spacetime itself. All three theories operate at the level of admissibility: they delimit what may occur, given a chosen formal framework.

What they do not specify is how admissible structures become physically realized as facts. They do not determine whether individual identity must be fixed, nor do they explain why realized parameter values appear mutually adjusted rather than arbitrary. These questions lie outside the scope of dynamical law.

Structural indifference resolves the first omission by removing individual identity from fundamental ontology unless enforced by structure. The coherence operator resolves the second by enforcing relational compatibility among realized roles without fixing absolute values. Together, they supply precisely what existing theories omit, without altering their predictive content.

This perspective reframes several longstanding conceptual issues. So-called fine-tuning of constants appears as an artifact of parametrization rather than a property of the world. Anthropic explanations lose their force, as coherence replaces selection. Probabilistic accounts of realization become optional rather than foundational, restricted to predictive practice rather than ontological necessity.

More broadly, the framework suggests that physical laws should be understood as locally valid descriptions of coherent regimes, not as globally imposed rules. Their effectiveness arises from the stability of coherence classes, not from universal numerical identity. This shift does not weaken physical explanation; it strengthens it by removing unnecessary metaphysical commitments.

Finally, the ontology proposed here accommodates the possibility of physical regimes beyond current theoretical reach. Regions with different coherence constraints, different degrees of identity fixation, or different admissibility structures may exist without contradiction. The present framework does not claim completeness. It provides conditions for realization, not a catalogue of all realizable worlds.

By separating admissibility from realization, identity from role, and numerical value from relational structure, structural indifference and the coherence operator clarify what it means for physical description to succeed. They do not replace existing theories. They explain why those theories work at all.

10 Conclusion

This paper has argued that the primary conceptual limitation of contemporary physics is not dynamical, statistical, or epistemic, but ontological. Modern physical theories successfully constrain admissible states and transitions, yet remain silent on the conditions under which admissible structures become realized physical facts.

We have identified two implicit ingredients underlying physical description. Structural indifference removes individual identity from fundamental ontology unless enforced by structure, allowing scalable and non-degenerate realization. The coherence operator enforces relational compatibility among admissible roles, ensuring internal consistency without fixing absolute parameter values.

Together, these notions explain how observable universality can arise without global uniformity of laws or constants. Local variability becomes compatible with stable structure, and identical observational patterns emerge through coherence rather than numerical identity. Quantum mechanics is shown to be complete at the level of admissibility but ontologically incomplete with respect to realization. Gravity, in turn, modulates the conditions of realization without altering quantum formalism.

The framework proposed here does not modify existing theories and introduces no new dynamics or probabilistic postulates. It instead articulates an ontological layer beneath quantum field theory, special relativity, and general relativity, clarifying what it means for physical description to succeed.

Physical laws work not because the universe fixes individual identities or numbers, but because it enforces coherence among roles. Once this is made explicit, the apparent necessity of fine-tuning, anthropic selection, and global determinism dissolves. What remains is a structurally coherent, locally variable, and ontologically economical account of physical realization.